

# Prediction (advantage) illusion due to retrieval interference: a computational model

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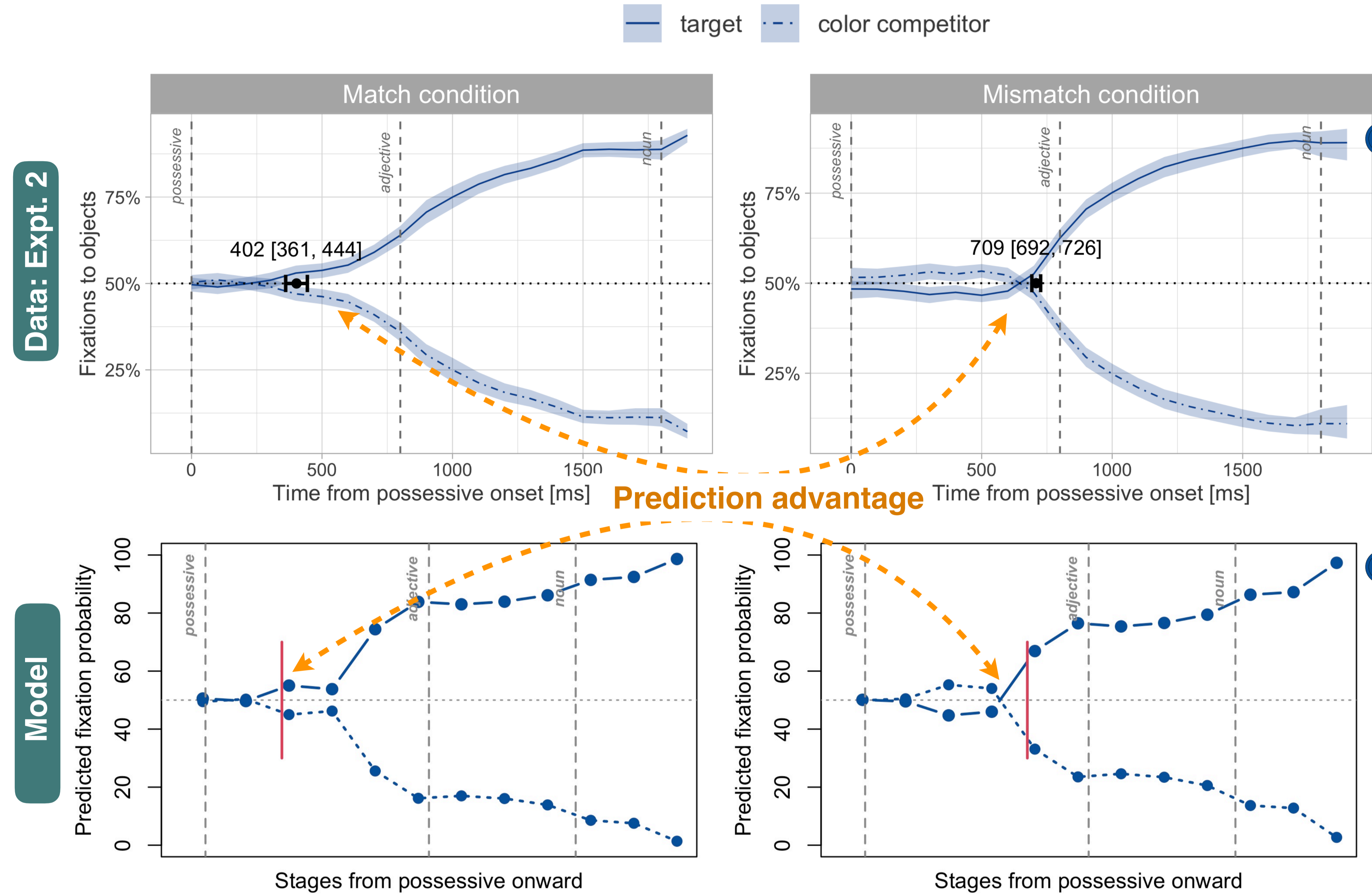
## SUMMARY

We propose a retrieval interference-based explanation of a prediction advantage effect observed in Stone et al. (2021). They reported two eye-tracking experiments in which participants listened to instructions involving German possessive pronouns, e.g. ‘Click on **his** blue button’, and were asked to select the correct object from a set of objects displayed on screen. Participants’ eye movements showed: (i) predictive processing such that the target object was fixated before its name was heard, and (ii) when the target and the antecedent of the pronoun matched in gender, predictions arose earlier than when the two genders mismatched — a prediction advantage. We propose that the prediction advantage arises due to similarity-based interference during antecedent retrieval: the overlap of gender features between the antecedent and possessum boosts the activation level of the latter and helps predicting it faster. We provide an ACT-R and cue-based retrieval model supporting this hypothesis. Our model also provides a computational implementation of the idea that prediction can be conceived as memory retrieval. In addition, we provide a preliminary ACT-R model of how linguistic processes could influence visual attention.

