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Why Do Classically Trained Singers Widen Their Throat?

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It appears that there are two conflicting requirements for vocal tract shapes in Western classical singing. The first requirement is a large sound output without amplification. The second is a wide pitch range without sudden changes in voice quality (e.g., register breaks). As simple as these requirements sound, they lead to some interesting solutions with regard to vocal tract geometry.

Consider the first requirement, large amounts of sound power emitted from the mouth. Acoustic power radiated from the mouth increases with mouth opening. We all know this intuitively. We open our mouths wide to call or shout. Brass and woodwind instruments have a bell to get more acoustic power into free space. It is difficult to sing loud on relatively closed vowels like /u/ and /i/.

The second requirement, producing a wide pitch range with a smooth voice quality throughout, is met by selecting vowels that allow dominant source harmonics to pass through formants in such a way that they do not change the output spectrum dramatically. In other words, the passing of dominant harmonics through formants should not elicit sudden sound quality change, and they should also not destabilize the vibration of the vocal folds with a register break. To accomplish this, the first formant frequency is often lowered by producing centralized vowels like /ʊ/, /I/, /ə/, or /ɔ/. The first formant frequencies of these vowels are around 400–600 Hz.

As an example, as a singer enters the C_4–C_5 octave (high for males and medium for females), where fundamental frequencies are between 261 Hz and 523 Hz, the second harmonic varies from 523–1047 Hz. Thus, it may be below or near F1 at the beginning of the octave (near C_4), but considerably above F1 at the end of the octave (near C_5). In other words, the second harmonic needs to pass through F1 for these vowels. Emphasis in classical singing is on balancing acoustic energy between several dominant harmonics (F_0, $2F_0$, and $3F_0$) while this transition takes place.

So, why the expanded throat? To maintain a relatively wide lip opening on vowels that have F1 in the 400–600 Hz range, the pharynx and mouth need to take on a neutral or inverted megaphone shape. If we were to open the mouth only and keep the rest of the vocal tract relatively narrow, F1 would rise sharply. This would delay the gradual passing of the second harmonic $2F_0$ over the first formant F1. The result would be a speech-like call or a belt.

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Classically trained singers avoid the speech-like call or belt because these phonations invite a sudden register adjustment at high pitches. To the contrary, the centralized vowels invite mixed registration, which can be extended to higher pitches without sudden adjustments. An added benefit is that a wide pharynx, together with a relatively narrow epilarynx tube, produces the operatic ring (singer's formant cluster). Its efficacy for balancing the spectrum and increasing high frequency energy for large performance halls is well known.

A new question arises, however. Mixed registration is also highly promoted by teachers of contemporary and commercial singing. How do singers of these styles mix without the excessive widening of the throat? The answer probably lies in the use of amplification. If the requirement of large radiated output power from the mouth is removed, the overall airway can be narrower (more speech-like) and the overall techniques of mixing and balancing the spectrum over a wide pitch range can be preserved.