

Linear changing duration is processed differently in speech and non-speech signals

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The German vowel system has a complex structure comprising a quantity distinction depending on lexical stress and syllable structure. The present study investigated the neural and behavioral processing of duration in vowels and non-speech stimuli in German native speakers.

The speech material consisted of a disyllabic, trochaic nonsense word /tat@/, in which the duration of /a/ was manipulated to produce a continuum between the category short and the category long. The vowel /a/ was chosen since its long and short cognates are differentiated merely on the basis of vowel duration.

With the speech material, 20 subjects were tested by an identification task, a goodness rating and an adaptive discrimination task. It was found that German vowel quantity matches the criteria for the categorical perception, i.e. the sharp category boundary between category short and long was accompanied by a maximum in identification response time and discrimination performance. Within the categories, it matches also the criteria for the perceptual magnet effect: the discrimination performance correlated inversely with goodness ratings, i.e. the discrimination ability deteriorates in the near proximity of the prototype.

In the MEG experiment, in addition to the speech material, non-speech stimuli were used as controls in a passive listening task. The noise-tone-noise-tone sequences were structure-matched to the speech stimuli. The aim of this experiment was to find the similarities as well as the differences between the neural correlates of the processing of linear changing duration in speech and non-speech.

Besides the stereotypical *M50-M100* complex to the stimulus onset, the second syllable / noise-tone part of the stimuli produced an *M50-M100* complex of their own (*S2M50* / *S2M100*). The amplitude strength of the *S2M50* deflection varied as a function of duration in both conditions: It increased linearly toward the category boundary found in the identification test and decreased afterwards. The *S2M50* deflection differed between the conditions insofar that it was absent for short tone durations, but was present for longer tone durations and for all vowel durations.

Both, the increase and the decrease of *S2M50* amplitude strength in both conditions and the absence of a *S2M50* deflection in the non-speech condition are discussed in the background of the "asymmetric sampling in time" hypothesis [1].

The different amplitude strength of the *S2M50* as a function of duration could result from location of the onset of the second syllable / part within the temporal window [2].

Furthermore, an additional *M50/M100*-like deflection between the first and the second syllable was found in case vowel duration exceeded the duration of the category boundary. This additional deflection was not observed in the non-speech stimuli. The *M50/M100*-like deflection might be interpreted as a top-down influenced perception of additional duration that results in the opening of an additional phonological "event" or "slot". This result thus indicates a nonlinear, categorical difference in the processing across short and long vowels.

The findings of the present study indicate an impact of phonological vowel categories on auditory processing of speech durations, in contrast to non-speech durations.

[1] Poeppel D. 2003. The analysis of speech in different temporal integration windows: cerebral lateralization as 'asymmetric sampling in time'. *Speech Communication* 41:245-55

[2] Yabe H, Koyama S, Kakigi R, Gunji A, Tervaniemi M, Sato Y, Kaneko S. 2001. Automatic discriminative sensitivity inside temporal window of sensory memory as a function of time. *Cognitive Brain Research* 12:39-48