

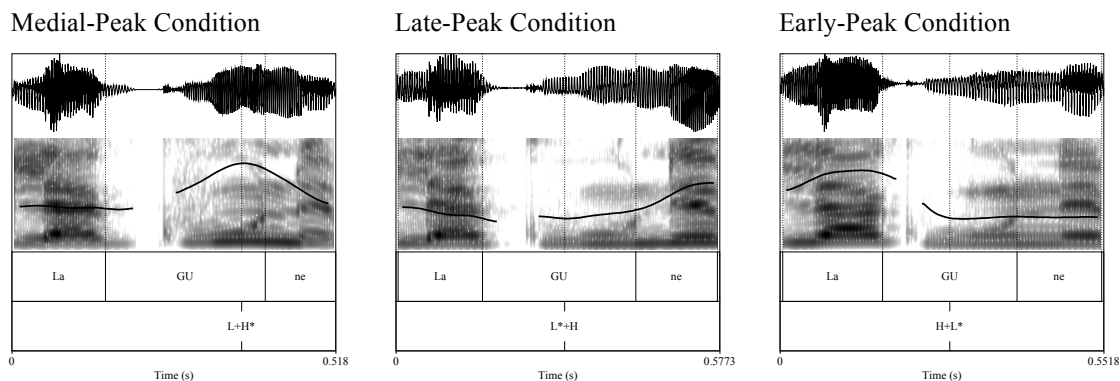
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## Only high-pitched stressed syllables are good (prominent?) word onsets for German 9-month-olds: intonation modulates the extraction of embedded words

Stressed syllables are characterized by increased prominence, thus standing out from their linguistic environment ([1]). When segmenting speech, infants acquiring a stress-timed language take these units as word onsets (e.g., [2], [3]). Stressed syllables are acoustically signaled by longer duration, higher intensity and shallower spectral tilt (e.g., [4]-[7]); they additionally receive  $f_0$ -movement when the words are accented. According to [8], peak contours are distinguished by the association of the peak with the stressed syllable, resulting in medial-peak accents, (L+)H\*, late-peak accents (L\*+H) and early-peak accents (H+L\*). Regarding speech perception, the position of pitch peaks is an unreliable stress cue and consequently no reliable segmentation cue. On the other hand, infants have been shown to exploit pitch information in segmenting artificial language input ([9]). In two head-turn-preference studies with German 9-month-olds, we investigated how utterance-level intonation modulates infants' extraction of embedded words.

In Experiment 1, 54 German 9-month-olds were familiarized with WSW-carriers, e.g., [la.'gu:ɪ.nə], embedded in sentences. The carriers were recorded in 3 intonation conditions: a peak-stress-association-condition (medial-peak) and 2 dissociation-conditions, one frequent (late-peak), one infrequent (early-peak, [10] for frequency distributions in IDS). Infants were randomly assigned to one of these conditions, Fig. 1.

Figure 1: Example smoothed pitch contours of WSW-carriers in three intonation conditions;  $f_0$ -range is shown between 120 and 400Hz.

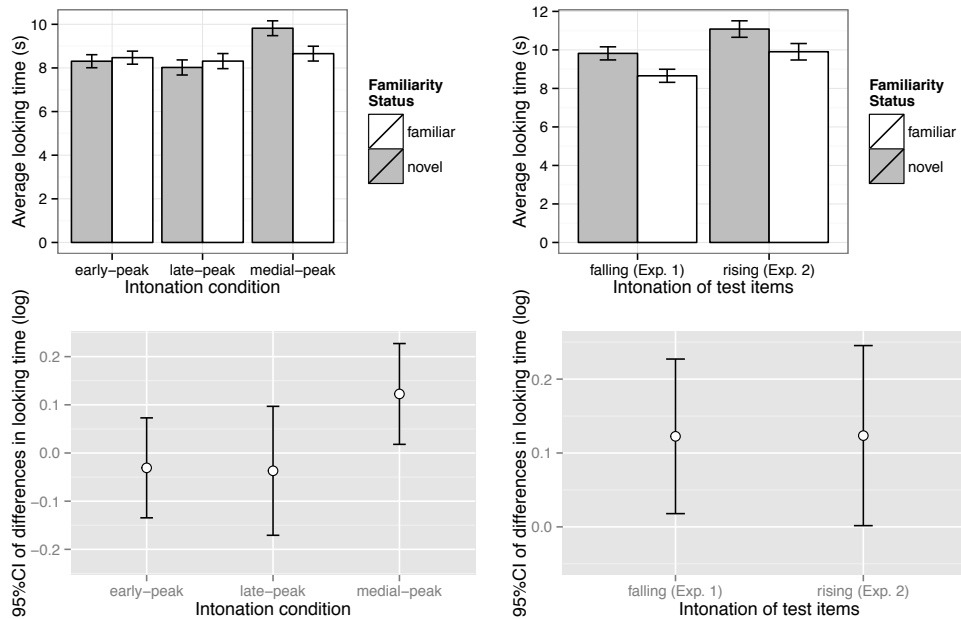


They were then tested on the recognition of the SW-units of the carriers, e.g., ['gu:ɪ.nə], recorded 15 times with high-falling intonation.

Looking times were averaged by *familiarity status* (novel/familiar) for each infant (Fig. 2). A *lmer* showed a significant interaction between *intonation condition* and *familiarity status* when comparing each of the dissociation-conditions to the association-condition (both  $p$ -values < 0.05). For the medial-peak condition, results showed a statistically significant effect of *familiarity status* ( $\beta = 0.12$ , 95%CI: [0.02;0.23], SE = 0.05,  $t = 2.5$ ,  $p = 0.02$ ). No effect was found for the two dissociation-conditions (both  $p$ -values > 0.5).

Experiment 2 replicated the medial-peak condition of Experiment 1 with test items in a different intonation (rises instead of falls). Another 18 9-month-olds were familiarized with the stimuli of the medial-peak condition of Experiment 1 and tested on the SW-units, now with rising intonation. Again, the results showed a significant novelty effect ( $\beta = 0.12$ , 95%CI: [0.002;0.25], SE = 0.06,  $t = 2.1$ ,  $p = 0.047$ ), comparable to Experiment 1, see Fig. 2.

Figure 2: Average looking times split by familiarity status and 95%CI of looking time differences (novel - familiar) in Experiment 1 (left) and Experiment 2 (right; for ease of comparison both medial-peak conditions are displayed).



Results suggest that for German 9-month-olds stressed syllables must be high-pitched to be prominent enough to be perceived as word onsets. Since input frequency of pitch accent types in IDS (Experiment 1) and test intonation (Experiment 2) had no effect, the underlying mechanism appears to be the salience of high-pitched stressed syllables.

## References

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