9-2009

"Chiaroscuro" and the Quest for Optimal Resonance

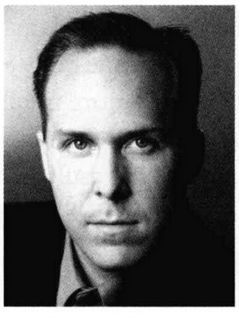
Adam Kirkpatrick
Kennesaw State University, dkirkpa1@kennesaw.edu

Recommended Citation

Kirkpatrick, Adam. ""Chiaroscuro" and the Quest for Optimal Resonance." Journal of Singing - The Official Journal of the National Association of Teachers of Singing 66.1 (2009): 15-21. Print.

Chiaroscuro and the Quest for Optimal Resonance

Adam Kirkpatrick



Adam Kirkpatrick

Journal of Singing, September/October 2009
Volume 66, No. 1, pp. 15–21

DIFFERENT OPINIONS ABOUND CONCERNING what constitutes a beautiful, well resonated tone in the singing voice. While many factors influence one's perception of tone color, let us entertain the notion that there are primarily two opposing extremes in timbre which are easily discerned by the untrained ear: bright and dark. Consider that every sound system has controls for treble and bass. At one end of the spectrum, there are some who prefer booming bass sounds that drown out high frequencies; others may prefer the piercing twang of treble tones. Nevertheless, the most desirable tone quality is found somewhere between the two extremes. Renowned Italian voice teachers like Mancini and Lamperti referred to this balanced timbre in the singing voice as *chiaroscuro*, which is simply a combination of the Italian words bright and dark, or clear and obscure. The aesthetic is simple: singers should strive for a beautiful mix of the two extremes of bright and dark timbre, where the sound has qualities of both tone colors simultaneously—treble and bass, if you will.

When *chiaroscuro* is achieved, the voice has both brilliance and warmth; resonance is optimal for singing purposes, yielding a strong and full tone that can be heard over an orchestra in a large theater. Discovering optimal resonance in singing is difficult because it is a moving target that is affected by changing pitches, vowels, consonants, and dynamics. To further complicate matters for the voice pedagogue who wishes to teach his students to sing with better resonance, the vowel concepts and colors that are optimal for one singer frequently are very different for another singer because of physiological differences and vocal ranges, especially between men and women singers where octave displacement is involved. While many voice pedagogues have written on the subject of resonance in far greater detail than will be attempted in this article, one is hard pressed to find any consensus among them on a practical method for teaching voice students to sing with optimal resonance. The purpose here is to propose a few exercises and approaches to discovering and fostering optimal resonance in the singing voice, building on the concept of *chiaroscuro* and resonance tract tuning.

UNDERSTANDING RESONANCE

What is resonance? At the most basic level resonance is sympathetic vibration, where the effect of the source vibration is magnified by synchronous vibrations. Resonance can occur when a vibrating object touches something solid, as is often the case in mechanical settings, or when the air within a room, tube, cavity, musical instrument, or other enclosure vibrates in sympathy with the vibrator. The latter type of resonance is of primary importance for the singer. The process by which vocal sounds are resonated is complex and affected by such factors as softness/hardness of the walls of the vocal tract and the size of the various resonance chambers of the voice (larynx, pharynx, sinuses, mouth, etc.) in isolation and in relation to one another.[1]

During balanced phonation, the sound produced at the glottal source is rich in overtones (especially in lower male voices)[2] which are whole-number multiples of the fundamental frequency of the vibrating vocal folds.[3] As this spectrum of sound passes through the resonators of the human vocal tract, some frequencies are intensified and enhanced, while others are dampened or filtered out completely.[4] Research has shown that the decibel levels of the voice within the throat and mouth during singing are unbearably loud, but the majority of that sound never escapes the body because of the filtering properties of the resonance tract.[5] "Loudest resonance occurs when the vocal tract has a pitch which resonates a harmonic or fundamental of the sung tone."[6]

When Coffin says the "vocal tract has a pitch," he means that the air inside the vocal tract, when vibrating, will sound at a distinctive pitch level independent of the sung tone. Consider the sound produced when one blows over the opening of an empty Coke bottle. The air moving over the aperture of the bottle causes the air within the enclosure to vibrate, sounding an audible, steady pitch. That sound is the pitch of the resonator, or rather the air within the resonator. Once one has discerned the pitch of the bottle/resonator, if he then matches the pitch with his voice and sings it toward the opening of the bottle, the bottle will vibrate synchronously with voice and add to the perceived loudness of the sung pitch through the power of resonance. The pitch of the human vocal tract, unlike the empty Coke bottle, can be tuned to match the sung pitch, or one of its overtones, by simply moving the articulators. The following discourse is designed to give singers a practical method for discerning the pitch of the vocal tract and understanding its relation to the sung tone, so as to enable the singer to find the optimal resonance for any given pitch on any given vowel.

