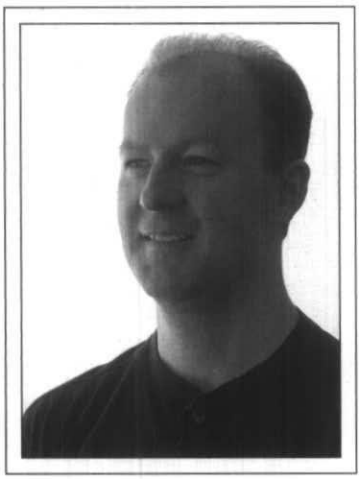
Vowel Modification Revisited



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In the last forty years, many voice pedagogy authors have written about the need for appropriate vowel modification. Modification involves shading vowels with respect to the location of vowel formants, so that the sung pitch or one of its harmonics receives an acoustical boost by being near a formant. The goals of modification include a unified quality throughout the entire range, smoother transitions between registers, enhanced dynamic range and control, and improved intelligibility. Elite singers, whether they consciously recognize they are modifying vowels or not, become experts at making subtle changes in vowels as they sing, or they do not have consistent careers. Modification concepts that have been widely accepted are summarized as follows:

1. Although there is a strong correlation between voice classification and formant frequencies, due to subtle articulation and anatomical differences, formant frequencies are unique to each individual.
2. The amount of modification needed varies with the size of the voice, the "weight" of the voice, the duration of the note being considered, the dynamic level, and how the note in question is approached. Sensitive singers report that the amount of modification they need may vary daily and also during the day, depending on how much they have warmed up.
3. Vowel formants are frequency bands, not one specific pitch.
4. Precise tuning of each note in a piece is not very practical nor is it acoustically beneficial. During a rapid passage, a singer may not have enough time to adjust for optimal resonance on each vowel on each note; moving on to the next note in the passage smoothly is a greater priority than exact tuning of each tone.
5. Males and females "tune" differently. In general, males seek to match harmonics above the fundamental to a formant, while females, especially in the upper voice, tend to reinforce the fundamental itself by matching it to the first or lowest formant (Figures 1 and 2).
6. Several general "rules" for modifying vowels exist (as summarized by Titze): (a) formant frequencies lower uniformly by lengthening the vocal tract (either by lowering the larynx or protruding the lips or some combination of both); (b) formant frequencies are lowered uniformly by lip rounding and raised by lip spreading; (c) fronting and arching the tongue lowers the first formant and raises the second formant, while backing and lowering the tongue raises the first formant and lowers the second formant; (d) opening the jaw raises the first formant and lowers the second formant.

Other information now needs to be integrated into pedagogical approaches. Three areas of continuing study have particular significance for singing teachers.

The effect of subglottal resonances upon vocal fold vibration. Just as the vocal tract above the vocal folds has different formants, so too does the subglottal airway. The primary difference is that vocal tract resonances can be altered consciously by moving the tongue, lips, jaw, palate, and larynx, while the subglottal airway remains basically the same for all vowels. So while the vocal tract formants vary from vowel to vowel, the subglottal formants are relatively "fixed," with only a slight amount of variation possible due to changes in laryngeal height. The relationship between the sung pitch and the effect of these subglottal formants on vocal fold vibration should be incorporated into pedagogical approaches (Figure 3).

The implication of subglottal resonances for singers is that at some pitches, particularly around D_3 and D_4, pressures due to subglottal resonances increase the amplitude of the vibration of the vocal folds, while at other pitches, especially around $G^{\#}_3$ and C_5, subglottal resonance factors decrease the amplitude of vocal fold vibration. Titze suggests that this change in vocal fold vibration can be controlled by adjusting vocal fold adduction slightly. When subglottal

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driving pressures substantially increase vocal fold vibration amplitude, a slight increase in abduction may be warranted to prevent overdriving the system; when subglottal driving pressures substantially decrease vibration amplitude, a slight increase in adduction may be helpful. By doing so, the singer may avoid large changes in intensity from one pitch area to another.

Male singers shift from using the first formant for reinforcement to using higher formants. While in the lower voice they match a harmonic to the first formant of the vowel being sung, in the *passaggio* and above they lengthen the vocal tract by protruding the lips and/or adjusting the position of the larynx downward slightly to match a higher harmonic to a lowered second formant or to the singer's formant. This is what is commonly described as "covering." Brighter voiced singers like Luciano Pavarotti in his prime and Alfredo Kraus are good examples of male singers who use the second formant-dominant strategy in the high voice. Placido Domingo, on the other hand, tends to use the singer's formant-dominant tuning strategy (Figure 4).

