Prediction during language comprehension may be under strategic control: evidence from eye movements

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Introduction

- Comprehenders generate predictions about upcoming language input, and their predictions are generally stronger when the sentential constraint is stronger [1,2].
- An open question is whether comprehenders can adjust when or how to predict based on task demands [1,3].
- The current study investigated how time constraints and feedback may affect listeners' predictive behaviour.
- We found that **a speeded-selection task where RT was timed and fed back can nullify, or even reverse, the correlation between sentential constraint and strength of prediction**.

Methods

- Participants listened to highly constraining sentences (e.g. "At Starbucks, Anne bought…"), while viewing pairs of objects consisting of an expected and an unexpected object (e.g. coffee vs. water).
- Sentence constraints were measured by cloze probabilities of the expected word (median=0.72, min=0.53, max=0.97).
- Two-thirds of these sentences ended with an expected target ("coffee"), one-third ended with an unexpected but plausible target ("water").
- Between-subject manipulation of task:
  - The **Non-speeded Group** (n=19) was simply asked to select the target picture, receiving feedback on their accuracy.
  - The **Speeded Group** (n=19) was instructed to select the target picture as accurately and as soon as possible, but only received feedback on their accuracy.
  - The **Speed-enforced (with feedback) Group** (n=19) received the same instructions as the Speeded Group, but received feedback on their performance using a traffic light feedback system (Figs 1 & 2).
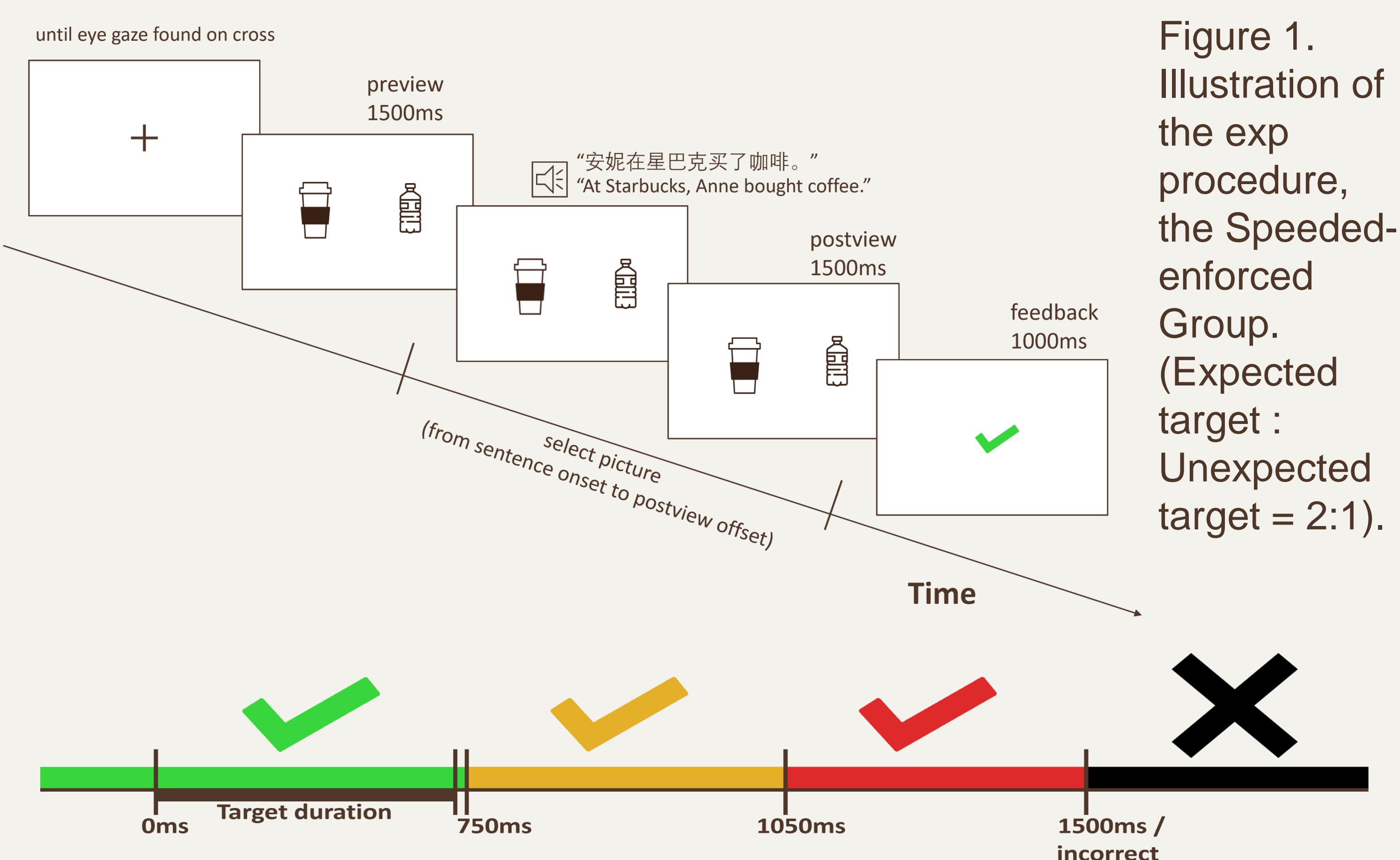

