

NONNATIVE SPEECH SOUNDS FAST: EVIDENCE FROM SPEECHRATE NORMALIZATION

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In spontaneous conversations, there is immense variability in the speed at which people speak. One means by which listeners compensate for this variability involves the interpretation of local durational cues relative to the rate of the context (speechrate normalization). When a target word follows a fast carrier sentence, the target word sounds relatively longer than when the same target follows a slow carrier sentence. This contrastive effect has been found in the perception of duration cues to lexical stress, word boundaries, and vowel duration to name but a few.

However, there is evidence that rate perception is not only sensitive to objective measures such as syllables per second, but also depends on the ease of processing the temporal signal (Block, Hancock, & Zakay, 2010, *Acta Psych*): that is, the higher the cognitive load, the faster a stimulus is perceived. For example, when listening to nonnative speech listeners judge sentences to sound faster than matched native sentences that are of the same overall duration (Anderson-Hsieh & Koehler, 1988, *Lang Learning*). However, suggestions that cognitive load may affect rate perception are based on explicit rate judgments. Explicit and implicit processing have often been shown to dissociate in the psychological literature (e.g., Vorberg et al. 2003, *PNAS*). Therefore, the present study investigated whether implicit processing of speechrate as measured by the well-studied effect of rate normalization shows different effects for native and nonnative speech. Speechrate normalization can be called implicit as listeners do not judge the rate of a sentence but rather categorize a sound contrast whose perception is affected by the perceived speechrate of the context.

Specifically, we studied speechrate normalization of the Dutch vowel contrast /a/ vs. /a:/ in temporally and spectrally matched native and nonnative sentences. Two native and two nonnative (Austrian) speakers of Dutch were recorded producing the same four semantically unconstraining sentences ending in the words *tak* /tak/ (branch) and *taak* /ta:k/ (task) at a fast and a normal rate. To ensure identical rates across speakers, carrier sentences were matched for total duration (PSOLA). Additional analyses of the long-term average spectra of the carriers suggested that any potential effect could not be due to spectral context effects.

One "*taak*" target was selected for each speaker, whose vowel was spectrally manipulated to be ambiguous between /a/ and /a/. These spectrally ambiguous targets were then used to create vowel duration continua ranging from 90 to 210 ms in steps of 20 ms. A pretest showed that continua were perceived as ranging from "*tak*" to "*taak*", with close to identical categorization functions for all speakers (i.e., no baseline differences when targets were categorized in isolation). Target continua were then spliced onto all carrier sentences from the respective speaker. Despite the spectral and temporal matching, accentedness ratings revealed a clearly perceivable foreign accent in the nonnative sentences.

Forty-five participants categorized 448 tokens as "*tak*" or "*taak*" (2 native + 2 nonnative speakers x 4 carriers x 2 rates x 7 continuum steps x 2 repetitions). Trials were presented in random order but blocked by nativeness with block order counterbalanced across participants. Generalized Linear Mixed Models revealed that listeners reported more "*taak*" responses when listening to fast sentences (i.e., the expected rate normalization effect), and when listening to nonnative speech. Given the contrastive nature of speechrate normalization, the latter effect suggests that nonnative sentences are perceived as faster than duration-matched native sentences. In line with previously reported explicit rate judgments, we suggest that our results may be explained in terms of cognitive load: the accent in nonnative speech places a relatively heavier cognitive load on the native listener as compared to native speech. Thus, it may be more difficult for the listener to 'keep up' with processing nonnative speech, resulting in a perceptually faster rate. Therefore, rate perception in speech is not dependent on syllable durations alone but also on the ease of processing of the signal.