Task effects on predictive eye-movements

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Introduction Language processing is a highly predictive process; parsers pre-activate upcoming content and structure using contextual cues, such as verbal meaning. Some proposals posit that predictive processing is primarily bottom-up. However, these cannot account for evidence that predictive processing may be sensitive to task-effects, such as when participants are explicitly instructed to predict [1, 2]. Across two studies, we sought to clarify the role of task-effects by investigating the effect of an implicit task-relevance manipulation and explicit prediction instructions on anticipatory fixations in the visual world paradigm.
Methods In Exp. 1, 121 young adult L1 English speakers listened to 68 English sentences in a 2 x 2 design: all participants heard first-clause verbs which were either predictive of the target noun (After John *answered* his phone, Mary sighed and produced her wallet) or non-predictive (After John *lost* his phone, …), and were instructed to attend either to the actions of the Male or Female character (see Table 1). Critical items had a Male character in the first clause and a Female character in the second clause; thus, the verbal cue was always task-relevant for Male-attending participants. While listening, participants viewed three images: the target, the second-clause noun, and a distractor (see Fig. 1). Exp. 2 (N = 60) was identical but instead instructed participants to actively predict what the Male character was acting upon (see Table 1). We compared these data to results from the Male-attending group in Exp. 1 to probe task effects.
Results We predicted that participants would show fewer and/or later predictive eye-movements to the target when the target cue was not relevant to their task (i.e., the Female-attending group). Generalized linear mixed-effects models in the predictive window (mean verb onset to target onset, offset by 200 ms) revealed more predictive fixations with predictive than non-predictive verbs [$b = 0.509$, $SE = 0.134$, $z = 3.79$, $p < 0.001$], but this effect was not reduced when information was not task-relevant [$b = 0.0078$, $SE = 0.102$, $z = 0.077$, $p = 0.939$] nor delayed in the Feminine-attending group, per a divergence point analysis (DPA) by bootstrapping [difference of -34 ms for the Male-attending vs. Female-attending group, 95% CI: -140 to 60 ms] (left and center panels, Fig. 2). For Experiment 2, we expected that if an explicit task influenced prediction, instructed participants would show more and earlier fixations to the target relative to those given an attentional task only. We found that an explicit prediction task led to more looks to the target in the predictive window [$b = 0.348$, $SE = 0.078$, $z = 4.45$, $p < 0.0001$], but this task did not interact with the predictiveness of the verb [$b = 0.232$, $SE = 0.155$, $z = 1.496$, $p = 0.135$]. However, anticipatory fixations for predictive vs. non-predictive verbs started earlier for participants explicitly instructed to predict [DPA, difference of -127 ms for Exp. 1 vs. Exp. 2, 95% CI: -220 to -20 ms] (rightmost panel, Fig. 2).
General Discussion These results suggest that verbal semantics-based (associative) predictions are automatic (Exp. 1) and insensitive to implicit task-demands. However, if there is an *explicit* task to predict (Exp. 2), predictive search is upregulated as in [3] across both predictive and non-predictive contexts and predictive information is used earlier, unlike findings in [3]. These results suggest that task-effects emerge when prediction is *explicitly*, not implicitly, prioritized and are characterized by more rapid visual search.

References: 1. **Kuperberg** & Jaeger (2016), *Lang. Cogn. Neurosci.*; 2. **Kaan** & Grüter (2021), *BPA.*; 3. **Ito** (2024), *Lang. Learn.*

		Experiment (Between-subject)		
		Exp. 1: Task-relevance of first-clause cue (Between-subject)		**Exp. 2: Explicit Instruction**
Condition (Within-subject)	Sample Sentence	Female-Attending Group (cue NOT task-relevant)	Male-Attending Group (cue task-relevant)	
Predictive Verb	After John *answered* his <u>phone</u>, Mary sighed and produced her wallet.	Q: What did Mary produce?	Q: What did John answer?	
Non-predictive Verb	After John *lost* his <u>phone</u>, Mary sighed and produced her wallet.		Q: What did John lose?	

Table 1. Examples of the experimental conditions in Exps. 1 & 2, which followed a 2 x 2 design. Critical verb in italics, target noun underscored. Factors bolded.

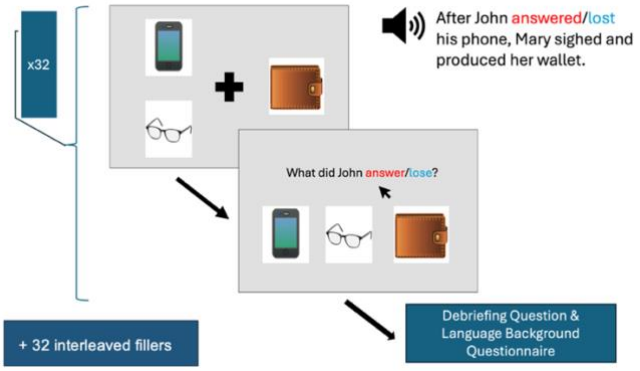

Fig. 1. Example experimental trial (predictive verbal cue in red, non-predictive verbal cue in blue)

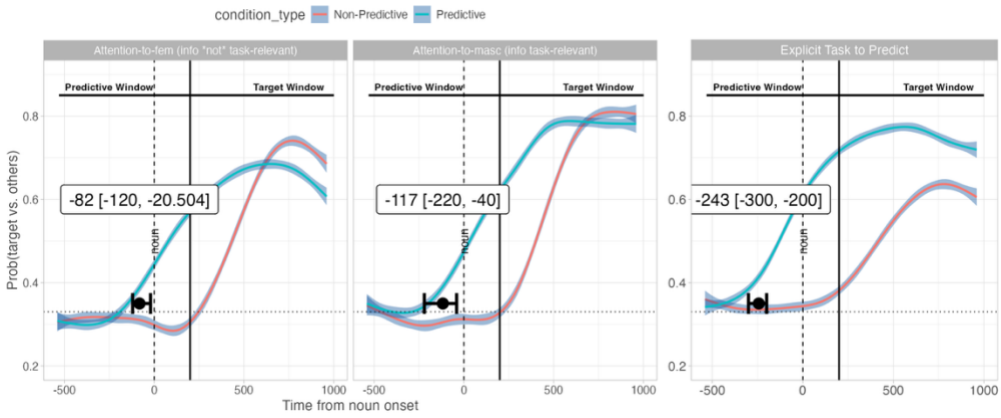

Fig. 2. From left to right: Probability of fixations to the target noun across attention groups in Exps.1 (far left to center: Female-attending (cue not task relevant; Male-attending (cue task-relevant)) and 2 (far right: Explicit Task to Predict); target onset is at 0 ms. Blue lines indicate a predictive verb, while red lines indicate a non-predictive verb. Estimated mean onsets of difference in fixations between predictive and nonpredictive verbs and their confidence intervals for each experimental condition are represented with a black dot and whisker in each column.