

Different speakers use different phonetic cues to convey the same phonological contrasts

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Mismatches between phonological contrasts and their phonetic correlates are well-attested, as are instances of phonetic variation on the level of the individual. For example, previous studies have shown individual differences in the production of the American English approximant /r/, with speakers using a variety of articulatory strategies to produce the segment, but all maintaining a consistent acoustic cue (Guenther et. al., 1999). The presence of articulatory variation with no corresponding acoustic variation suggests that individual differences are permissible so long as the acoustic target is preserved. There have also been studies showing that phonetic cues to contrast are different from what would be expected from the phonological features at play. It is attested, for example, that the cue to obstruent voicing is in fact the duration of the preceding vowel (Denes, 1955); however, there is no evidence for individual variation in the extent to which the acoustic signal differs from what is predicted by the phonological contrast. This study bridges the gap between these two findings, presenting evidence from a study of Modern Hebrew (MH) fricatives demonstrating that the acoustic target need not be consistent across speakers, and that individuals may draw upon varying types of acoustic cues to make the relevant contrasts.

The MH consonantal inventory contains six contrastive fricatives: /v z f s ʃ χ/ (Bolozky, 1997). The phonological features that distinguish among these fricatives are voicing and place of articulation; it is expected, therefore, for the phonetic signal to reflect these cues consistently, each phoneme possessing its own acoustic cue signaling both voicing and place. However, this study uses a corpus of MH speech to show that different speakers employ different phonetic cues to maintain these phonological contrasts. These phonetic cues differ not only by speaker but by contrast, with one contrast maintained by one cue and another by another; each speaker has their own combinations of cue and contrast, and they are not consistently predicted by the phonological features at play. This implies that the MH hearer must be aware of all of these possible contrastive phonetic cues, but be able to accept any subset thereof in perceptually accommodating to a given speaker.

The data analyzed in the present study is taken from WAV recordings used in *Israel Story* (*Sipur Israeli*), a podcast available online that features “everyday stories, told by, and about, regular Israelis” (<http://israelstory.org/en/about-us/>). Recordings from three women and three men (ages 33-46) were analyzed, all of whom were native speakers of Hebrew with reported normal speech and hearing. The samples were selected from the *Israel Story* corpus for audio quality and lack of background noise. TextGrids for each speech sample were segmented manually in Praat (Boersma & Weenink, 2017), by a highly proficient MH heritage speaker, using visible frication and the reduction of amplitude in the wave as acoustic landmarks for fricative segmentation. Only intervocalic tokens of fricatives were examined in this study, resulting in 242 tokens across the six contrastive fricatives. For each of these segments, the duration, intensity, harmonics-to-noise ratio, and center of gravity were extracted (Gradoville, 2011). In addition, measures of F0 were taken at twenty-one evenly-spaced points across each token. The number

of these points at which there was a measurable F0 was then divided by twenty-one, resulting in the percentage of the duration of a given segment during which there was voicing, following the methodology used for fricative voicing analysis in Rohena-Madrado (2011). Speakers were analyzed individually, with respect only to the phonemes for which they produced at least ten intervocalic tokens. Duration was found to remain the same across fricative types, regardless of voicing or place, for each speaker ($p > 0.05$). Tukey HSD tests revealed whether the remaining four measures served to differentiate between each of the possible pairs of contrastive fricatives. The results show that though there is not one acoustic measure that is responsible for maintaining all of the contrasts among fricatives, each speaker uses at least one cue to preserve every phonemic distinction. However, different speakers use different cues or combination of cues to phonetically convey the same phonological contrast, with no apparent patterns either within or across speakers.

These results imply that the MH speaker is at liberty to use one of many possible strategies for maintaining a phonological contrast, as long as this strategy involves at least one of the several phonetic cues relevant to the perception of the phonemes in question. The hearer, in turn, accommodates to each individual speaker and their idiosyncratic acoustic strategy in order to perceive the correct contrast. Therefore, the phonology must be sensitive to each of the possible acoustic correlates to a given phonological contrast, but must also allow for any subset of these correlates to be sufficient for the perception of a given contrast.

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