Default and exceptional stress processing in Spanish: an ERP analysis

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In this paper we set out to investigate the status of stress as an abstract category and its connection with both the phonetic parameters and lexical access. In a neurophysiological experiment measuring event-related potentials (ERPs), we tested the generativist hypothesis concerning lexical storage vis à vis its competing usage-based model [1]. We also tested the hypothesis that in Spanish, in the absence of intonational cues, intensity in the higher regions of the spectrum is of major importance in stress perception [6].

Spanish is characterised by variable stress with an uneven distribution of penultimate, antepenultimate and final-stressed words in the language. Over 64% of all Spanish words are stressed on the penultimate syllable [2] (78.9% in [3]), while antepenults constitute merely 8% (or 2.76%) and should be considered exceptional. This frequency pattern, together with the partial morphological and phonetic predictability of each of the stress types, allows us to assume that there is a default penult pattern derivable by rules with lexical exceptions that have to be learned (see e.g. [4]). At the same time, given variable stress and the existence of minimal pairs, we expect that Spanish speakers are sensitive to stress differences in perception and successfully identify stressed syllables (they are not 'stress-deaf', [5]). Moreover, it was demonstrated that stress perception in Spanish depends on several cues, most importantly pitch, duration and intensity. In non-accented words, spectral tilt was reported to play an important role instead of general intensity differences between stressed and unstressed vowels [6, 7]. With this in mind, we decided to (a) investigate the abstraction of phonetic detail to stress as a phonological category by testing two differently distributed stress patterns, and (b) look at the neurophysiological response to both F0 and spectral tilt changes that affect stress perception. More specifically, we wanted to establish whether the default penultimate stress pattern is processed differently than the exceptional antepenult and whether the latter but not the former is stored in the mental lexicon to facilitate word retrieval (compare other papers studying stress perception with the use of EEG: [8, 9]). To achieve this goal, we must gain access not only to pre-lexical processing, but also to semantic activation responsible for linking phonology with meaning, hence we used a semantic processing EEG paradigm evoking the N400 negativity effect [10]. As a second task, we used a passive oddball paradigm disentangling F0 from intensity cues and designed to evoke a mismatch negativity response (MMN, [11]).

32 native speakers of Spanish (19 females) aged 19-32 listened to 240 stimuli including either correctly or incorrectly stressed trisyllabic words. 60 penults and 60 antepenults with a CV.CV.CV structure were recorded with a female native speaker in two versions and then spliced into an invariable carrier sentence. The words from the two patterns were of matching frequencies and controlled for phonological neighbourhood. Antepenults had a deviant version with penultimate stress and vice versa. A subset of 16 participants took part in the second task, which involved passive listening to a correctly stressed antepenult native word and three randomly distributed deviants, each of which occurred 8% of the time. The first deviant differed from the standard in the F0 of the last syllable, the second differed in the spectral tilt and the third (control) had a vowel change.