A bright tone is achieved by tuning the resonance tract of the voice so that overtones of a higher frequency are enhanced, while, simultaneously, lower frequencies that are present in the sound spectrum at the glottal source are dampened or filtered out. Conversely, a dark tone is produced when one manipulates the resonance tract so that lower frequencies are strengthened and emphasized, while, at the same time, higher overtones are filtered out or attenuated. When *chiaroscuro* is achieved, more of the sound is allowed to escape the body and enter the listener's ears. In other words, more frequencies within the sound spectrum are magnified than attenuated, and the voice sounds louder. The resultant tone is stronger, fuller, and richer in color. This type of resonance is optimal for singing purposes, because one is able to sing louder and with less effort.

Chiaroscuro timbre is achieved by singing with the customary "open throat" and lowered larynx associated with good classical singing, while simultaneously matching the overall pitch of the vocal tract to the fundamental frequency of the sung pitch or one of its overtones. This tuning of the vocal tract is primarily accomplished by varying the position of the articulators—jaw, lips, tongue, soft palate, etc.—in other words, changing the shape of the mouth and throat. The vowel often is affected by a change in embouchure because the shape of the mouth that results in the optimally resonated tone is not always natural to the vowel one is trying to sing.

Vowel modification necessarily occurs in *chiaroscuro* singing because of laws of physics. Formant frequencies associated with a given vowel are relatively consistent and based primarily on the pitch of the mouth, independent of the sung pitch.[7] Most vowels have two prominent frequencies in the sound spectrum which, in a sense, "form" the vowel; thus the term "formant" frequencies. An /i/ vowel, for example, has one strong harmonic in the vicinity of 250 Hz, and another around 3,000 Hz.[8] When a soprano therefore attempts to sing a "high C" (fundamental frequency of 1,047 Hz), she already far exceeds the lower formant frequency of /i/ (ca. 250 Hz) and is not very close mathematically to the second formant (ca. 3,000 Hz) either. The resultant sound will not resemble an /i/ vowel, nor will it be optimally resonant. As far as loudest resonance is concerned, the

/a/ vowel is optimally suited for the soprano high C because the formant frequencies of this vowel are both around 1,000 Hz,[9] which means the pitch of the vocal tract will very closely match the fundamental frequency of the sung pitch (1,047 Hz).

Generally speaking, one raises the pitch of the resonance tract by opening the mouth more, raising the tongue, and spreading the lips both vertically and laterally, thus shortening and narrowing the resonance tract. Raising the larynx and narrowing the pharynx will further raise the pitch of the resonance tract, but such constriction is undesirable for singing and can be injurious. To lower the pitch of the vocal tract one enlarges or lengthens it by lowering the larynx, dilating the pharynx, raising the soft palate, lowering/relaxing the tongue, and rounding and extending the lips.

RECOGNIZING OPTIMAL RESONANCE/*CHIAROSCURO*

It is relatively obvious to the spectator and the singer when optimal resonance occurs, but it is not always immediately clear to the singer producing the tone how it was accomplished. Once optimal resonance, or *chiaroscuro*, is achieved, the singer and the audience alike are usually struck by the sudden increase in volume, energy, and beauty. When *chiaroscuro* is achieved, the singer should perceive an increased degree of vibration in the resonators: the larynx, pharynx, sinuses, and mouth primarily; and, to a lesser extent, the chest. It is important for the singer to feel as well as hear when the tone is optimal. "Placement" terminology, which is so common in singing jargon, is used by singers and voice teachers attempting to discuss resonance from a physical or kinesthetic perspective. Aurally, one has the perception that someone has just turned on a microphone when resonance is optimal; the sound has a rich ringing quality and is more intense, while the singer seems to expend relatively little effort in producing the sound. Kinesthetically, however, the singer feels more like his head has just become a speaker; every part of the vocal tract seems to vibrate synchronously with the tone being sung.