Figure 1. Illustration of the exp procedure, the Speeded-enforced Group. (Expected target : Unexpected target = 2:1).

"安妮在星巴克买了咖啡。"
"At Starbucks, Anne bought coffee."

Figure 2. Feedback system used for the Speed-enforced Group.
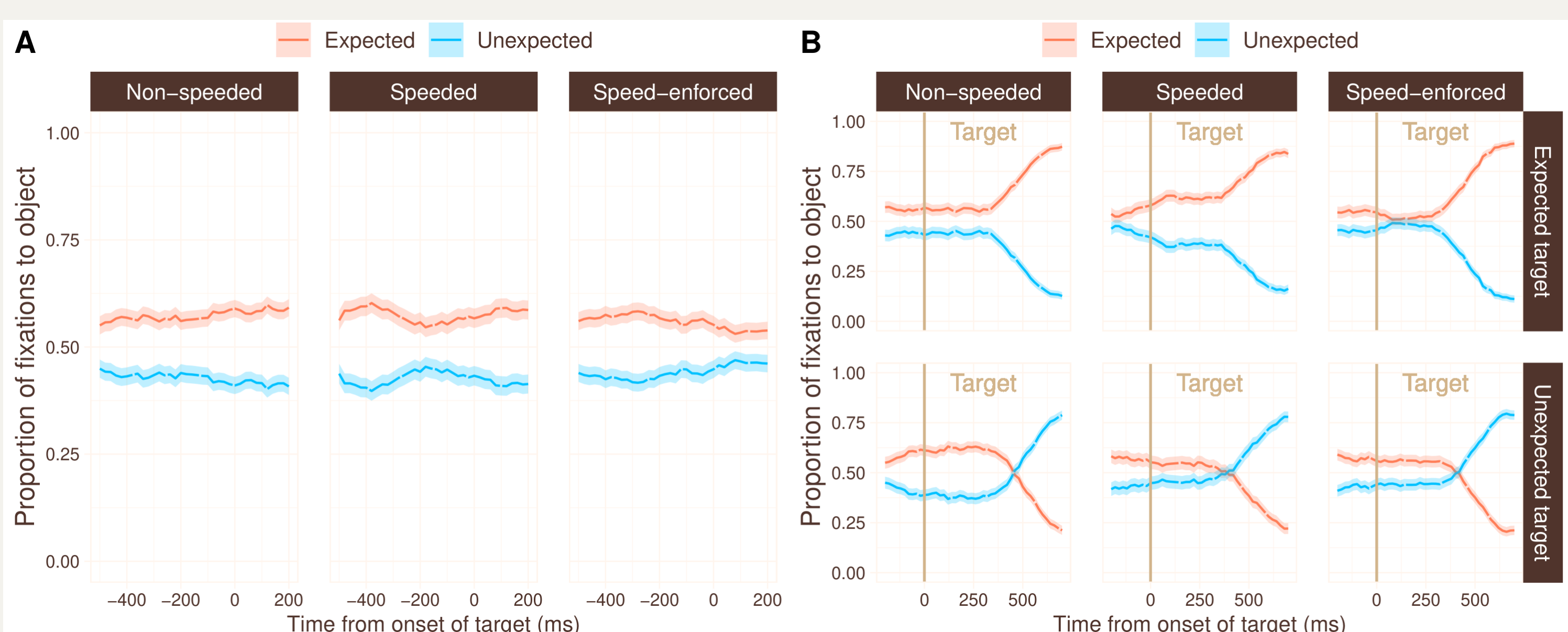

