Categorical perception of lexical stress: A cross-linguistic study
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Previous research has shown that listeners’ perception of speech sounds is affected by phonological properties of their native language with better discrimination of acoustic differences if two sounds span a category boundary than when they fall within a category. So far, research on categorical perception has concentrated on phonemes (e.g., Liberman et al., 1957) and lexical tones (e.g., Hallé et al., 2004), while the issue of categorical perception of lexical stress is largely unexplored. Our study aims at filling this gap by comparing the perception of lexical stress by native listeners of German versus French. German has lexical stress while French does not and it has previously been found that French listeners are less sensitive to stress than listeners of lexical stress languages (e.g., Dupoux et al., 1997). However, the question of whether, as we hypothesize, native listeners of lexical stress languages perceive stress more categorically (as “trochees” (strong-weak) or “iambics” (weak-strong)) than native listeners of languages without lexical stress is still open.

General method and predictions. Categorical perception can be studied by means of speech continua on which speech sounds or utterances are gradually varied by an acoustic property. In categorical perception, all tokens on a continuum that fall within a category should be perceived as the same, while tokens from different categories should be perceived as different, irrespective of the step on the continuum on which the tokens occur. In discrimination tasks, listeners are asked to discriminate pairs of tokens on a continuum. They have more difficulties if the tokens fall within the same category than when they are part of two different categories (reflecting phonological knowledge beyond acoustic sensitivity, Hallé et al., 2004). In identification tasks, listeners are asked to associate tokens of a continuum with one of the two tokens of its edges. Listeners find this particularly difficult for tokens towards the center of the continuum (reflecting acoustic sensitivity; Hallé et al., 2004), but if the middle area of a continuum coincides with a category boundary, the relation between acoustic distance of the tokens and the identification response will not be linear: listeners will have clear identification preferences as soon as tokens fall within a category (reflecting phonological knowledge; Hallé et al., 2004; Stevens et al., 1964). Following Hallé et al.’s method, we conducted a discrimination and an identification experiment using a lexical stress continuum, for which we predicted that Germans would show clearer patterns of categorical perception than the French. We created an 8-step continuum of the nonword /gaba/ from trochaic ([ga:baː]; step 1) to iambic ([gaː1 baː]; step 8) by simultaneously varying segment duration and the pitch and amplitude contours. Both experiments were analyzed using generalized additive mixed models (GAMM; Baayen et al., 2015; van Rij et al., 2015), which can model non-linear effects of continuous fixed and random factors.

Discrimination experiment. 20 French and 20 German participants heard AXB triplets in which X was identical with either A or B. A and B always differed by two steps on the continuum (e.g., 1-1-3; 4-4-2; 5-5-7). The task was to decide whether X was equal to A or B. A plot of the GAMM (Figure 1) shows that the Germans gave more correct responses when an A and B were from the middle area of the continuum (AB = 2-4, 3-5, 4-6, 5-7) than from an edge (AB = 1-3 and 6-8), suggesting that their perception of lexical stress is categorical: they have more difficulties discriminating between “within-category” tokens than between “across-category” tokens. Model results (Figure 1) suggest that the French’s proportion of correct response gradually increased from the trochaic to the iambic part of the continuum, indicating they were sensitive to acoustic differences between tokens, and that the steps in the iambic part were maybe perceptually more salient to them than the steps in the trochaic area. Differences between groups are revealed by model comparisons: An inclusion of different smooths for each group improved the model ($\chi^2(2) = 27.86, p < .001$). Their smooths of the correct responses differed significantly in the middle area of the continuum (trials 2-4 – 5-7), where the Germans gave more correct responses than the French.

Identification experiment. 20 French and 20 German participants heard AXB triplets in which A and B were always either step 1 or step 8, and X could be any token on the continuum (e.g., 1-5-8; 8-3-1; 1-7-8). The task was to decide whether X sounded more like A or like B. The model plot (Figure 2) suggests that both groups gave more trochee-responses when X was at steps 1-4, more
iamb-responses when X was at steps 6-8, but they had difficulties associating step 5 with either of them, indicating that the perceived categorical boundary is around step 5. Different smooths per group resulted in a marginally better model ($\chi^2(2) = 2.42, p = .089$), indicating group differences that occur at steps 2-3, where Germans gave more trochee-responses than the French, and at steps 5-7, where the Germans give more iamb-responses than the French. These results suggest that German listeners perceive lexical stress in a more categorical way than French listeners.

**General discussion.** Together, the results provide evidence for categorical perception of lexical stress and point to differences between German and French listeners. Both the French and the Germans show a sensitivity to prosodic changes on the continuum, but compared to the French, the Germans show a greater influence of categorical perception in both tasks, where their perception of lexical stress more clearly depended on a within- versus between-category difference. Previous studies have assumed an influence of abstract representations of lexical stress on prosodic perception by native listeners of languages with lexical stress in order to account for their better stress and rhythm processing abilities when compared to native listeners of French (e.g., Bhatara et al., 2013; Dupoux et al., 1997). The current findings support these assumptions by providing evidence that a perception of prosodic variation is influenced by language experience with lexical stress.

**Figure 1:** Discrimination (Exp. 1): Proportion of accurate responses (y-axis) for each “AB” trial (1-3 – 6-8) by French (dashed line) versus German (solid line) listeners. Shades indicate confidence intervals.

**Figure 2:** Identification (Exp. 2): Proportion of iambic (i.e., step 8) responses for each step (1-8) of “X” by French (dashed line) versus German (solid line) listeners. Shades indicate confidence intervals.

**References**