Vibrato is another indicator of optimal resonance. As Miller observed, vibrato is deeply connected with our concept of timbre.[10] In fact, when resonance is optimal, vibrato almost always expresses itself, even if no vibrato was present before. The reason for this phenomenon is not very complicated. Resonance cannot be optimal unless phonation is balanced and of an intensity level that will produce a sound rich in overtones that can be resonated. If the source sound is aspirate and weak, no amount of resonance tuning will result in the desired *chiaroscuro* tone. Balanced phonation and breath support are essential ingredients in the *chiaroscuro* tone. Vibrato is quite naturally present when phonation and breath support are balanced, so it is not surprising that vibrato is present during *chiaroscuro* singing. Breath support is variable and affected by such factors as vowels, consonants, registration of the voice, dynamics, and pitches being sung.[11]

Like breath support, optimal resonance is mercurial and changes in relation to pitch, vowels, consonants, registration, and dynamics (inasmuch as a pitch sung softly or in head voice will have fewer overtones).[12] If a tenor sings a beautifully resonated /i/ on middle C (C_4), he may feel inclined to say: "I have a great /i/ vowel!" After all, the fundamental frequency of C_4 is 262 cycles per second, placing it right in the vicinity of the first formant of the /i/ vowel (ca. 250 Hz). This means that if the singer's concept of /i/ is in line with the standards of what most people discern as /i/, his vocal tract is almost automatically tuned to magnify the fundamental frequency and resonate. However, change the pitch on which the /i/ is sung to a A_4 (440 Hz), without retuning the resonators/reshaping the mouth, and the same /i/ vowel that was great on C_4 sounds much less resonant and probably quite strained at the higher pitch level. The nearest vowel to /i/ that will result in *chiaroscuro* or loudest resonance on a tenor "high A" is in the vicinity of /I/ or /e/, where the first formant of the vowel is closer to 440 Hz.[13] Since the target moves continually, it is difficult for the singer to hit the mark every time. It is important, therefore, that the singer have a method or process that will help him/her to discover the optimal resonance on any spectrum of vowels and pitches.

The quest for a methodic approach to teaching resonance has led some voice teachers to use spectrographic technology and sophisticated computer software that analyzes vocal sounds and gives immediate visual feedback to the singer. The singer learns by watching the spectrograph to track particular resonance factors that contribute to a *chiaroscuro* tone. It is important to note that the use of voice analysis software, while it may help students visually recognize when optimal resonance has occurred, does not really provide a method for discovering optimal resonance in the singing voice. After all, one could continue to sing poorly resonated tones while watching the computer screen graphically depict the failure to achieve optimal resonance.

So how does one teach resonance? The process is one of discovery that involves exploration and experimentation. It necessitates some degree of vowel modification, much to the chagrin of many voice teachers. Furthermore, one cannot assume a rigid embouchure or jaw position; the articulators must be allowed to move freely from one posture to another to tune the resonance tract. For the most part, we know what we are looking for, a tone that is brilliant and warm at the same time, robust but not pushed, easy, beautiful, energized, and vibrant. However, before a universal method that accomplishes all this can be developed, there is a fundamental question that must be answered: How do I tune my resonance tract to match an overtone or the fundamental of the sung pitch?

Coffin was a proponent of using vowels to tune the resonator to the sung pitch. He charted the vowels that resonate well on each pitch of the chromatic scale; based on the formant frequencies of each vowel and its relationship to the fundamental frequency and overtones of the sung pitch, he suggested which vowels will resonate optimally. If you are a "do-it-yourselfer" and you know the frequency of the pitch you wish to sing and its first few overtones, you may also consult Vennard's vowel formant graph and decide for yourself which vowel is optimal for resonance purposes.[14]

The problem with the vowel approach to tuning the resonator to the sung pitch is that it is based on the formant frequencies of the vowels which are not concrete, but vary greatly. For example, the /u/ vowel's first formant frequency is in the neighborhood of 250 Hz plus or minus 75 Hz.[15] That leaves about 150 Hz wiggle room, where the vowel is still intelligible and clear. Using the vowel tuning method, one could deduce that the pitch D_4 (294 Hz) will resonate really well on /u/. The fundamental frequency of D_4 falls within the scope of the first formant frequency of /u/ (250 Hz plus or minus 75). This vowel can therefore have great resonance at this pitch level. But how likely is it that the singer's instinctual concept of /u/ will lead him/her to form an embouchure that tunes the resonance tract to match exactly the fundamental frequency of 294 Hz? The answer is: highly unlikely. So, once again: How do I tune my resonance tract to match an overtone or the fundamental of the sung pitch? The following answer is a bit unconventional, but it works most of the time.

