

Finding Resonance: A Tool for Singers and Phoneticians to Explore Formant Tuning

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Sociolinguistic studies of vowel quality in pop songs have acknowledged the importance of singing technique, without exploring in depth its effect on singers' vowel realisation choices (Gibson 2024). This paper introduces a tool for rapid inspection of harmonic–formant proximity in sung or spoken vowels. Due to source-filter interactions, certain vowel qualities can be difficult to sing reliably at specific pitches. Alignment of formants to harmonics ('formant tuning') has long been a topic of study in both the acoustics of singing (Sundberg 1987, Herbst et al. 2023) and vocal pedagogy (Bozeman 2025). A recent study has also demonstrated the existence of formant-harmonic alignment in spontaneous speech (Story et al. 2025). Untrained singers may intuitively adjust vowels to enhance intensity, vocal ease and timbral aesthetics.

The *Finding Resonance* tool (FR) comprises a Praat and an R script that allow users to select vowels of interest by recording their voice in Praat or uploading existing audio files. FR estimates f_0 , F1, F2, F3, and formant bandwidths for each vowel, and computes the nearest harmonic to each formant, converting its distance into cents (hundredths of a semitone). Spectral analysis determines which harmonic has greatest local prominence. These measures are provided to the user as exported plots and tables. Two modes are provided: fixed- f_0 mode (as shown in Figure 1) assumes a stable sung f_0 across tokens, and plots a static harmonic lattice behind a vowel space, allowing users to see how close the F1 and F2 of their vowels are to nearby harmonics, as well as displaying the bandwidth of each vowel formant. Free- f_0 mode instead draws harmonic intersections per token based on each vowel's f_0 , offering a compact display of formant-harmonic proximity. Optional settings include scaling vowel labels by intensity, labelling the harmonic with most local spectral prominence, and indicating cases where F3, not F1 or F2, is the closest formant-harmonic pairing (shown by blue arrow in Figure 1). The tool introduced here can help phoneticians explore the acoustic basis for singers' vowel choices and assist singers in identifying the resonant 'sweet spots' for specific sung vowels.

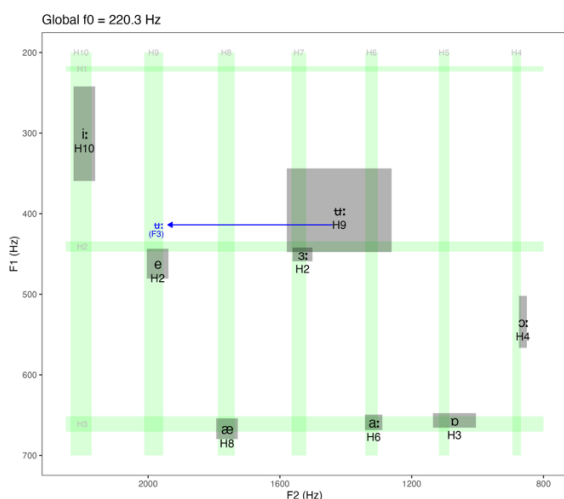


Figure 1. Illustration of Finding Resonance output in fixed- f_0 mode. Vowel labels show the F1/F2, surrounded by grey rectangles showing the bandwidth of each formant. Green bands show each multiple of the (static) fundamental (± 25 cents). Below the vowel label, the most prominent harmonic (with respect to the average intensity of its neighbours) is marked. In cases where the closest formant-harmonic pairing is with F3, an arrow connects the token to the vowel's F3 value.

Bozeman, K. 2025. Practical Vocal Acoustics: Pedagogic Applications for Teachers and Singers. Bloomsbury. **Gibson, A.** 2024. Pop Song English as a supralocal norm. *Language in Society* 53(3). 471–498. **Herbst, C., B. H. Story & D. Meyer.** 2023. Acoustical theory of vowel modification strategies in belting. *J Voice*. **Story, B. H., L. Maxfield, A. Palaparthi, S. Hargus Ferguson & I. Titze.** 2025. Detection of synchronization of the voice source and vocal tract in connected speech. *JASA* 158(3). 2207-2224. **Sundberg, J.** 1987. *The Science of the Singing Voice*. Northern Illinois University Press.