

# 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.

### Exp 1A (classifier)

- 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.

### Exp 1B (numeral tone)

- 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.

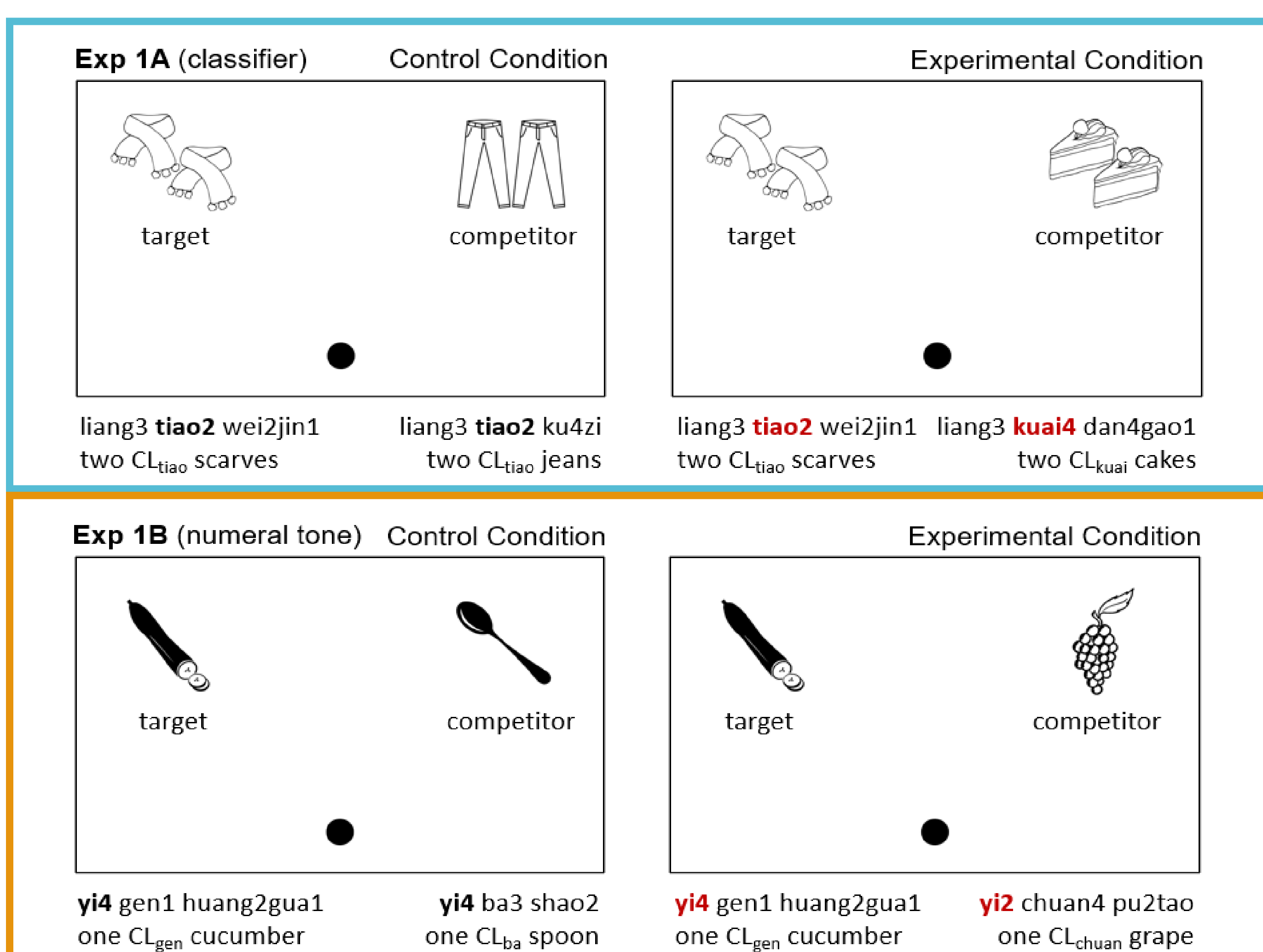


Fig. 1. A sample visual display of materials.

- For numeral tone, we tested the yi sandhi using the numeral **yi** ('one') and the T3 sandhi using the numeral **liang** ('two').