The importance of tuning the fundamental or its harmonics slightly below a resonance formant peak. In order to keep the vocal tract inertive (which assists sustained vocal fold oscillation) and to keep the pitch change due to vibrato in phase with the rise in amplitude that occurs as the formant is approached during each vibrato cycle (so that loudness rises and falls in sync with the vibrato), singers should not try to tune exactly to a formant, but rather slightly below it. This often means singing a *slightly* more open vowel, so that the formant in question remains slightly higher than the fundamental or harmonic that is close to it.

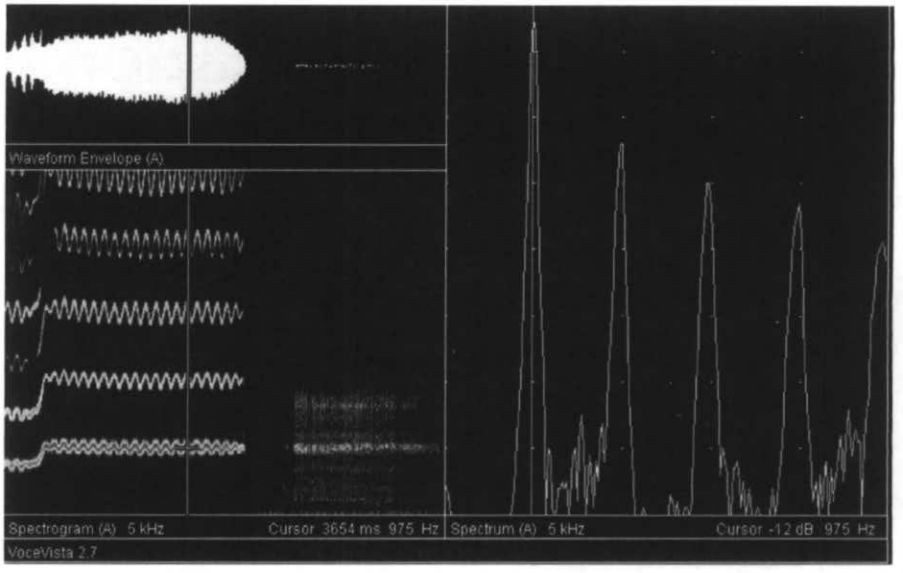

Figure 1. A professional soprano singing B_5, then using vocal fry (lower right corner of the spectrogram) to highlight the location of vowel formants. Note the close proximity of the fundamental to the first formant.

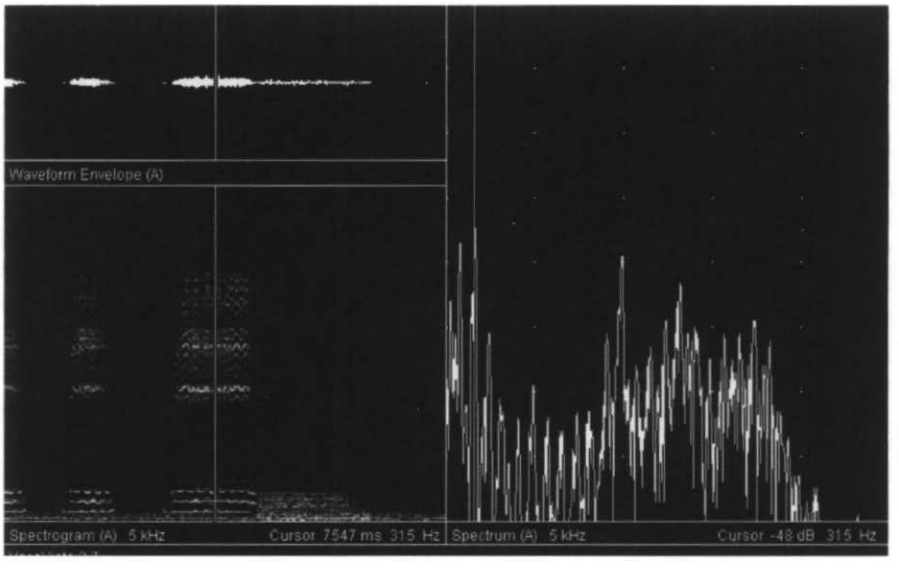

Figure 2. The author singing the vowel /i/ on E^{b}_{3}. Note the strength in the second harmonic (H2) at 315 Hz (close to the first formant) and the twelfth harmonic (H12) at approximately 2000 Hz (in close proximity to the second formant).