The results confirmed the existence of a default stress pattern in Spanish, revealing no N400 effect in the penults as opposed to the antepenults. Accuracy, reaction times and ERPs taken together suggest that stress cues are combined and abstracted to a phonological structure that is either computed online based on grammatical rules (default) or stored in the lexicon together with the representation of the whole word (exceptions). As for the individual cues involved in stress processing in the absence of sentence intonation, the role of spectral tilt was not confirmed. The hearers apparently tune in to F0 to the same extent as to segmental vowel changes, but not intensity shifts.
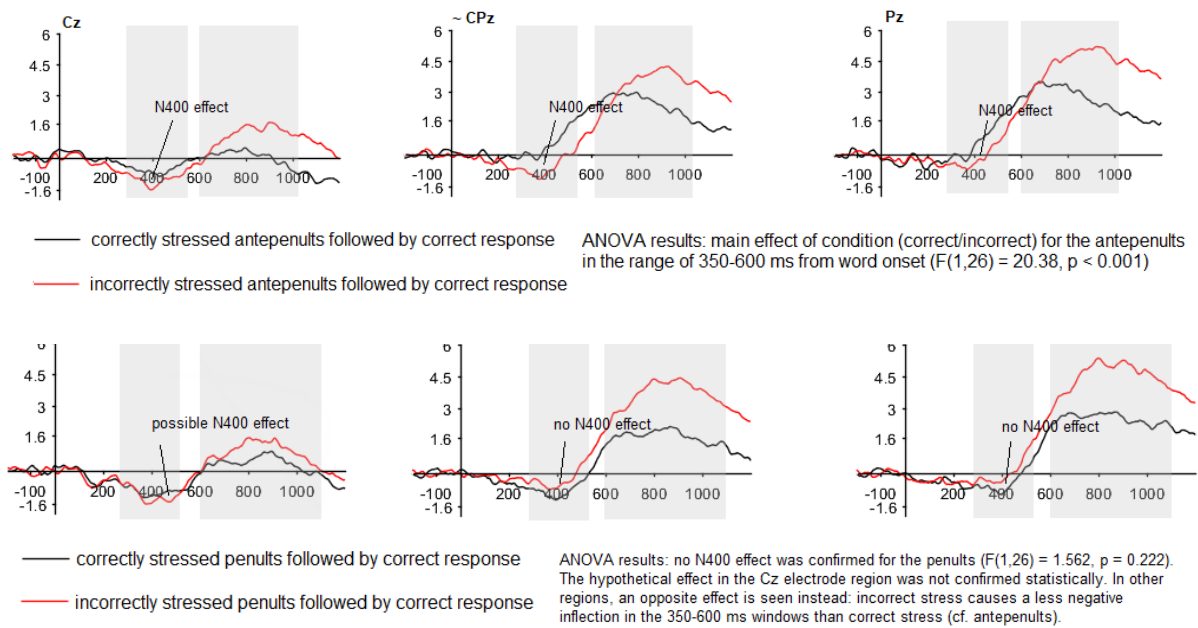
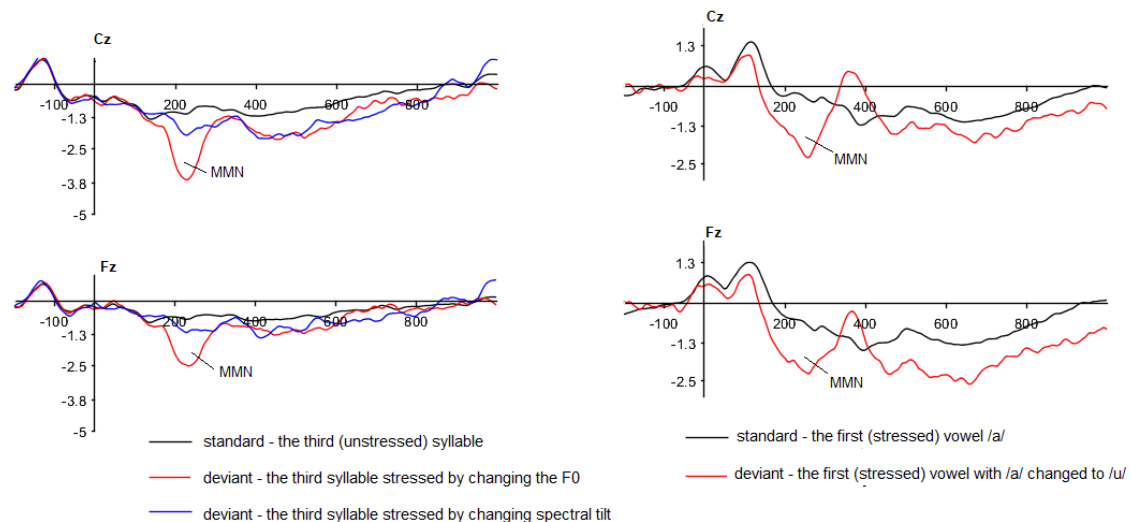Fig. 1. Summary results of the N400 experiment. Positive values up.

Fig. 2. MMN effect in the case of F0 (left) and vowel changes (right), but not spectral tilt (left, blue line).

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