Co-registration of mouse cursor and eye movements reveals comparable sensitivity of mouse and eye-tracking to prediction during language comprehension

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- Mouse cursor tracking is becoming a popular tool for psycholinguists [1], but it is unclear whether it is as sensitive as other methods such as eye-tracking.
- In this study, we tested whether listeners of Mandarin Chinese can use nominal classifiers and tonal information in pre-classifier numerals to make predictions about upcoming words.
- We registered listeners' eye- and mouse cursor-movements simultaneously.
- **Mouse cursor tracking and eye-tracking results were highly comparable**, and replicated existing eye-tracking results that listeners used nominal classifiers [2,3], but not numeral tones [4], to predict.

Methods.

- Participants (n=47) viewed pairs of images on the top corners of the screen while listening to simple instructions, which contain a critical NP consisting of a numeral, a classifier, and a noun (Fig. 1).
- Participants started each trial by clicking on a black circle at the bottom centre of the screen. Once they started moving the cursor upwards, the instruction was presented auditorily with a syllable onset asynchrony (SOA) of 500ms.
- In **Exp 1A**, the target and competitor were associated with different **nominal classifiers** in Mandarin Chinese in the Experimental condition, but they shared the same classifier in the Control condition.
  - The classifier was informative of the target's identity in the Experimental condition only.
- In **Exp 1B,** the two object labels always required distinct nominal classifiers and they differed in whether they triggered a change in the lexical tone (aka **tone sandhi**) in the preceding numeral (or not).
  - The tone of the pre-classifier numeral was informative about the upcoming classifier and noun in the Experimental condition but not in the Control condition.
  - We tested the T3 sandhi using the numeral *liang3* ('two'), and the *yi* sandhi using the numeral *yi1* ('one').

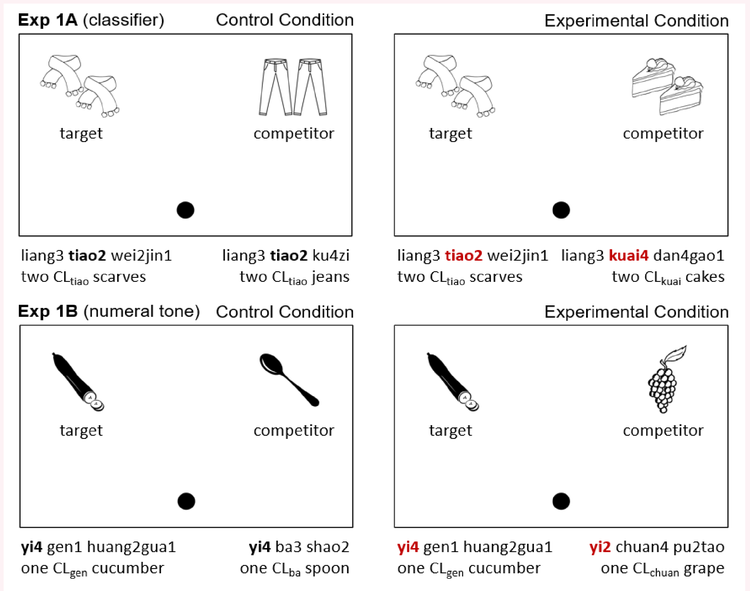

Fig. 1. A sample visual display of materials.

Results.

- **Exp 1A**
  - **Eye-tracking**: significantly faster looks to the target object in the Experimental condition (Fig. 2A).
  - **Mouse cursor tracking**: significantly faster mouse cursor movements towards the target in the Experimental condition (Fig. 3A).
  - Listeners used classifiers to predict the upcoming noun.
- **Exp 1B**
  - No significant differences in divergence points were found between conditions in either eye or mouse cursor movements (Figs 2B, 2C, 3B, 3C).
  - Listeners were not able to use tone sandhi in the numeral to predict the upcoming classifier and noun.
- **Divergence points [5] in eye movements and mouse movements were highly similar (mean mouse-eye difference = 74.2ms, max = 107ms).**
- We obtained highly similar results in a follow-up experiment (n=31) using a slower speech rate (800ms SOA).

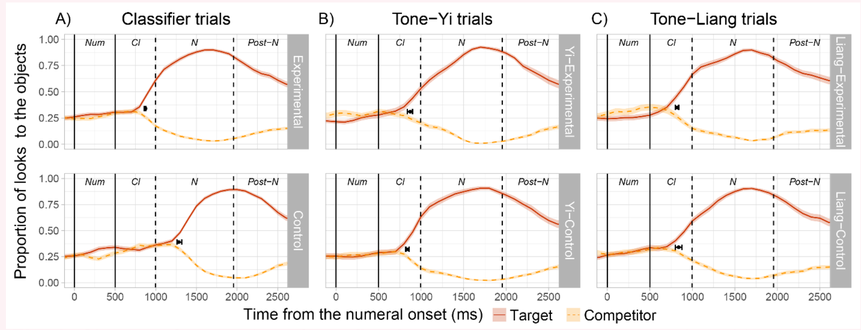

Fig. 2. Change of proportion of **eye fixations** on the target and competitor object across all conditions. Solid dots and horizontal error bars indicate the mean onset of significantly more looks to the target object and 95% confidence intervals of the mean.

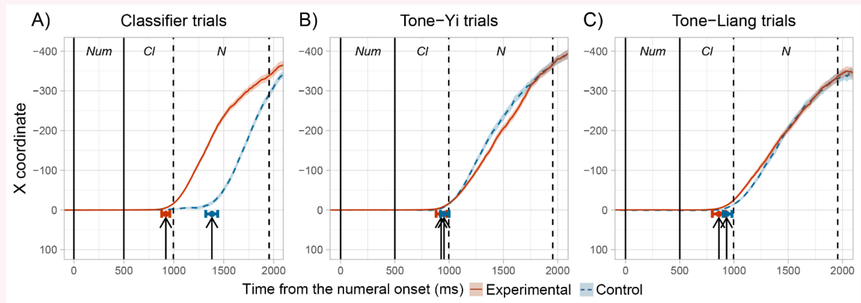

Fig. 3. Change of the cursor's x-coordinate in **mouse cursor positions** across all conditions. Solid dots and horizontal error bars indicate the mean onset of significant deviance from the midline (X=0) towards the target object and 95% confidence intervals.

Conclusion.

- Replicating previous studies [2-4], we found that Mandarin Chinese listeners could use nominal classifiers, but not tone sandhi in a numeral, to predict upcoming language.
- Crucially, the divergence points detected in mouse movements and those detected in eye movements are remarkably similar.

★ **Our results suggest that mouse cursor tracking has comparable sensitivity to prediction during language comprehension to eye-tracking**.

References

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