How might singers and teachers apply this information to singing repertoire? Here are a few examples:

- Baritone: "Bella siccome un angelo," Donizetti, *Don Pasquale*, sustained final note of the cadenza on the word "cor" on the pitch D^{b}_{4} (277 Hz).

Subglottal driving pressures are highly positive at this pitch level, approaching their maximum. And, as this note is below the *passaggio*, optimal vocal tract resonance tuning involves tuning the second harmonic (H2, at 554 Hz) to slightly below the first formant (F1) of a vowel.

Recommendations:

(a) Slightly increase abduction to avoid overdriving vocal fold vibra-

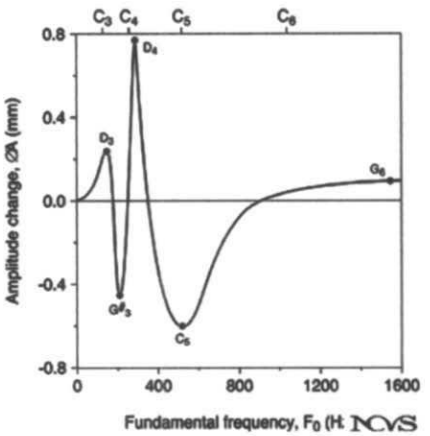

Figure 3: Vocal fold vibrational amplitude change as a function of fundamental frequency, due to subglottal pressure variations in the vocal fold driving pressure. From Titze, *Principles of Voice Production*. Used with permission.

