

Perception of acoustic, informational and structural prominence in English, French, and Spanish

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In many theoretical models, prominence relates to prosodic structure: prominence is assigned to the word that is the structural head, or nucleus, of the prosodic phrase. In some languages nuclear prominence has a fixed location at the end of the phrase [1]. In other languages, it is assigned to a word based on its information status (focused or discourse-new) and is variable in its phrasal location [2]. We ask how this difference in the function of prosody, as signaling prosodic boundaries and/or information status, is reflected in listeners' perception of prominence, comparing languages with different prominence systems—English, Spanish and French [3]. Such differences are predicted based on prior work showing that prominence perception is influenced by expectations about the prosodic realization of a word, taking into account linguistic context [4,5]. In English, nuclear prominence bears an obligatory pitch accent and the default location is the rightmost content word in the prosodic phrase. But focus, along with several other factors, can locate nuclear accent earlier in the phrase, with the consequence that there is a strong link between acoustic and informational prominence. In Spanish, nuclear prominence is also marked by pitch accent and has a fixed location on the phrase-final (content) word, but words with marked focus cannot always be located in this position as the order of words within constituents is not flexible, so the link between acoustic and informational prominence is weaker in Spanish than in English. French occupies a middle ground. The nuclear accent is most often phrase-final but it can also occur earlier in the phrase under some marked focus structures, though less commonly than in English. In this paper we compare English, Spanish and French for the influence of non-acoustic factors (adjacency to a prosodic boundary; word frequency) in the perception of prominence.

Using Rapid Prosody Transcription [3], we instruct listeners to attend to acoustic criteria or to informational ('meaning-based') criteria through different task instructions, and compare prominence ratings across tasks and languages. We test several hypotheses: (i) low frequency words (ie., with high information value), are more likely to be judged prominent, especially under the meaning-based instructions, and this effect is greatest for English; (ii) the (content) word preceding a marked boundary is more likely to be judged prominent, especially under the meaning-based instructions, and this effect is greatest for Spanish; (iii) the difference in prominence rating under acoustic and informational criteria is smallest in English due to the strong association between prominence and information status.

30 native speakers of each language were recruited from Illinois (English), Lyon (French), and Valladolid (Spanish), to participate in a prominence and boundary marking experiment. Participants were given no training and had little or no linguistics background. They listened over headphones to excerpts of spontaneous speech in their native language, drawn from the Buckeye Corpus (English, 15 speakers, mean duration 17.5 s, 864 words total [6]), the Corpus du Français Parlé Parisien (French, 14 speakers, mean dur. 24.2 s, 1062 words [7]), and the Glissando corpus (Spanish, 12 speakers, mean dur. 15.5 s, 887 words [8]). Simultaneous with audio presentation, transcripts of the excerpts without punctuation or capitalization were displayed on a computer screen, and participants clicked on words they heard as prominent or as preceding a boundary. Prominence judgments were made in real time based on auditory impression alone. Boundaries and prominence were judged twice for the same materials (order counter-balanced), once as defined in terms of explicit auditory cues (e.g., loudness, pitch), and once defined in terms of information value (e.g., which words contain the main points of information).

Prominence ratings from all participants for content words were aggregated and a single mixed effects logistic regression model was run in R, with each participant's rating (0 or 1) for each word as the dependent variable, totaling 66,540 observations. Fixed effects of interest were log word frequency and boundary marking (0 or 1); other fixed effects (part-of-speech, F0, speech rate, intensity) were included as control variables, along with their interaction with language and task instruction. The maximum random effects structure supported by the data (random intercepts for transcriber and word token as item) was used. All continuous variables were scaled prior to analysis. Here we report on the effects of log word

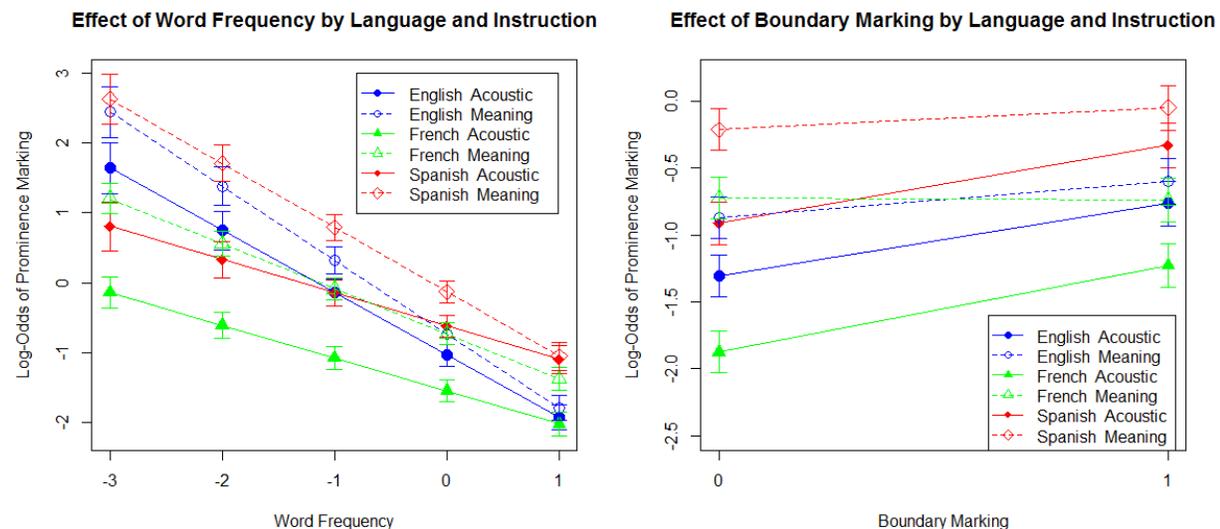
frequency and boundary marking in the three languages under the two instructions. The interaction of language, instruction, and log word frequency, and the interaction of language, instruction, and boundary-marking were both significant (LRT p -values .0003 and .0137 respectively).

Results (see Fig. 1) confirm hypothesis (i): Less frequent words were more often judged to be prominent, with a larger effect size under meaning-based instructions for all three languages, and the largest overall effect for English (see Table 1). Hypothesis (ii) is only partially confirmed: Words preceding a boundary (score = 1 in right side of Fig. 1) were more likely to be judged as prominent; however, against our prediction the greater boundary effect occurs under acoustic instructions for all languages. Finally, hypothesis (iii) is confirmed: English showed the smallest differences in prominence as rated based on acoustic vs. meaning-based factors.

These findings reveal differences in prominence perception across languages that reflect differences in the relationship between prominence, prosodic boundaries and information status. An informational factor like word frequency most strongly influences prominence ratings for English, where prominence is the primary expression of information status. But despite differences in the phrasal location of nuclear prominence among the languages, the structural factor of adjacency to a prosodic boundary uniformly influences prominence perception based on acoustic criteria in all languages. Listeners in all three languages tend to perceive an acoustically-cued structural prominence on the phrase-final word, suggesting the primacy of a structural nuclear prominence in prosodic theory.

Table 1. Effect sizes for a one s.d. increase in log word frequency, and a change from no boundary marked to boundary marked, by language and instruction.

Estimates (log-odds)	English		French		Spanish	
	Acoustic	Meaning	Acoustic	Meaning	Acoustic	Meaning
Word Frequency	-0.8928	-1.0602	-0.4698	-0.6466	-0.4763	-0.9212
Boundary Marking	0.5397	0.2685	0.6472	-0.019 (<i>n.s.</i>)	0.5838	0.1634



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