The search for invariant acoustic cues in the speech signal remains controversial, particularly for the categorization of place of articulation for stop consonants. Although it now seems unlikely that a single unique or invariant property directly maps the acoustic signal onto phonetic or phonological categories, determining which acoustic properties are relevant for speech perception remains an open question.

One potential cue for categorizing place of articulation in stop consonants is the locus equation, which reflects the linear relationship between the second formant (F2) at vowel onset and midvowel nucleus of the vowel following a stop consonant (e.g., Sussman et al., 1991). The locus equation has now been established as a robust metric across languages and speaking styles; however, there is a discrepancy between the time span that locus equations are derived from and the time span that is sufficient for behavioral categorization. While traditional locus equations use F2 values measured at two points separated by 60-110 ms, listeners are able to categorize place of articulation for voiced stops based on only the initial 10-30 ms of stop-vowel syllables (Blumstein and Stevens, 1980). For the locus equation to be considered a perceptually plausible cue for place of articulation for stop consonants, it has to be distinctive when calculated much earlier in the vowel than the traditional locus equation.

To investigate the locus equation’s utility on a more perceptually realistic timescale, modified locus equation coefficients were obtained from multiple F2vowel measurement points. Twenty English speakers (ten female, ten male) read 150 /CVt/ syllables (/b/ /d/ or /g/ in ten vowel contexts repeated five times). F2 was measured at vowel onset and at each glottal pulse up to and including the traditional midvowel nucleus. Linear regressions were performed and locus equation coefficients obtained for each pitch period as a function of place of articulation. Slope and y-intercept combinations significantly differed by place as early as one to two pitch periods post-onset, corresponding to the first 10-20 ms of F2 transition (see Figure 1). These differences, as well as high classification rates obtained from discriminant analyses using slope and y-intercept coefficients as predictors, suggest that the locus equation may be a potential cue for the perceptual categorization of place of articulation across vowel contexts and across speakers.
References


**FIG.1.** Group mean locus equation scatterplots obtained from first (panel a), second (panel b), and third time points (panel c), and traditional locus equation midvowel nucleus (panel d). Each point represents the average value for one vowel type across all speakers.