

ARE THERE UNIVERSAL PROSODIC CUES TO SPEECH STRUCTURE?

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Prosodic variation informs listeners about speech structure. Furthermore, perceptual interpretation of the valency of variation along prosodic dimensions appears universal: sounds that are longer, louder or higher in pitch are more salient, other things being equal. Of course, languages differ in how prosodic features are combined and organised with respect to lexical, syntactic and pragmatic structure: for example, patterns of stress placement and the interpretation of intonational sequences are well documented to be language-specific (e.g., Ladd, 2008). However, there is evidence that certain form-function associations are universal. For example, the iambic-trochaic law asserts that elements made salient through higher pitch or greater loudness are interpreted as sequence-initial, whilst lengthened segments are typically interpreted as sequence-final (Hayes, 1995).

The use of final vowel lengthening as a cue to speech structure has been demonstrated for several languages and may well be universal (e.g., Beckman, 1992; Tyler & Cutler, 2009). Lengthening of onset consonants in word-initial syllables is widely observed across languages, however (Keating, Cho, Fougeron & Hsu, 2003), and is also a potentially universal segmentation cue. We examined whether the localisation of lengthening – consonant vs vowel – is indeed critical for its structural interpretation, and whether this interpretation is language-independent.

Using an artificial language learning paradigm (Saffran, Newport & Aslin, 1996), we tested how durational variation in sequences of nonsense trisyllables affected listeners' segmentation behaviour. In Experiment 1, synthesised words such as *pabiku*, *golatu*, *tinudo* and *daropi* were presented in continuous randomised sequence for six minutes, in a between-subjects design with four timing conditions. When the onset consonant of the word-initial syllable was lengthened (e.g., *pabiku*), recognition in subsequent two-alternative forced-choice tests (*words vs foils*) was better than both the evenly-timed condition ($p < .05$) and when a medial consonant was lengthened (e.g., *pa**b**iku*, $p < .005$). Furthermore, lengthening of the initial syllable's vowel (e.g., *pa**a**biku*) led to recognition no better than the evenly-timed condition, and worse than with initial consonant lengthening ($p < .01$). This indicates that segmentation is not simply boosted because rhythmic alternation confers a regular timing contrast. Rather, the localisation of the lengthening effect is crucial. Thus, whilst vowel lengthening is a cue to an upcoming boundary (e.g., Saffran *et al.*, 1996), consonant lengthening signals a preceding boundary, at least for English listeners.

Experiment 2, with two further conditions, supported this structural interpretation. When the initial consonant and final vowel were lengthened (e.g., *pa**b**iku*), recognition was better than for even timing ($p < .001$), while recognition was worse with lengthening of medial vowel-consonant sequences (e.g., *pa**a**biku*) than in all other conditions ($p < .05$ for all comparisons).

Experiment 3 examined whether the interpretation of localised consonant lengthening as sequence-initial generalised to languages – Hungarian and Italian – with prosodic characteristics rather distinct from those of English. We created a new artificial language in which trisyllabic sequences (*bitusa*, *nudopa*, *ripolu*, *subako*) did not resemble any real English, Hungarian or Italian words. We found that native speakers of all three languages showed better recognition when initial consonants were lengthened relative to the evenly-timed condition ($p < .001$). Furthermore, there was no interaction between timing condition and native language, suggesting that interpretation of lengthened consonants as sequence-initial may indeed be language-independent.