DIGITAL PALPITATIONS OF THE BUCCAL AND LARYNGEAL REGIONS

One way to tune the resonance tract is by digitally palpitating the buccal and/or laryngeal regions; that is, thumping yourself on the cheek and/or larynx while changing your embouchure to match the pitch you wish to sing. This works for most of the female singing range and the head voice ranges of men. Suppose you are having trouble achieving a beautiful and resonant tone on a high B flat (male or female octave) in one of your arias. If you want to know the posture of the articulators that will result in an optimally resonated high B flat, simply position your mouth and larynx as if to sing the vowel of the word which the composer has placed on that note, and thump your cheek or larynx to discern the pitch of your vocal tract. The palpitation of the cheek or larynx yields a percussive pitch which can easily be heard if one thumps sufficiently hard. Compare the pitch of the resonance tract to the pitch you desire to sing. Open the mouth wider (laterally and vertically) and/or elevate the hump of the tongue to raise the pitch of the resonance tract, or round/extend the lips, close the mouth and relax the tongue to lower the pitch. You can actually tune your mouth to match the pitch this way. Once you have discovered the proper embouchure that results in a matching pitch on that vowel, simply sing through it and enjoy a well resonated, *chiaroscuro* high B flat, or any other high note for that matter.

Experiment with different vowels and pitch levels, and notice that vowels become progressively less discernable as you ascend into the higher extent of the vocal range. The digital palpitation approach to vocal tract tuning obviously cannot be employed during a performance; nevertheless, one can practice this way and learn through repetition to consistently reproduce the proper embouchure for a given note within a song or aria. Digital palpitations provide a concrete, low tech and scientifically based method for finding the most resonant tone on any given vowel and pitch. The only drawback of this method is that one leaves the practice room with a little redness of the cheek or neck.

Male resonance strategies often differ from those of female singers.[16] Male singers spend much of their singing lives at a pitch level where the fundamental frequency of the sung note is lower than the vocal tract can match; the vocal tract can be stretched only so long to tune to low notes before one hits rock bottom. Thus, when men sing in their middle and low ranges, they tune their resonance tracts to match one of the overtones of the sung pitch rather than the fundamental frequency.[17]

The result is that, as men ascend the scale, they begin with a rather open mouth at the low range and gradually relax their embouchures (lowering the pitch of the vocal tract) upon approaching the second *passaggio*, or "break" between chest and head voice. Depending on the voice type, this generally occurs for most men somewhere between D_4 (294 Hz) and G_4 (392 Hz). It is important to note that this is the exact same pitch range where women singers usually transition from chest voice to middle voice. There is a discernable shift in tone color as a man ascends to these pitches, what some people describe as "cover" or a darkening of the tone. This discernable *passaggio* or change in tone color seems to be more the result of resonance factors than the action of the thyroarytenoids and cricothyroid muscles. One simply emphasizes or magnifies the fundamental frequency at this point in the ascending scale rather than one of the sung pitch's "brighter" or higher frequency overtones. Thus the tone sounds "darker."

Depending on the length and size of the vocal tract, one usually finds that it is possible to match the fundamental frequency of the sung tone beginning at the pitch range D_4–G_4 (294–392 Hz) and extending to the upper extreme of the vocal range (ca. 1,397 Hz for women, or

F_6). Coffin describes the range where one matches the pitch of the resonance tract to the fundamental frequency of the sung pitch as the "vowel register."[18] The digital palpitation approach to resonance tuning works best in this register which encompasses most of the female singing range (except the lower/chest voice range) and the head voice range of men. If, however, you find thumping yourself in the face and throat abhorrent, consider the following two approaches to resonance tract tuning that are based on the concept of *chiaroscuro*.

The *Chiaroscuro* Maneuver

Within the descriptive term *chiaroscuro* (bright-dark) itself lies another secret to solving the optimal resonance problem. If one is having difficulty finding good resonance on a specific vowel at a particular pitch level in a song, one can explore the extremes of tone color within the vowel while sustaining the pitch in order to find the point along the continuum from bright to dark tone color that results in the loudest resonance. Start with a very bright tone and progressively darken it until the sound becomes energized and resonant. At some point along the continuum from bright to dark, the singer will usually experience optimal resonance, and he/she will recognize the blooming of the tone at that pivotal moment. This simple exercise can be done on any vowel, at any pitch level within the singer's range, with or without consonants, and at any variety of dynamic levels. Using this exploratory maneuver, singers discover their true vocal identities and individual timbres, as opposed to manipulating their tone in an attempt to imitate someone else's voice. It offers the singer a methodic approach to discovering optimal resonance, and the results are often stunning and profound.