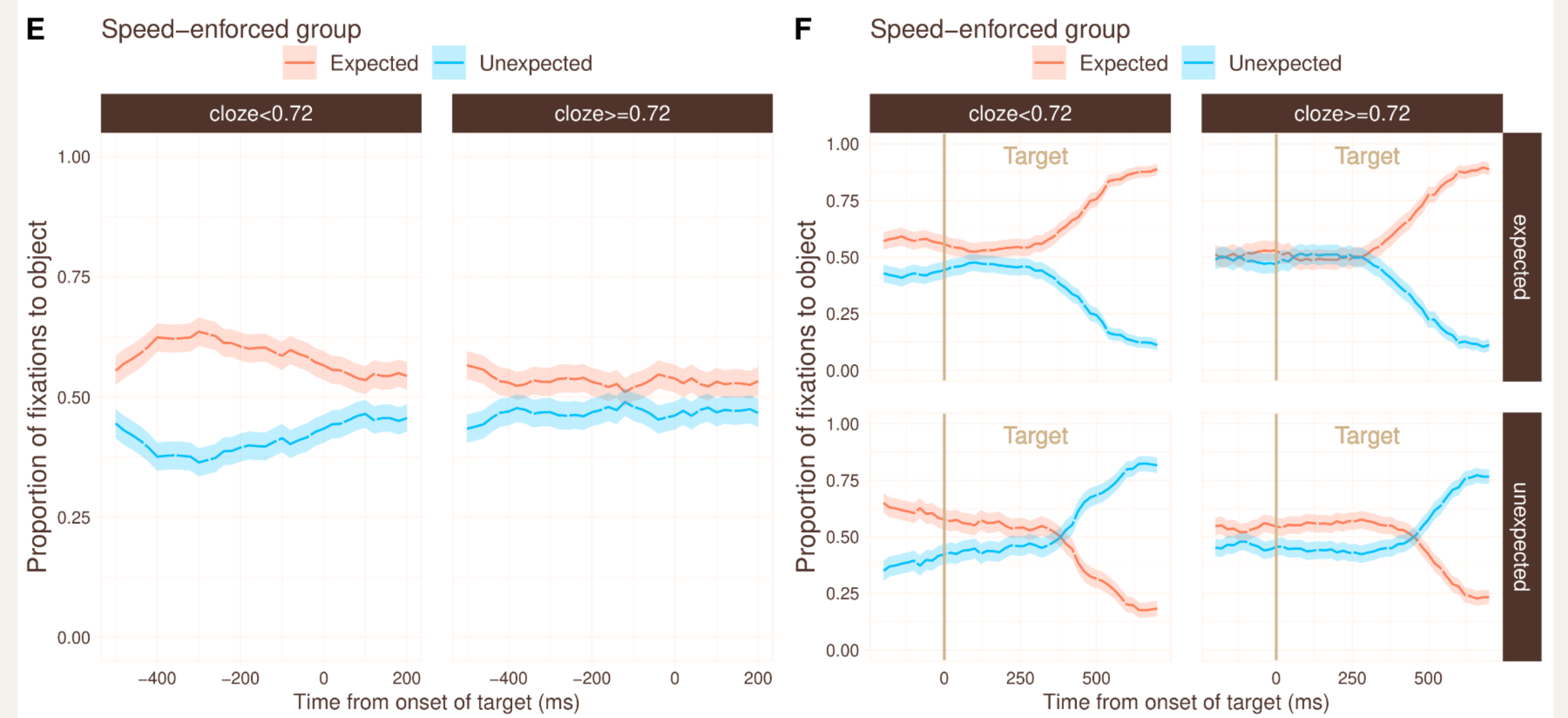Figure 3. Proportion of fixations to each object, by-group.