## MODEL ASSUMPTIONS

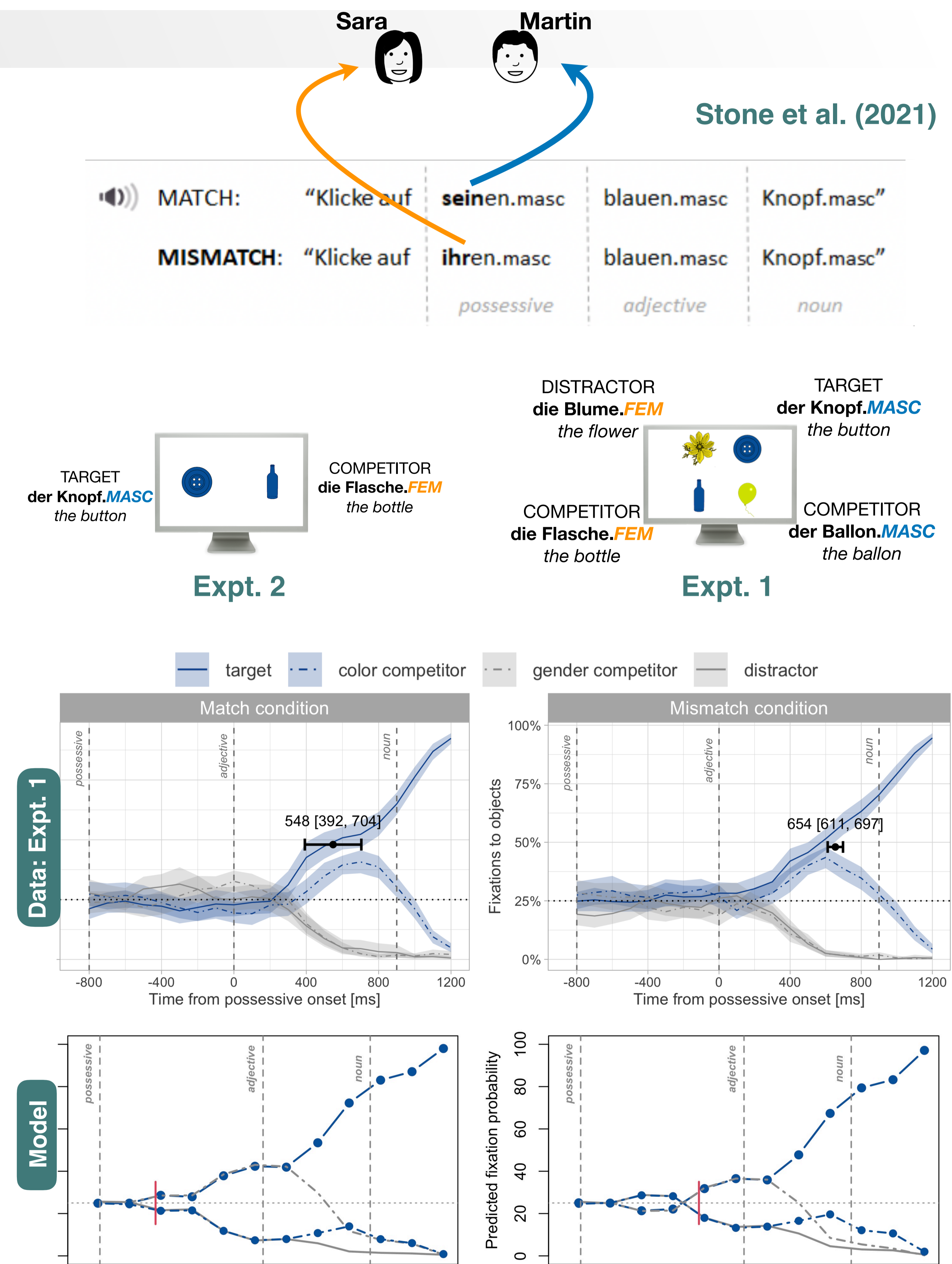
1. The model predicts the target object (the possessum) at each input word: This models participants’ goal during the experiment, since their task was to click on the target object as quickly as possible. Thus, we assume that they would try to predict the target object with each new bit of linguistic information.
2. Objects displayed on screen are stored as referents in ACT-R’s declarative memory ⇒ the memory representations of Martin, Sara, button and bottle are referents that are accessible during sentence processing.
3. The prediction of the target object is implemented as a retrieval of the memory representation of its referent: motivated based on the model of sentence-picture matching task in Patil et al. (2016).
4. The prediction steps weight color cues higher than linguistic cues: models the saliency of visual features over linguistic features in a visual world task (Coco & Keller 2015).
5. When processing the possessive pronoun, the antecedent retrieval precedes the target prediction: reflects the linear order of the two agreement morphemes in the possessive.
6. The probability of fixating an object is directly proportional to the activation of the memory representations of the object — higher activation means higher probability of fixation (Patil et al. 2016).

## RESULTS



## CONCLUSIONS

- The *illusion of prediction advantage* arises through **similarity-based interference and the interaction between retrieval and prediction** processes: the gender cue in the antecedent retrieval boosts the activation of the predicted target
- A **computational implementation** of the proposal “**prediction is memory retrieval**” (Chow et al. 2016)
- **Limitations & future work:** with multiple competitors (Expt. 1) participants delay the prediction decision, whereas the model is rational — uses all the disambiguation information as soon as it is available to predict the target ⇒ The model could be modified to use different combinations of weights for linguistic (e.g. agreement) and visual (e.g. color) cues



**References:** [1] Stone, K., Verissimo, J., Schad, D. J., Oltrögge, E., Vasishth, S., & Lago, S. (2021). *Language, Cognition and Neuroscience*. [2] Patil, Hanne, Buchert, De Bleser & Vasishth (2016) *Cognitive Science*. [3] Coco, M. I., & Keller, F. (2015). The interaction of visual and linguistic saliency during syntactic ambiguity resolution. *Quarterly Journal of Experimental Psychology*. [4] Chow, W.-Y., Momma, S., Smith, C., Lau, E., & Phillips, C. (2016). Prediction as memory retrieval: timing and mechanisms. *Language, Cognition and Neuroscience*.

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