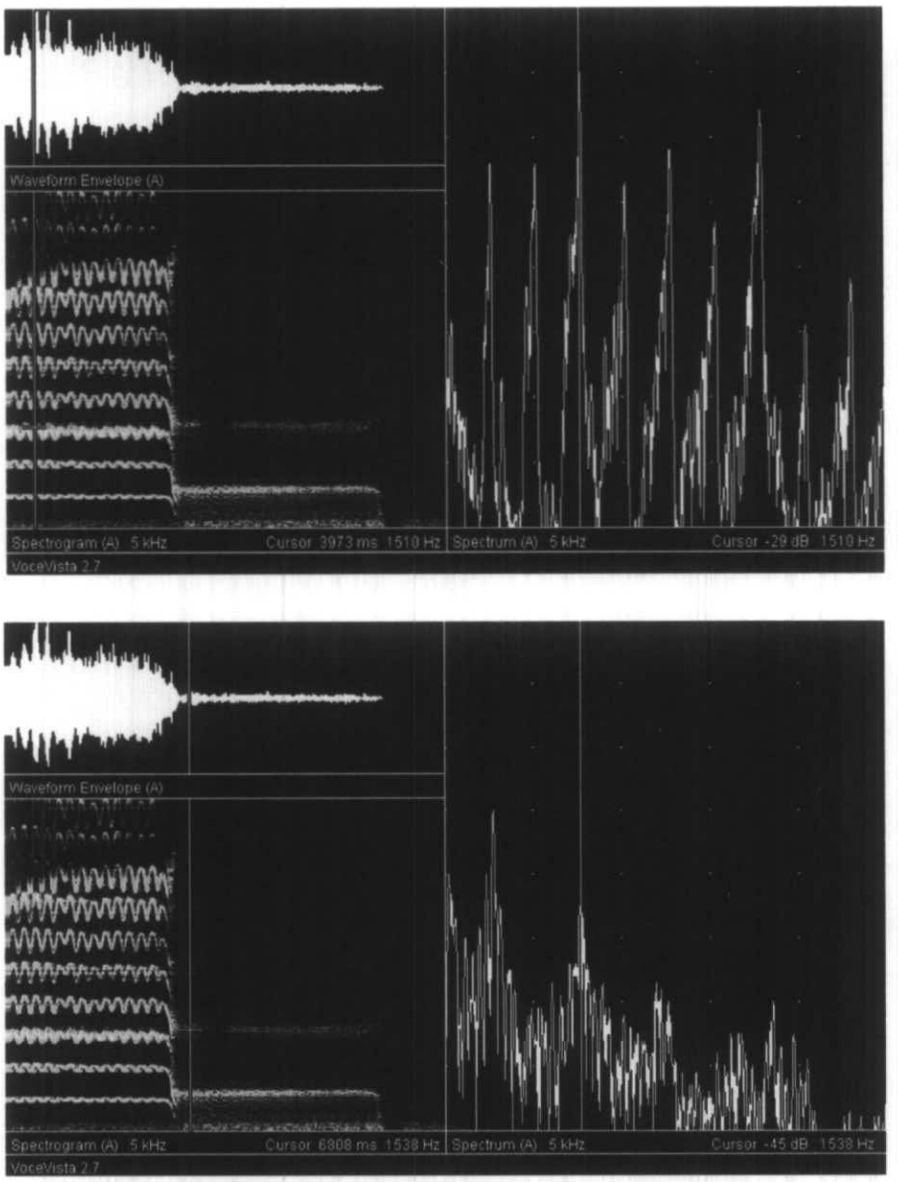

Figure 4. The author singing the word "parais" on B^b_4 (upper image) and using vocal fry on the same vowel shape (lower image). F1 ~ 550 Hz, F2 ~ 1540. Note that H3 is in close proximity to F2.

tion amplitude with subglottal pressures; the singer might achieve this by focusing on air flow while singing.

(b) Shade the vowel toward a more open form of /o/, so that the second harmonic at 554 Hz is close to but slightly below the first formant of the more open vowel (approx. 570–600 Hz). Exact shading will vary with each singer.

- Soprano: "Steal me, sweet thief," Menotti, *The Old Maid and the Thief*, climactic high note on "steal" on B^b_5 (932 Hz).

Subglottal driving pressures are negligible or slightly positive at this pitch range. Optimal vocal tract resonance in the female high voice involves tuning the fundamental frequency (i.e., the sung pitch) to slightly below the first formant; however, with the fundamental so high at 932 Hz, the /i/ vowel in the word "steal" is not appropriate, with its first formant at approximately 370 Hz. In fact, no speech production vowel has a first formant at 932 Hz. The closest vowels are /æ/ at approximately 770 Hz and /ɑ/ at approximately 890 Hz. This pitch is around the upper limit of where the sung pitch and the first formant can be tuned to each other.

Recommendations:

(a) Slightly increase abduction as needed to equalize the effect of subglottal driving pressures; again, instructing the singer to use a high air flow might be one way to achieve this.

(b) Slightly elevate the larynx and use a wide, flat mouth shape, in order to raise the first formant of the vowel as high as possible.

- Tenor: "Il mio tesoro," Mozart, *Don Giovanni*, sustained notes on "vado" on F_4 (349 Hz).

Subglottal driving pressures are slightly positive to negligible. Between D_4 and C_5, subglottal driving pressures shift from maximally increasing

vibrational amplitude to maximally decreasing it. Depending on the tessitura of the singer, the note can be sung "open" or "covered."

Recommendations:

(a) For a high tessitura voice with a bright timbre, sing the note more "open" by maintaining the vowel /ɑ/, so that the second harmonic (H2) at 698 Hz sits just below the first formant of the /ɑ/ vowel (approximately 740 Hz).

(b) For a slightly lower tessitura voice with a richer timbre, sing the note more "covered" by lowering the larynx (and all formant frequencies), thereby moving the third harmonic (H3) at 1047 Hz closer to a lowered second formant of the /ɑ/ vowel (at approximately 1100–1200 Hz).

As always, each singer is unique. Fine adjustments for slight individual differences and how to best teach these concepts are left up to the teacher and the performer. Some singers prefer objective visual feedback about vowel tuning by using a spectrum analysis program like Voce Vista or Gram in the studio or the practice room; others respond best to verbal suggestions of target vowels to sing; some others thrive on kinesthetic commands like "adjust the space or lift of that vowel a bit more for the pitch and power of that note;" and still other singers find demonstration/imitation or imagery most effective. *Chacun à son gout*! As always, optimal sound output must constantly be weighed against the need for intelligibility. In almost every case, however, optimal acoustical tuning will both aid ease of production and improve intelligibility.

For further information on this subject, readers are referred to the sources in the Bibliography.

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