Facilitation vs. inhibition as mechanisms for syntactic constraints on word recognition

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There is broad agreement that context affects language comprehension, but less attention has been paid to the mechanisms that integrate contextual and perceptual information. During auditory word recognition, one obvious possibility is that context could block sensitivity to perceptual matches by completely *inhibiting* lexical candidates that don't fit the context so that they are eliminated from the cohort and don't compete for recognition. An alternative considered less often is that context *facilitates* items that match its constraints, without affecting items that don't. We consider this issue through the lens of syntactic category, whose constraints should be relatively straight-forward: when context predicts a verb, either verbs could be facilitated or non-verbs could be inhibited. As predicted by the total inhibition account, two recent studies report no competition from words whose categories don't fit the context (Magnuson et al., 2008; Strand et al., 2018), but this is in conflict with earlier work that has shown the opposite (e.g. Tanenhaus et al., 1979; Tyler, 1984). To investigate this, we ran simulations in jTRACE (Strauss et al., 2007) that then informed a new experiment in the visual world paradigm designed to distinguish between an inhibitory and a facilitatory mechanism for category constraint. This experiment provides clear evidence against top-down precedence over perceptual information.

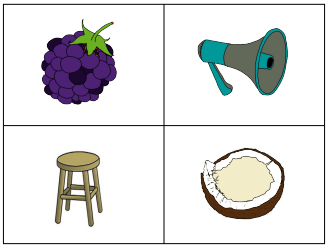
Our simulations explored the role of the response candidate set in measures of word recognition, and suggested that the extent to which we can expect correspondence between activation and response probability for a given item depends very much on the activity of the other items in that set. This is a first step toward explaining the apparent conflict between methods whose candidate sets vary in size, and provided us with insight into what experimental design properties would maximize the chances of detecting cross-category phonological competition if it were occurring. In the visual world paradigm, this includes not displaying pictures for the auditory targets in critical trials (following Huettig & McQueen, 2007) so that only the activation of the competitor can be expected to change in response to the input (see Figure 1a). It is also critical that advance cues to noun or verb status do not allow a pictured item to be ruled out as a referent before target auditory input even begins (an issue in Strand et al. (2018)).

In our visual world experiment (N=144, after 21 exclusions), we presented displays containing four pictures of objects with noun-only names (Figure 1a). These were presented while participants listened to noun-constraining ("They hated the **gremlin** in the haunted house") or verb-constraining ("They hated to **greet** rude visitors") sentence contexts containing an auditory target word for which one of the pictures (grapes) was a phonological competitor. Only filler trials contained pictures matching their auditory targets. For verb-context fillers this meant using noun-biased (and therefore picture-able) noun-verb homophones ("She chose to **frame** her diploma") so that across the experiment there was always a reason to look for a referent, regardless of the context, and there were no visual cues distinguishing noun and verb referents. Participants were instructed to indicate after each trial whether they had seen anything related to the sentence. We tested for increased fixations to the competitor picture relative to baseline using temporal cluster tests in the window 100-550 ms after auditory target onset. In the verb-constraining context, the proportion of fixations should not increase over baseline if wrong-category candidates are inhibited. However, a significant increase occurred in both noun (264-550 ms) and verb (317-454 ms) contexts (Figure 1b), and there was no significant difference in competition between the contexts. A parallel manipulation used noun-verb homophones (e.g. frame, plant) as competitors. Because their frequencies were noun-biased, we anticipated more competition in noun context than verb context in the case of a facilitatory constraint, but this result was not supported statistically. Future work will aim to clarify this as well as the timing of the constraint. We conclude that wrong-category lexical candidates do demonstrate phonological competition, ruling out complete inhibition as the mechanism for the syntactic category constraint.

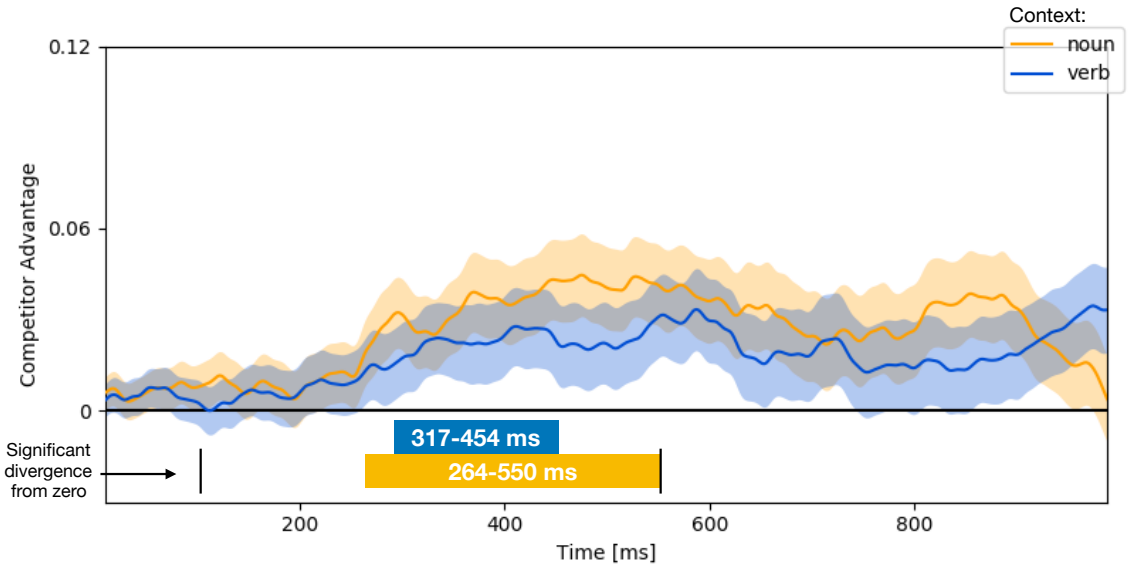
Figure 1: Design and results of visual world experiment

(a) Noun and verb sentence contexts presented auditorily with four noun-only pictures, one of which (grapes) is a cohort competitor of the auditory target (gremlin or greet). Critical trials do not contain a picture for the auditory target.

"They hated the gremlin in the haunted house."
"They hated to greet rude visitors."



(b) Competitor advantage, or increase in proportion of fixations to the noun-only competitor picture (grapes) relative to baseline, in noun (gremlin) and verb (greet) contexts.



References

Huettig, F., & McQueen, J. M. (2007). The tug of war between phonological, semantic and shape information in language-mediated visual search. *Journal of Memory and Language*.

Magnuson, J. S., Tanenhaus, M. K., & Aslin, R. N. (2008). Immediate effects of form-class constraints on spoken word recognition. *Cognition*.

Strand, J. F., Brown, V. A., Brown, H. E., & Berg, J. J. (2018). Keep Listening: Grammatical Context Reduces but Does Not Eliminate Activation of Unexpected Words. *Journal of Experimental Psychology: Learning, Memory, and Cognition.*

Strauss, T. J., Harris, H. D., & Magnuson, J. S. (2007). jTRACE: A reimplementation and extension of the TRACE model of speech perception and spoken word recognition. *Behavior Research Methods*.

Tanenhaus, M. K., Leiman, J. M., & Seidenberg, M. S. (1979). Evidence for multiple stages in the processing of ambiguous words in syntactic contexts. *Journal of Verbal Learning and Verbal Behavior*.

Tyler, L. K. (1984). The structure of the initial cohort: Evidence from gating. *Perception & Psychophysics*.