Linguistic contrast enhancement under prosodic strengthening in L1 and L2 speech

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Studies on the phonetics-prosody interface have shown that phonetic encoding of abstract phonological units is modulated by prosodic structure in which they occur (Keating 2006, Fletcher 2010, Cho 2011). Phonemes are, for example, produced with heightened phonetic clarity in strong prosodic landmark locations (e.g., prominent syllables, domain-initial positions). This prosodic strengthening effect has been assumed to be linked to the phonological system of the language, so that it induces enhancement of phonological features, resulting in an increase in phonological contrast and ultimately heightening lexical distinction (Cho 2005, de Jong 1995, 2004). While there has been ample evidence for prosodic strengthening patterns across languages, our understanding of the relationship between prosodic strengthening and linguistic contrast is still at an embryonic stage. For example, only a few studies have directly tested how phonological contrast is indeed enhanced under prosodic strengthening environments (de Jong 1995, 2004; Cho & McQueen 2005). Furthermore, despite the increasing awareness of the role of the phonetics-prosody interface, studies on prosodic strengthening effects have been limited to L1 speech, leaving many relevant questions unsolved regarding L2 speech.

The present study therefore explores how phonological contrast is phonetically enhanced under two types of prosodic strengthening (i.e., prominence and phrase boundary) in both L1 (English) and L2 (by Korean learners of English), by investigating phonetic encoding patterns of vowel contrasts between /i/ and /u/ and between /e/ and /æ/. The prominence conditions tested are related to the information structure as they are obtained with three focus types: phonologically-focused (=PF, e.g., bed-bad), lexically-focused (=LF, e.g., bed-chair), and unfocused (=UF). We also test how domain-initial strengthening (phrase-initial vs. phrase-medial) influences phonetic encoding patterns of vowel contrasts, and whether/how prominence effects are further constrained by prosodic position.

Twelve native speakers of American English and 24 Korean learners of English (36 in total) participated in the study. Two types of minimal pairs of 16 English monosyllabic CVC words were used as follows:

(1) /i/-/u/: heat-hit, heed-hid, beat-bit, bead-bid  (2) /e/-/æ/: bed-bad, bet-bat, ped-pad, pet-pat

Each word was embedded in carrier sentences, which consisted of a prime and a test sentence. The prime sentence was always a question, used to induce intended focus types for the target words in the test sentence. The target word was placed in phrase-initial or in phrase-medial positions, and it was either phonologically-focused (PF), lexically-focused (LF) or unfocused (UF, with lexical contrast on the following word). Sample sentences of a target word ‘bed’ in phrase-initial position are given below:

Phon.FOC: Did you write ‘BAD fast again’? Not exactly. ‘BED fast again’ was what I wrote.
Lex.FOC: Did you write ‘CHAIR fast again’? Not exactly. ‘BED fast again’ was what I wrote.
Unfocused: Did you write ‘bed SLOWLY again’? Not exactly. ‘bed FAST again’ was what I wrote.

Participants answered pre-recorded prime sentences with test sentences. A total of 10,368 tokens (36 spks x 16 target words x 2 boundaries x 3 focus types x 3 repetitions) were obtained for analysis. We measured F1 and F2 at the steady-state point of the vowel and vowel duration, and calculated acoustic differences in these measures (F1 diff., F2 diff., V-dur diff.) for each minimal pair to test how the phonetic distance between the contrasting vowels is directly influenced by prosodic strengthening. The significant results obtained with repeated measures ANOVAs with Focus and Boundary (within-subject factors) and Language (between-subject factor) are summarized below.