Figure 4. Proportion of fixations to objects, the Speed-enforced Group, separating stronger vs. weaker sentence constraints.
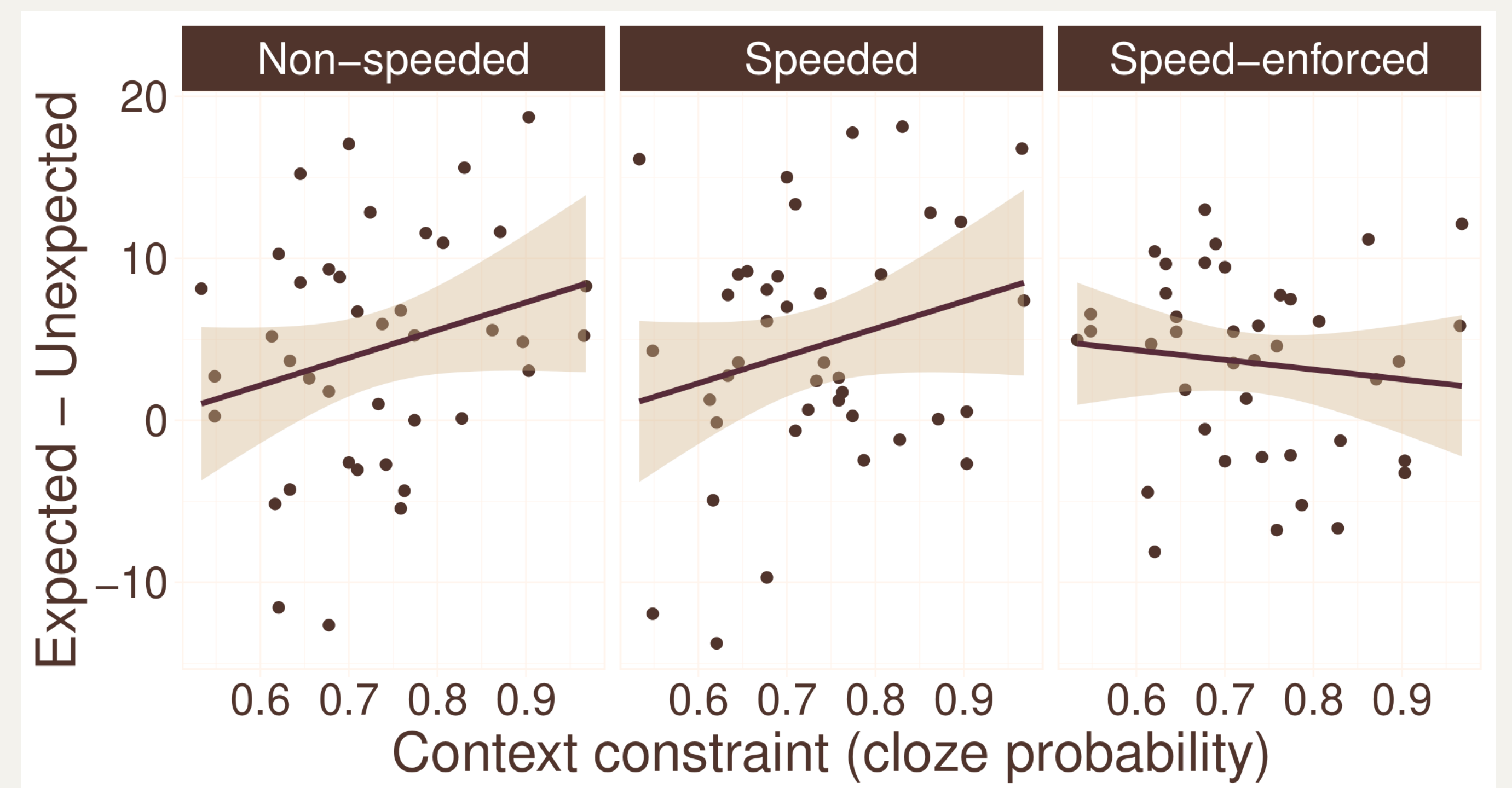

Figure 5. Differences between the number of observations with fixations on the expected object and the unexpected object (Expected-Unexpected) by sentential constraint, before target onset (-500 – 200ms).

Results

- The difference between fixations to the expected object and the unexpected object (prediction effect) were analysed for a window between -500ms and 200ms after target onset.
- Mixed-effect linear regression models revealed:
  - A main effect of Group (prediction effect was significantly smaller in the Speed-enforced Group, β=11.24, p=0.02).
  - **An interaction between Group and Constraint** (the impact of sentence constraint on prediction effects was significantly different in the Speed-enforced Group than the grand average, β=-16.28, p=0.02).
  - Sentential Constraint was a positive predictor of prediction effect for the Non-speeded Group (β=17.09) and the Speeded Group (β=17.77), **but a negative predictor for the Speed-enforced Group (β=-6.58),** albeit non-significant.

Discussions

- Although listeners in the Non-speeded and the Speeded group were more likely to look at the expected object before target onset in more constraining sentences, listeners in the Speed-enforced group showed the opposite effect.
- Contrary to what happens typically, listeners in the Speed-enforced Group's predictions were **weaker** when the sentences were more constraining:
  - Having to revise a wrong prediction takes time which may cost them the coveted "green tick".
  - Listeners may inhibit or suppress their predictions to avoid potential prediction errors.
  - They seemed more likely to suppress their predictions when the sentence is more constraining.
- In summary, comprehenders can adjust when to predict based on the task demand.

References

[1] Ryskin, R., & Nieuwland, M. S. (2023). Prediction during language comprehension: what is next?. *Trends in Cognitive Sciences, 27*(11), 1032-1052.
[2] DeLong, K. A., Urbach, T. P., & Kutas, M. (2005). Probabilistic word pre-activation during language comprehension inferred from electrical brain activity. *Nature neuroscience, 8*(8), 1117-1121.
[3] Huettig, F., & Guerra, E. (2019). Effects of speech rate, preview time of visual context, and participant instructions reveal strong limits on prediction in language processing. *Brain Research, 1706*, 196-208.