Neural representation of syntactic prediction: A simultaneous eye-tracking and EEG study

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THE GOALS

- The likelihood a verb co-occurs with syntactic structures, verb bias, strongly guides incremental sentence processing (Garnsey et al., 1997; Snedeker & Trueswell, 2004; Ryskin et al., 2017).
- However, most evidence of prediction is inferred from processing cost when unexpected words are encountered.

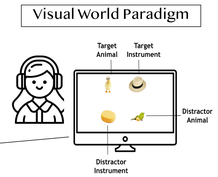
Research Questions:

- How early is syntactic prediction formed?
- What are the neural features of syntactic prediction?

METHODS

- 25 young right-handers (mean age=22.3 years, SD=1.4 years, 5 males)
- Verb bias task (Ryskin et al., 2017, Exp. 1)

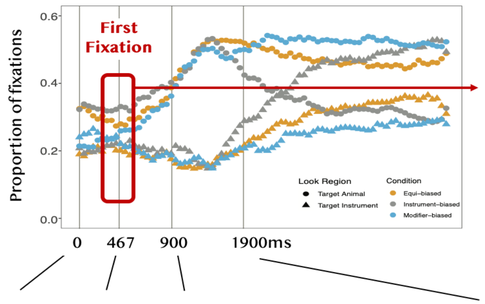
1. Instrument-biased verb
   "*Strike the bear with the necklace.*"
2. Equi-biased verb
   "*Feel the chicken with the feather.*"
3. Modifier-biased verb
   "*Pet the duck with the hat.*"

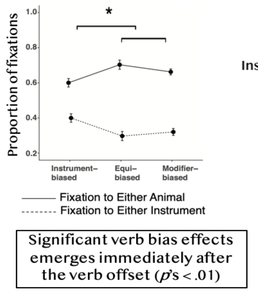


- Data analysis:
  1. Anticipatory looking (Linear mixed-level model)
     - The first fixation after the offset of the verb
     - Last more than 200 msec
  2. Decoding EEG topographic patterns
  3. ERP anchor to individual's anticipatory looking
     - Cluster-based permutation *p*'s < 0.05

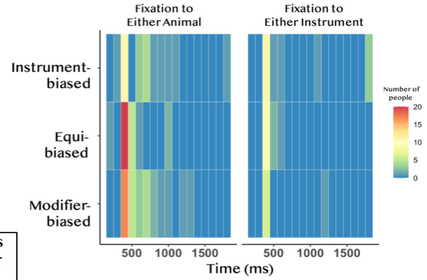
RESULTS

Analysis 1. How early is syntactic prediction formed?





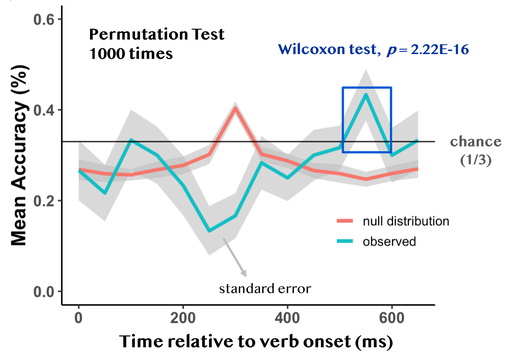
Significant verb bias effects emerges immediately after the verb offset (*p*'s < .01)



The probabilistic map of first fixation pattern after verb offset

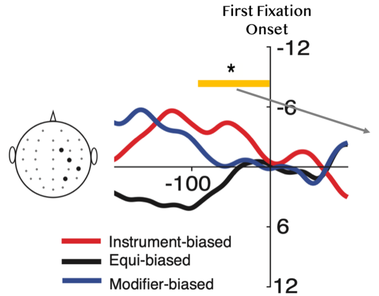
"Pet the duck with the hat."

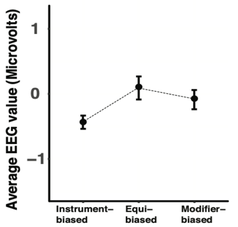
Decode verb bias prediction using Support Vector Machine
smoothing window 100 ms, sliding window 50 ms, cross-validation.



Analysis 2. What are the neural features of syntactic prediction

ERP analysis (time-lock to individual's first fixation)





A greater **negativity** in the instrument-biased condition compared to the modifier-biased condition between -100 and 0 ms **before** the first fixation

SUMMARY

- How early is syntactic prediction formed: <u>after the verb and before the first NP.</u>
  - First fixation patterns showed a verb bias effect: more looks to the instruments and less looks to the animals upon hearing the instrument-biased verbs, compared to the modifier and equi-biased verbs.
- What are the neural features of syntactic prediction?
  - Listeners' <u>EEG topographic patterns</u> reliably decode the three verb biases between 500-600 ms after the verb onset.
  - Listeners' ERPs showed a greater negativity elicited by the instrument-biased verb, compared to the modifier- and equi-biased verbs 100 ms before the first fixation.

FUTURE ANALYSIS

- How does early verb bias effect impact final ambiguity resolution?

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