Phonetic reduction, perceptual illusions, and phonotactic legality
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Language experience leads not only to knowledge of what combinations of sounds are allowed in that language, but often also to language-specific strategies employed to repair certain disallowed combinations. Such learning can lead to perceptual illusions whereby illicit sequences are perceived as though they had been repaired (e.g. Dupoux et al., 1999). For instance, Spanish exhibits a well-known prohibition of word-initial /s/-consonant clusters (henceforth #sC). Where necessary (e.g. in foreign loanwords such as *esnob* → *esnob*) such clusters are productively repaired by adding a prothetic /e/ (Harris, 1983; Hooper, 1976). This strategy has been linked to perception of an illusory /e/, but not other vowels, preceding #sC sequences (Carlson, et al., 2015; Cuertos, et al., 2011).

On the other hand, phonetic reduction in otherwise well-formed words, such as reduction or deletion of the initial vowel in Spanish words beginning with #VsC can yield apparent illicit sequences (#sC) in speech. While the legality of the remaining sequence does not appear to be an obstacle to such reduction (Davidson, 2006), there may nonetheless be a relationship between phonetic reduction and the presence of a strongly preferred repair strategy, such as /e/-prothesis. In this study we probe this relationship by asking whether reduction of the initial vowel in Spanish #esC words like *espalda* ‘back’, which matches the default repair vowel, is more prone to reduction than other initial vowels, such as in *aspirina*.

We explore this question in the speech production of speakers of Andalusian Spanish. The test items were 20 words, half beginning in #esC (e.g. *espalda*) and half in #asC (e.g. *aspirina*), along with 20 fillers containing no sC clusters. The initial vowel was always unstressed. 15 native speakers (10 female) with minimal L2 knowledge read each word aloud in isolation twice, in semi-randomized order (in which no token was repeated consecutively), at 1 second intervals. Productions were recorded in a quiet room using a headworn Shure SM10A microphone and a Zoom H4n recorder. The widespread lenition of coda /s/ in Andalusian Spanish (common in many dialects) was expected to affect initial vowel production, but we anticipated that /s/ lenition would interact with the potential reduction of the initial vowel, and planned to incorporate this into our analyses.

Ultimately, 578 valid tokens (288 with initial /a/ and 290 with initial /e/) were collected and coded for the duration of the word initial vowel and the following /s/ using Praat (Boersma & Weenink, 2015). Vowel onset was set at the beginning of a visible waveform prior to the strong frication indicative of /s/ and offset was taken to be the onset of strong frication or aspiration, or when /s/ was absent, the onset of the following consonant closure. Analyses were performed using logistic and linear mixed effects regression with the maximal random effects structure justified by the design.

Outright vowel deletion, defined as the absence of any vocalic material preceding the /s/ (in no case were both the vowel and /s/ deleted), was uncommon, occurring in 3% of tokens overall. However, initial /e/ was deleted significantly more often (5%) than initial /a/ (0.3%, one token), supporting the hypothesis that the prothetic repair vowel is more prone to deletion than other vowels in this context. To probe further, we analyzed the durations of the initial vowel and of /s/ (with the exception of two items with /st/ clusters, where the offset of /s/ could not be determined reliably). The results, seen in the Figure, showed a negative relationship between the duration of the initial vowel and that of the following /s/: reduction of the vowel was accompanied by comparatively longer /s/, and vice versa. Crucially, a robust interaction showed that this relationship held only when the initial vowel was /e/, but duration of /a/ was not related to the duration of the following /s/. Note that the interaction remained robust even when tokens with zero duration of one segment or the other were removed. Thus, initial /e/ reduction, the prothetic vowel, was more pronounced than /a/ reduction, but /s/ lenition appears to dampen /e/ reduction: when /s/ was at its minimum, initial /e/ was as long as /a/.

These findings provide compelling evidence for a relationship between automatic phonotactic repair strategies and phonetic reduction in speech, and we entertain several possible explanations for this. It may be that reduction is enabled when the reduced material can be restored via perceptual repair, but it may also be that articulatory, frequency, or other properties favoring reduction of sequences such as /es/ make...
those sequences good candidates for phonotactic repair, or contribute to perceptual illusions (e.g. Davidson & Shaw, 2012). The present findings thus shed light on how speech perception and production dynamically influence phonological systems.

Figure. Durations of initial /e/ and /a/ as a function of duration of the following /s/. Ribbons show 95% confidence intervals.

References