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

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Context can influence language comprehension by enabling prediction of upcoming syntactic structure. In this work we consider the mechanism by which resulting expectations for the syntactic category of an incoming word are integrated with the auditory input that allows that word to be recognized. One obvious possibility is that predictions could block sensitivity to perceptual matches by completely *inhibiting* inappropriate lexical candidates so that they are eliminated from the cohort and don't compete for recognition. An alternative considered less often is that the category prediction *facilitates* items that match its constraints, without affecting items that don't. In short, when an upcoming word is predicted to be a verb, either non-verbs could be inhibited or verbs could be facilitated. In line with the total inhibition account, two recent studies report no competition from words whose categories don't fit the context [1,2], but this is in conflict with earlier work that has shown the opposite [3,4]. To investigate this, we ran simulations in jTRACE [5] that then informed a new experiment in the visual world paradigm designed to distinguish between an inhibitory and a facilitatory mechanism for the category constraint. This experiment provides clear evidence against the precedence of top-down syntactic category predictions over perceptual information, supporting and extending the conclusions of older work in cross-modal priming and gating that wrong-category candidates do compete.

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 substantially on the activity of the other items in that set. This is a first step toward explaining the apparent conflict between methods whose response 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 [6]) so that only the activation of the competitor is 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; this is a potential issue in Strand et al. [2] that could lead to the appearance of inhibition regardless of whether wrong-category candidates are activated.

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 ambiguous homophones (e.g. frame, plant) as competitors. Because their frequencies were noun-biased and we hypothesized that the constraint would apply in proportion to frequency in the category, we anticipated more competition in noun context than verb context, and that the timing of this difference would indicate the timing of the constraint. While we found significant competition in both noun and verb contexts, the expected difference between them was not supported statistically, potentially due to low power. 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, and indicating that top-down syntactic category predictions do not override bottom-up auditory cues.

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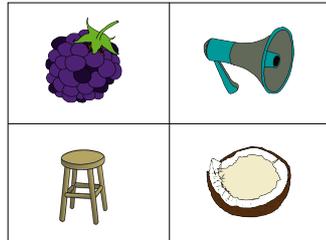
(b) Competitor advantage, or increase in proportion of fixations to the noun-only competitor picture (grapes) relative to baseline, in noun (gremlin) and verb (greet) contexts.
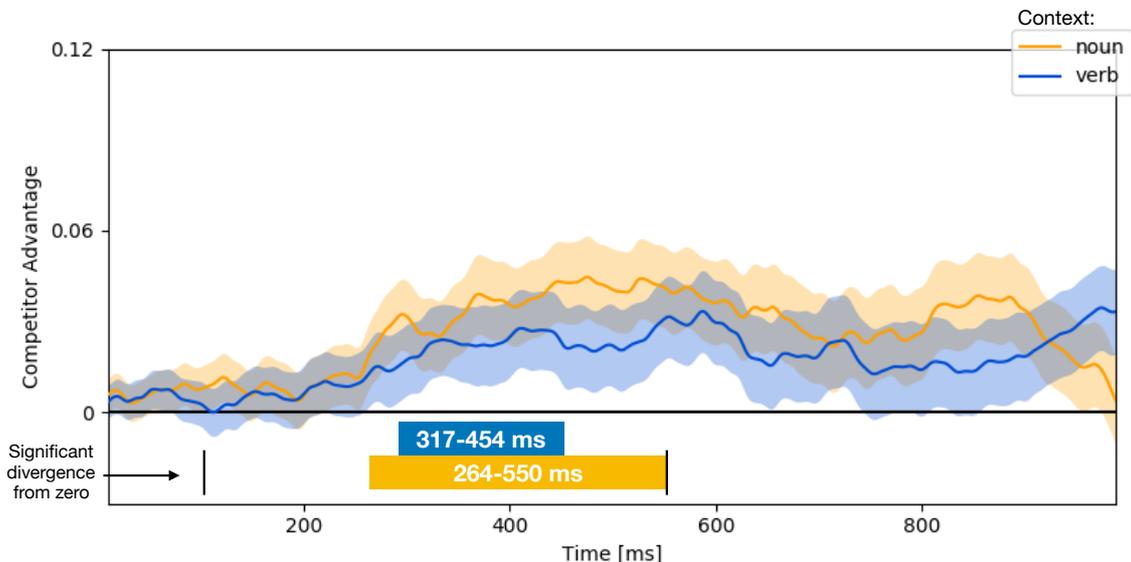
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