

# Phrase Initial Temporal Effects in Hebrew

Acoustic lengthening at major prosodic boundaries has been extensively studied (e.g. Oller, 1973; Klatt, 1975; Wightman et al., 1992; Shattuck-Hufnagel and Turk, 1998) but its exact nature is still not clear. While phrase final lengthening is relatively well established (Wightman et al., 1992; Berkovits, 1993; Rietveld and Gussenhoven, 1995; Cambier-Langeveld, 1997), phrase initial effects are understudied. Phrase initial lengthening has been found in English (Shattuck-Hufnagel and Turk, 1998; Cho et al., 2007. But see Wightman et al., 1992, who did not find phrase initial lengthening in English), French (Tabain, 2003), and Greek (Katsika, 2009). However, the exact domain of lengthening and its interaction with lexical prominence are not well understood.

The current acoustic study was conducted to examine the scope of phrase initial lengthening in Hebrew, and its interaction with lexical stress. Six native speakers produced test words with either an initial fricative, an initial affricate, or an initial stop, followed by the vowel /i/, a nasal, and finally the vowel /a/ (the words are /tina/, /tima/, /pina/, /kima/, /sima/, /zima/, /fina/ and /tsina/). Each one of the test words appeared in two lexical stress conditions, penultimate and final, and in two positions in a prosodic phrase, immediately following a prosodic boundary and phrase medially. In total, 32 sentences were constructed: 2 boundary conditions x 2 stress conditions x 8 words. Each one of the sentences was repeated 8 times, for a total of 256 sentences per speaker.

Results from one speaker were analyzed thus far, analysis of five more speakers is currently being conducted. The duration of each of the four segments in each word was measured. A 2 (boundary: sentence initial, sentence medial) x 2 (stress: penultimate, final) ANOVA was conducted on the z-scores of the segment durations. The ANOVA was conducted separately for each of the segments: the leftmost consonant (C1), the leftmost vowel (V1), the rightmost consonant (C2) and the rightmost vowel (V2). Main effect of boundary was found for C1, C2 and V2, such that C1 was longer phrase initially (i.e. immediately adjacent to the boundary) than sentence medially (i.e. farther away from the boundary), while C2 and V2 were longer phrase medially than phrase initially. The lengthening and shortening were not equal in their degree: while C1 lengthened on average by 108%, C2 was shortened by 8.7% on average, and V2 was shortened by 4.6% on average. In addition, the fricatives showed less lengthening on average than the stops and the affricate: stops were lengthened on average by 138.32%, fricatives were lengthened by 80.17% on average, and the affricate was lengthened by 70.48% on average. Main effect of stress was found for V1, C2 and V2, and marginally for C1 ( $p = 0.06$ ), such that for C1 and V1 segments were longer in penultimate stress than in final stress, whereas for C2 and V2 segments were longer in final stress than in penultimate stress. No interaction was found between boundary and stress.

The discussed results indicate lengthening of the segment immediately following the boundary, followed by no lengthening of the following segment, followed by a compensatory

shortening of the last two segments. The lengthening of the segment immediately adjacent to the boundary is consistent with previous findings (Shattuck-Hufnagel and Turk, 1998; Byrd et al., 2006; Katsika, 2009). The compensatory shortening which follows the lengthening is similar to the effect found by Byrd et al. (2006). The shortening is interpreted here, as it is interpreted in Byrd et al. (2006), as restoration of the utterance's original temporal properties, i.e., its timing had the lengthening did not take place.

## References

- Berkovits, R. (1993). Progressive Utterance-Final Lengthening in Syllables with Final Fricatives. *Language and Speech*, 36(1):89–98.
- Byrd, D., Krivokapić, J., and Lee, S. (2006). How Far, How Long: On the Temporal Scope of Prosodic Boundary Effects. *Journal of the Acoustical Society of America*, 120(3):1589–1599.
- Cambier-Langeveld, G. M. (1997). The Domain of Final Lengthening in the Production of Dutch. In de Hoop, H. and Coerts, J., editors, *Linguistics in The Netherlands 1997*, Language Acquisition and Language Disorders 28, pages 13–24. John Benjamins, Amsterdam/Philadelphia.
- Cho, T., McQueen, J. M., and Cox, E. A. (2007). Prosodically Driven Phonetic Detail in Speech Processing: The Case of Domain-Initial Strengthening in English. *Journal of Phonetics*, 35(2):210–243.
- Katsika, A. (2009). Boundary and Prominence-Related Lengthening and Their Interaction. *Journal of the Acoustical Society of America*, 125(4):2572–2572.
- Klatt, D. H. (1975). Vowel Lengthening is Syntactically Determined in a Connected Discourse. *Journal of Phonetics*, 3(3):129–140.
- Oller, D. K. (1973). The Effect of Position in Utterance on Speech Segment Duration in English. *Journal of the Acoustical Society of America*, 54(5):1235–1247.
- Rietveld, T. and Gussenhoven, C. (1995). Aligning Pitch Targets in Speech Synthesis: Effects of Syllable Structure. *Journal of Phonetics*, 23(4):375–385.
- Shattuck-Hufnagel, S. and Turk, A. (1998). The Domain of Phrase-Final Lengthening in English. *Journal of the Acoustical Society of America*, 103(5):1235–1236.
- Tabain, M. (2003). Effects of Prosodic Boundary on /aC/ Sequences: Acoustic Results. *Journal of the Acoustical Society of America*, 113(1):516–531.
- Wightman, C. W., Shattuck-Hufnagel, S., Ostendorf, M., and Price, P. J. (1992). Segmental Durations in the Vicinity of Prosodic Phrase Boundaries. *Journal of the Acoustical Society of America*, 91(3):1707–1717.