Effects of perceptual cue weighting on lexical activation

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Listeners quickly adapt their sound category expectations to address inherent ambiguities in speech signals due to extensive variability. This adaptability can be facilitated by the multiple acoustic dimensions that define speech categories and the lexical context which also aids in the swift resolution of ambiguities in speech signals. Recent studies have documented significant individual differences in perceptual cue weighting and lexical recruitment during speech perception, raising questions about the robustness of human linguistic communication and the underlying mechanism for such variation. Of particular interests are recent findings that the relative perceptual weighting between cues is modulated by the quality of auditory brainstem encoding of those cues [6]. Impoverished auditory encoding of the input signal [5, 7] could lead to less precise activation at the phoneme level, which in turn could lead to a less precise, thus more extensive, lexical network being activated. Changes in lexical activation can lead to variability in lexical influence during processing. This study tests this prediction by investigating the link between individual differences in cue weighting and lexical recruitment during speech perception.

Methods. Seventy-four native American English speakers (Ages 21-45; Female = 24) recruited from Prolific completed a two-alternative forced choice task and a word identification in noise task on Qualtrics. The 2AFC task asked listeners to classify a *bet-bat* continuum varying along five formant and five duration steps; stimuli based on [3]. The word identification employed the design and stimuli from [8] where participants were presented with individual words in a background of multitalker babble, and asked to type their response into a text box. Participants' vocabulary proficiency was estimated using a brief version of the Vocabulary Size Test (VST; [4]).

Results. Listeners' "bet"-responses were modeled with logistic mixed effects regressions in R. The fixed effect predictors, all statistically significant, included in the model were FORMANT step, DURATION, and their interaction. The model also included by-subject and by-word random intercepts, as well as by-subject random slopes for FORMANT and DURATION. Word identification accuracy was also modeled with logistic mixed effects regressions with log lexical FREQUENCY and number of phonological neighbors as fixed (statistically significant) factors, and by-subject and by-word random intercepts, in addition to by-subject random slopes for the two lexical factors. VST scores and its interaction with lexical frequency were also included to account for the effects of vocabulary size on word identification.

There are significant positive correlations between perceptual cue weights, as indexed by the logistic regression coefficients for FORMANT and DURATION, and the magnitude of lexical frequency effect (FORMANT $\sim$ FREQUENCY: $\rho = 0.37$, $p < 0.01$; DURATION $\sim$ FREQUENCY: $\rho = 0.28$, $p < 0.05$; Figure 1), suggesting that individuals who pay less attention to the formant or duration cues are more strongly affected by lexical frequency in word identification. While there is a positive trend between the effect of phonological neighborhood density and FORMANT, the correlation did not reach significance.

Conclusions. Our findings confirmed the hypothesis that individual variability in perceptual cue weighting modulates lexical effects in speech processing. Specifically, individuals who pay less attention to phonetic cues are more likely to rely on lexical frequency in word identification. The lack of a significant effect of cue weighting and phonological neighborhood effects is puzzling. Further research is in progress to clarify the nature of this connection.

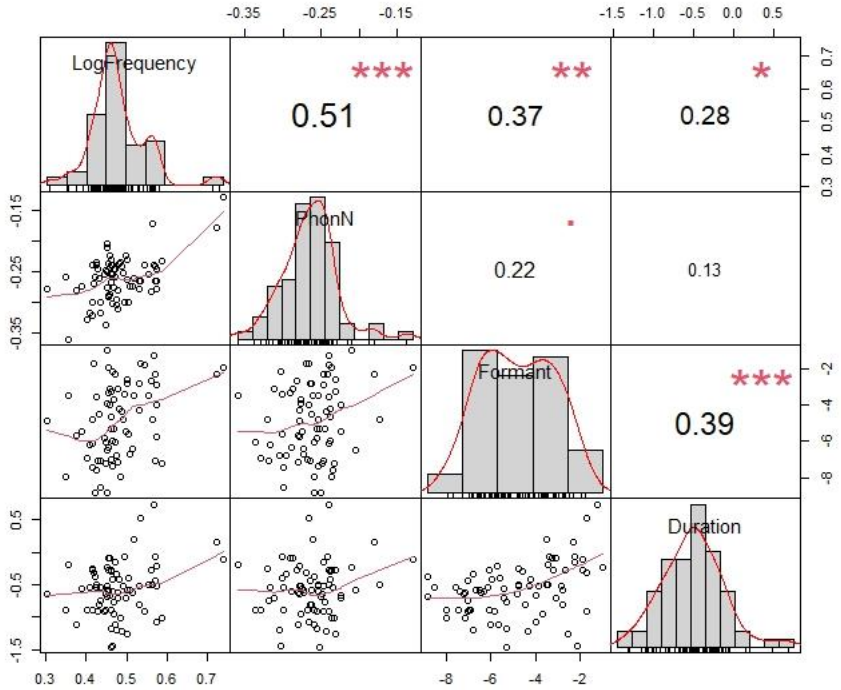

Fig. 1. Correlations between log lexical frequency (from the SUBTLEXUS database; [2]), number of phonological neighbors (PhonN; [1]), formant weight and duration weight. Each point corresponds to the estimates of a participant. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$

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