Domain-general working memory modulates semantic prediction in native speakers

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While there is rich evidence that people can predict upcoming language [1] [2], studies have found that prediction is modulated by various factors, suggesting that not everyone predicts to the same extent. This study investigated one of such factors, working memory (WM), the cognitive structure that serves to maintain or manipulate information over a short time during concurrent processing activities [3]. While some studies found a correlation between WM and prediction, they do not convincingly show that prediction requires WM resources because a correlation does not show a causal relationship [4] [5]. It is also unclear whether non-linguistic WM is engaged in prediction [6] [7]. To investigate whether domain-general WM plays a role in linguistic prediction, the current study tested whether native speakers' predictions are modulated by a spatial WM load [8], which should require domain-general WM but not verbal WM. Eighty-two native English speakers listened to English sentences in which the target word was predictable or unpredictable based on the preceding verb and the depicted objects. For example, they heard “The woman, who is wearing a white dress, will bite/bring (predictable/unpredictable) one of the doughnuts”, while viewing the pictures of the target (doughnut) and three unrelated distractors (nail polish, notepad, and umbrella) (Figure 1). In half of the trials, they additionally performed a spatial WM task. If the prediction requires domain-general WM resources, we expected a smaller or delayed predictability effect when participants performed the additional spatial WM task compared to when they did not.

A cluster-based permutation analysis detected positive clusters showing more target fixations in the predictable vs. unpredictable condition in both load (the red line in Figure 2, cluster mass statistic = 12990, $p < .001$) and no-load (the red line in Figure 2, cluster mass statistic = 18998, $p < .001$) tasks. It further revealed an interaction of predictability by task (the purple lines in Figure 2, cluster mass statistics = 192 & 251, ps < .001), indicating that the predictability effect was larger in the no-load condition than in the load condition. A divergence point analysis showed that the looks to the target in the predictable and unpredictable conditions started to diverge on average at -1818 ms, 95% CI = [-1920, -1680] in the load task and -1852 ms, 95% CI = [-1920, -1760] in the no-load task relative to the target word onset. Thus, the speed of prediction was similar in the load and no-load tasks.

The results suggest that verb-based semantic prediction is modulated by domain-general WM resources. Domain-general WM may be used for maintaining representations of the context or for selecting or inhibiting relevant representations, as suggested by Ryskin et al. [5].

Figure 1. An illustration of load and no-load task. The task was blocked, and the order of the task was counterbalanced across participants. The experiment had a 2 (Condition: Predictable vs. Unpredictable) by 2 (Task: Load vs. No Load) within-subject design.

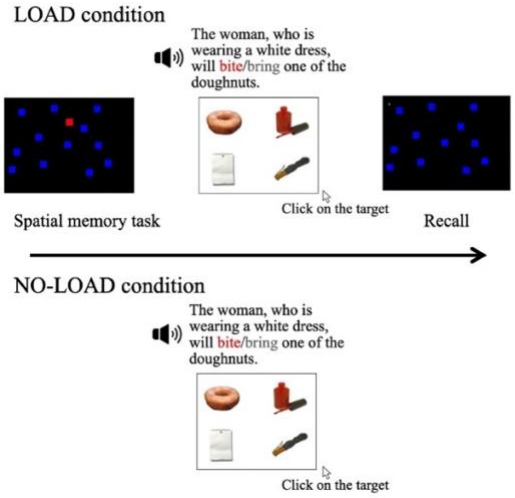
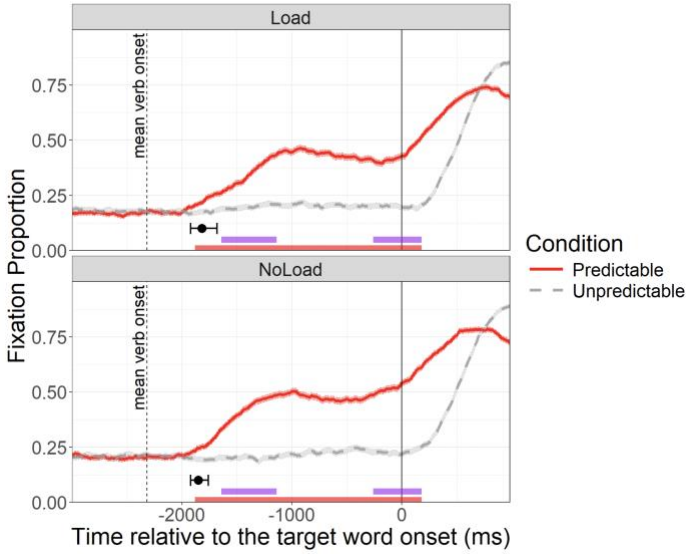


Figure 2. Results of the cluster-based permutation analysis and divergence point analysis. The x-axis shows time relative to the target word onset (in ms) and the y-axis the fixation proportion on the target for each condition and task. The black dots at y = .1 show the mean divergence points in the load and no-load tasks with 95% credible intervals.



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