

Language specific representations in word stress perception: ERP evidence

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The speech signal consists of two types of acoustical information: segmental information, being the property of speech sounds, and suprasegmental or prosodic information, being the property of several successive speech sounds. During speech perception, both of these are extracted from the speech input simultaneously and are encoded in separate memory representations. Thus, when listeners recognize speech, they are processing a prosodically determined variant [1]. We can identify several different types of prosodic information, the most important ones being length, rhythm, intonation and stress [2]. In the present talk, I focus on the processing of stress.

Stress, similarly to other prosodic features, is a multidimensional information, comprising several different acoustic changes, such as intensity and fundamental frequency (f₀). Stress is a relative emphasis given to certain syllables within words or to certain words in sentences [3]. Word stress plays either a culminative or demarcative role, that is emphasizing or separating certain parts of the speech stream, thus potentially contributing to the segmentation of continuous speech into words [4]. Languages differ considerably in the use of word stress: in the position of the stressed syllable within multisyllabic words (initial, final, penultimate, etc.); in the variability of the stressed syllable's position (free or fixed); and whether stress can distinguish lexical meaning (contrastive or non-contrastive). Fixed-stress languages (like Hungarian) mandatorily assign syllable stress to a specific position within a word, and stress is non-contrastive. Therefore, it can be assumed that stress processing demonstrates language specificity.

In this talk, I will present event-related brain potential (ERP) results related to the processing of word stress patterns from three different studies, using meaningless pseudowords [5], meaningful words [6] and pseudowords spoken by foreign speakers. The basic premise of the studies was that words stress is processed in relation to long-term representation, which are pre-lexical and language specific. Consequently, we can assume that both words and pseudowords are processed similarly, and foreign words are processed differently from native words. In order to study these assumptions, we applied the passive oddball paradigm to elicit the Mismatch Negativity (MMN) ERP component, a fronto-centrally negative waveform appearing to the pre-attentive detection of violation of simple or complex regularities [7].

In the experiments, Hungarian participants heard disyllabic words (ba'ba, meaning 'baby'), pseudowords (bɛ'bɛ) and pseudowords pronounced either by a Hungarian or a German speaker (be:'be:). Stress could be either on the first (legal stress) or on the second (illegal stress) syllable. The experimental design in all three experiments was similar. We used two conditions: in the first, stimuli with the legal stress were standards and stimuli with illegal stress were deviants; in the second condition, the standards and the deviants were reversed. This allowed us to calculate the MMN component by subtracting ERPs to the standard from the ERPs to the deviant using physically identical stimuli.

Results showed that the pseudoword deviant having an illegal stress pattern elicited two consecutive ERP components that were considered as MMN, whereas the deviant having a legal stress pattern did not elicit MMN. Moreover, pseudowords with a legal stress pattern elicited very similar ERP responses irrespective of their role in the oddball sequence, i.e., if they were standards or deviants, demonstrating that their processing relied on long-term instead of short-term (stimulus sequence related) memory traces (see Fig.1.). Meaningful words elicited similar ERP deflections, but the lexical status slightly modulated the processing of stress patterns. This modulation was different for the legal and illegal stress patterns (see Fig.2.). Finally, the comparison of pseudowords with native and non-native pronunciation showed that all pseudowords in the deviant

position elicited an Early Differentiating Negativity (EDN) and a Mismatch Negativity (MMN) component, except for the Hungarian pseudowords stressed on the first syllable. This suggests that Hungarian listeners did not process the native legal stress pattern as deviant, but the same stress pattern with a non-native accent was processed as deviant.

In conclusion, our data show that word stress pattern change is processed preattentively by the human brain, and this is slightly modulated by the lexical status of the word. Words and pseudowords with legal stress pattern do not initiate an error detection mechanism, as indicated by the lack of MMN component, but only if they are native sounding. We suggest that this is an evidence that word stress is processed based on prelexical language specific stress representations.

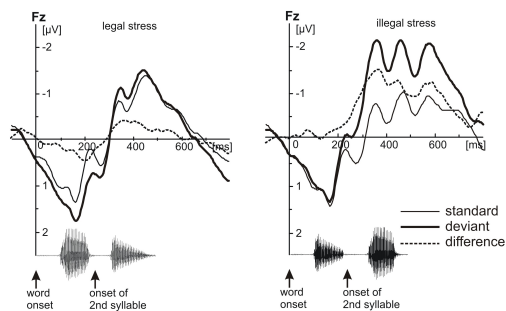


Fig.1. ERPs elicited by the pseudoword with legal and illegal stress pattern in the standard and deviant positions. The figures depict ERPs to the same stimulus in two different positions, and the difference wave obtained by subtracting the ERPs to the same pseudoword in the deviant and standard positions.

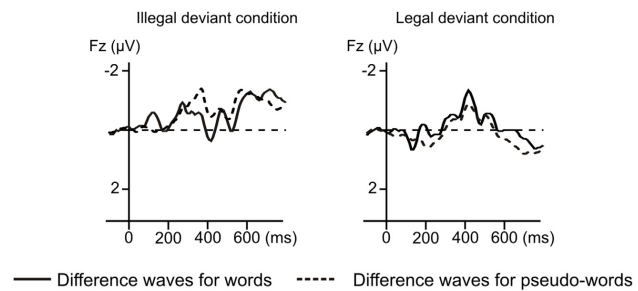


Fig.2. Difference wave ERPs for words and pseudowords.

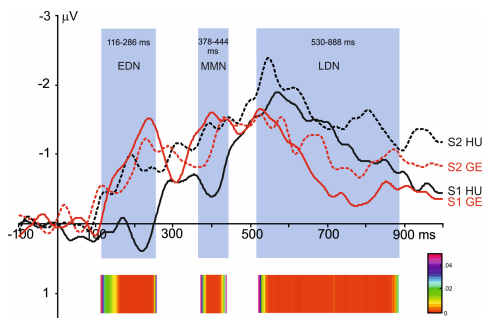


Fig.3. Difference wave ERPs cross-linguistic study. The results of the TANOVA analysis are depicted below the ERPs. Colored intervals show the significant Language x Stress position interaction. S1: stimuli with stress on the first syllable; S2: stimuli with stress on the second syllable; HU: Hungarian stimuli; GE: German stimuli. EDN: Early Differentiating Negativity; LDN: Late Discriminative Negativity.

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