First, (not surprisingly) there was a clear Language effect in both spectral (F1 diff., F2 diff.) and temporal dimensions (V-dur diff.): native (English) speakers showed a much greater phonetic distance between the contrasting vowels compared to non-native (Korean) speakers. Interestingly, Korean speakers showed much lesser phonetic distinction for /e/-/æ/ than for /i/-/u/, especially in the temporal dimension, while English speakers showed a similar degree of temporal distinction for both pairs. The difference between Korean and English speakers is attributable to different sources for the temporal difference. For /e/-/æ/, the temporal difference is intrinsically linked to the vowel height, but Koreans did not make a clear vowel height distinction (as reflected in F1 diff.), thus showing no robust temporal effect (due to the vowel height). For /i/-/u/, on the other hand, the temporal difference arises with the phonological feature [+/- tense], and Korean speakers appear to exploit the phonologically-driven temporal cue to make the vowel contrast. (Korean speakers are assumed to be more sensitive to the temporal than to the spectral cue due to their L1 experience with a relatively sparse vowel space in Korean.)
Turning to prominence (focus) effects, English (native) speakers enhanced the contrast for /i/-/ɪ/ in both F1 and V-dur when the vowels were focused (PF=LF>UF). Korean speakers, in contrast, showed a pattern of PF>LF>UF only in V-dur. In other words, English speakers enhanced [+/-tense] for /i/-/ɪ/ contrast in both spectral and temporal dimensions, whereas Korean speakers enhanced [+/-tense] only in the temporal dimension. For /ɛ/-/ɛ̆/, English speakers showed a focus effect in both the spectral and the temporal dimensions (PF>LF>UF in F1; PF=LF>UF in V-dur). Korean speakers showed a similar focus effect in both the spectral and the temporal dimension (PF=LF>UF in F1; PF>LF=UF in V-dur), though the magnitude of enhancement was far smaller compared to the focus effect with English speakers. The prominence-induced enhancement pattern in the spectral (F1) dimension for both English and Korean speakers can be interpreted as a phonological enhancement of [+/−low] for /ɛ/-/ɛ̆/, which is accompanied by a phonetic temporal enhancement due to the intrinsic vowel height difference. But the focus effect of Korean speakers was much smaller in degree, and that Koreans maintained the vowel contrast only when focused while English speakers did so across the board.

Another interesting point is that English speakers showed no distinction between the Phonological and the Lexical Focus in the temporal dimension, but Koreans showed a pattern of PF>LF in the temporal dimension for both /i/-/ɪ/ and /ɛ/-/ɛ̆/. This suggests that phonological focus increased the non-native speakers’ phonological awareness of the vowel contrast (more than lexical focus did), which is reflected in the temporal dimension to which Korean speakers are sensitive (more than to the spectral dimension, due to the sparse vowel space in Korean).

Finally, a boundary (domain-initial) effect was found on /i/-/ɪ/ with native speakers, but only in V-dur—i.e., the temporal distance was larger in IP-initial than in IP-medial syllables. Korean speakers did not show any boundary effect on /i/-/ɪ/. For /ɛ/-/ɛ̆/, both native and non-native speakers showed boundary-induced enhancement in F2 difference. Note that this differs from the prominence-driven enhancement pattern found in F1 difference. The boundary factor, therefore, did not give rise to as robust phonological contrast enhancement as the focus effect did, and the observed boundary effects appear to be different from the focus effects in nature, consistent with the view that the boundary effect is driven by the delimitative function (enhancing the prosodic boundary juncture) and the prominence effect by the culminative function (enhancing the phonological contrast) (e.g., Beckman 1996; Keating 2006).

In conclusion, the results provided concrete empirical evidence that prominence-induced prosodic strengthening that arises with the information structure makes reference to the phonological system of a given language in both L1 and L2 speech: It maximizes phonological contrast by virtue of enhancing phonetic features such as F1/F2 and V-dur. The results also showed that boundary-induced prosodic strengthening is associated with a different type of enhancement, suggesting that speakers encode different aspects of prosodic structure in phonetically different ways. Furthermore, the non-native Korean speakers’ strengthening patterns indicate that prosodically-conditioned enhancement of phonological contrast is further modulated by the speakers’ L1 experience (i.e., Koreans exploit the temporal dimension as they are less sensitive to the spectral differences of English vowels due to their L1 experience). It is hoped that the present study sparks further studies that illuminate the nature of the phonetics-prosody interface in connection with linguistic contrast in both L1 and L2.

References