## Results

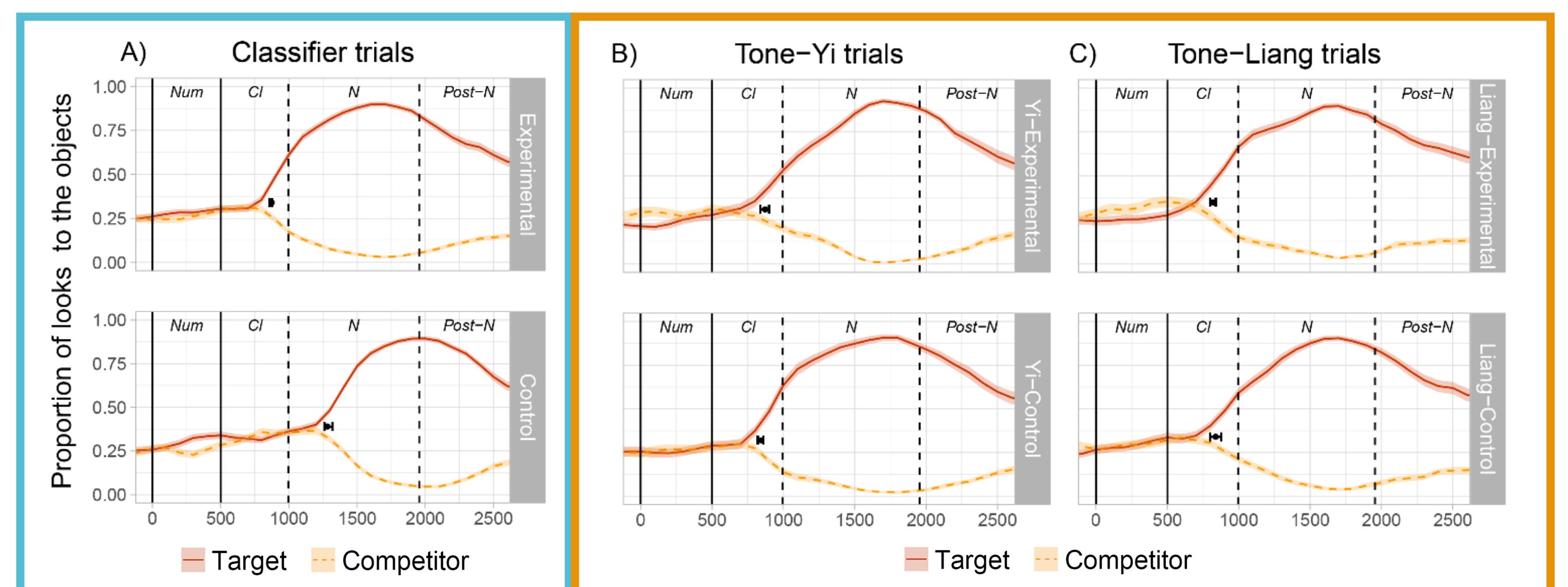


Fig. 2. Change of proportion of **eye fixations** on the target and competitor object across all conditions. Solid dots and horizontal error bars indicate the mean onset of significantly more looks to the target object and 95% confidence intervals of the mean.

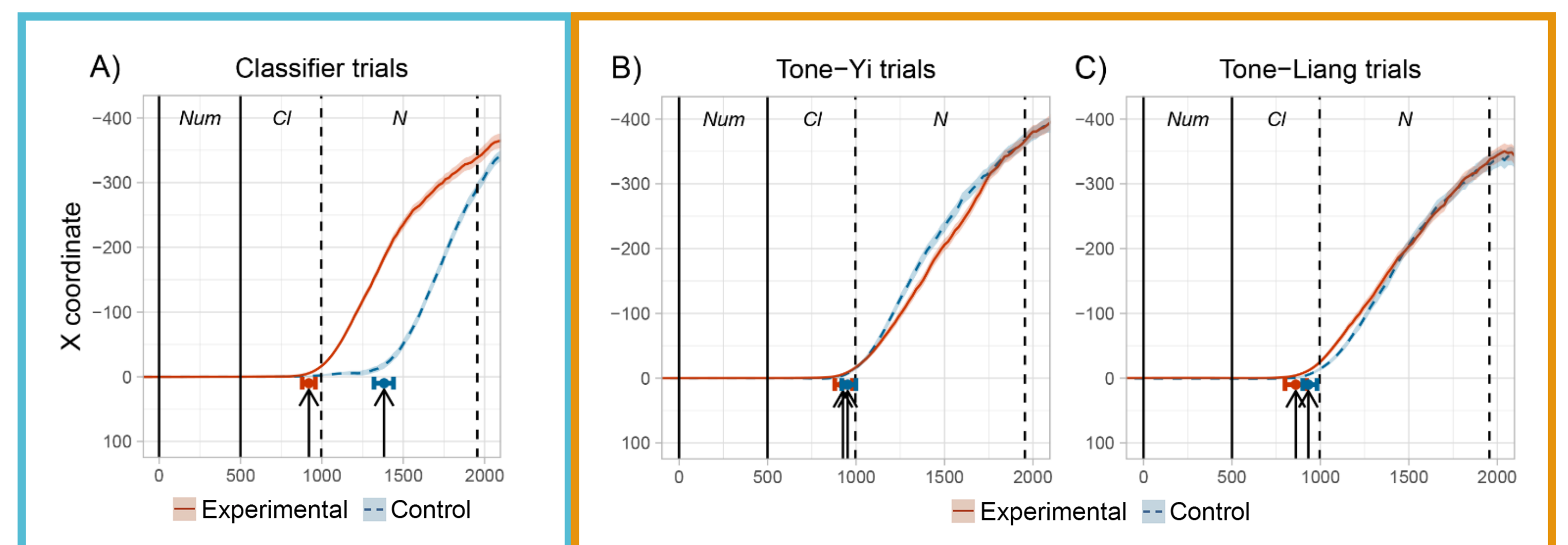


Fig. 3. Change of the **cursor's x-coordinate** in mouse cursor positions across all conditions. Solid dots and horizontal error bars indicate the mean onset of significant deviation from the midline ( $X=0$ ) towards the target object and 95% confidence intervals.

### Exp 1A (classifier)

- 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).

### Exp 1B (numeral tone)

- No significant differences in divergence points were found between conditions in either eye or mouse cursor movements (Figs 2B, 2C, 3B, 3C).

- **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).

## 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

[1] Spivey, M. J., Grosjean, M., & Knoblich, G. (2005). *Proceedings of the National Academy of Sciences*, 102(29), 10393-10398. [2] Chow, W. Y., & Chen, D. (2020). *Language, cognition and neuroscience*, 35(9), 1149-1161. [3] Klein, N. M., Carlson, G. N., Li, R., Jaeger, T. F., & Tanenhaus, M. K. (2012). In *Count and mass across languages*, 261-282. [4] Huo, Y. & Chow, W.Y. (2022) Poster presented at the Architectures and Mechanisms of Language Processing (AMLAP) 2022. [5] Stone, K., Lago, S., & Schad, D. J. (2021). *Bilingualism: Language and Cognition*, 24(5), 833-841.