Start by choosing a vowel that needs work. Let us take the /i/ vowel, for example. Tell the singer to sustain at the desired pitch level a very bright /i/ and gradually darken it by opening the throat, relaxing the tongue and rounding/extending the lips until the point of loudest resonance. As the singer relaxes the articulators, the vowel may migrate toward /I/. Apply this concept to any vowel by singing the nearest bright relative on the closed side of the desired vowel and migrating toward the next darkest or more open vowel on the other side of the desired vowel. If the tone becomes dull and muffled, you have gone too far to the dark side.

The *Scurochiaro* Maneuver

While the term *chiaroscuro* places bright before dark, it could just as easily have been the other way around, that is, *scurochiaro*, or dark-bright. In fact, this opposite approach is common, especially among male singers, and often referred to as "hooking" the tone. If one finds that an undesirably high laryngeal position results when a singer uses the *chiaroscuro* maneuver, then try the *scurochiaro* approach. In this maneuver, the singer begins with an open, dark and relaxed vowel like /ʌ/ and then closes down to the vowel they want to sing, brightening the tone as the articulators raise the pitch of the vocal tract. The goal is to find the proper embouchure which results in optimal resonance by quickly tuning the mouth from dark to bright.

This is how it works. A singer wants to improve his /e/ vowel on a certain note, so at the onset of phonation he begins with a darker more relaxed version of the vowel and migrates rapidly toward /e/. The singer should be able to hear and feel when the resonance is optimal and hold the embouchure that results in a desirable *chiaroscuro* timbre. Many baritones and tenors use this trick in performances to facilitate high notes. It yields a characteristic diphthong that can be annoying and may be accompanied by a scooping of the pitch. The perceived scoop up from below the pitch is partially an illusion created by the darker tone color at the onset of phonation in which the higher frequencies of the sound spectrum are attenuated temporarily.

When a woman performs the *scurochiaro* maneuver on a high note it is much less discernable than when her male counterparts do it. In fact, a female singer may find she is able to subtly use this maneuver in public performances to improve the resonance of her high notes without anyone in the audience perceiving it. The audience just hears the really beautiful and thrilling high note without realizing that resonance tuning took place.

In summary, a singer must tune the resonance tract to match the fundamental frequency of the sung pitch, or one of its overtones, if optimal resonance is to occur. Digital palpitations, the *chiaroscuro* maneuver, and the *scurochiaro* maneuver provide systematic methods which result in resonance tuning. All three devices may not serve each singer well, but usually at least one of them will. While these methods are not foolproof, they provide simple, scientifically based processes for discovering optimal resonance. If one practices these devices, has reasonably good ears, or at least can kinesthetically sense vibration in the resonators, he/she will quickly learn to recognize optimal resonance, improve the tone of the voice and sing with greater consistency, ease and power.

NOTES

1. William Vennard, *Singing: The Mechanism and The Technic*, revised ed. (New York: Carl Fischer, 1967), 83–85.
2. Berton Coffin, *Overtones of Bel Canto* (Metuchen, NJ: Scarecrow Press, 1980), 11.
3. Richard Miller, *The Structure of Singing* (New York: Schirmer Books, 1986), 50.
4. Ibid., 48.
5. Ingo Titze, "How Loud Is My Voice Inside My Mouth and Throat?" *Journal of Singing* 62, no. 2 (November/December, 2005): 177, 178.
6. Berton Coffin, *Chromatic Vowel Chart for Voice Building and Tone Placing* (Metuchen, NJ: Scarecrow Press, 1980).
7. Miller, 50.
8. Vennard, 137.
9. Ibid.
10. Miller, 182.
11. Coffin, *Overtones*, 20.
12. Ibid., 11.
13. Vennard, 137.
14. The graph is located on p. 11 of Vennard.
15. Vennard, 137.
16. Paul Kiesgen, "Resonance Strategies for Male Singers" (lecture given at the NATS National Conference, Minneapolis, 2006).
17. Coffin, *Overtones*, 17.
18. Ibid., 16, 17.

Dr. Adam Kirkpatrick, assistant professor of music at Kennesaw State University, has sung operatic roles and concerts professionally in many theaters throughout the United States, singing with the Cincinnati Opera, Atlanta Opera, Santa Fe Opera, Tri-Cities Opera (NY), Dayton Opera, Florida State Opera, Knoxville Symphony, Newton Symphony (Boston, MA), Tallahassee Symphony (FL), LaGrange Symphony (GA), Axtell Symphony (NE), and more. Kirkpatrick holds a BM and MM in voice performance from the Cincinnati College-Conservatory of Music, and earned his Doctor of Music degree from Florida State University. Though he spends most of his professional life teaching voice and singing, Kirkpatrick also finds time to write and publish articles related to voice and singing. He is also author of the novel *Lincoln's Shadow*.