More participants, fewer trials

More participants, fewer trials: A silver lining of moving eye-tracking experiments online

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The traditional approach to predictive processing research has involved testing participants on a large number of trials. This approach does not account for the fact that language processing may not be stable but instead may be adjusted during a long experiment. Here we use web-based visual world eye-tracking to investigate whether data from the beginning and the end of a predictive processing experiment show similar or different patterns. If the data show different patterns, this would suggest that early trials (or fewer trials overall) may better capture participants' behavior before they develop task-specific responses. This concern is particularly relevant in tasks for measuring surprisal since participants may adjust their expectations over the course of an experiment. A potential benefit of web-based eye-tracking is the opportunity to test many more participants on fewer items, still yielding a dataset of standard size.

Design. We replicated an L1 and L2 Mandarin Chinese classifier visual world experiment [1] using the webcam and materials improved through a norming task (N=68). In the eye-tracking experiment, participants (N_{L1}=47; N_{L2}=46) first heard a sentence containing location information (e.g., “Look in the closet.”), followed by the simultaneous presentation of 4 images and a spoken classifier-noun phrase (e.g., “Is there a [classifier] scarf/snake?”). Eye movements were recorded as participants searched for the target amongst a location match (e.g., socks) that shared only location semantic relevance, a classifier match (e.g., snake) that shared only class membership (e.g., classifier *tiáo* for long, thin items), a location & classifier match (e.g., scarf), and a distractor (e.g., watermelon). Two location-target conditions were created (e.g., match: closet-scarf; mismatch: closet-snake), resulting in 14 match trials, 14 mismatch trials, and 20 fillers.

Analysis. Data from the eye-tracking experiment were analyzed two ways: (i) The time-course analysis captured real-time changes of participants’ looks; (ii) The Location Advantage score (see example 1) measured the extent to which participants use location information; L1 and L2 processing were then compared via linear mixed-effect regression analysis. Each analysis was run with data from all trials, the first 6 trials, and the last 6 trials.

Results. As is shown in Table 1 and Figure 1, both Location Advantage analysis and time-course analysis revealed changes in L1 and L2 processing. Analysis based on all trials suggests that L2 listeners, like L1 listeners, can integrate location information and classifier information to make predictions about upcoming nouns, except that they do so at a slower rate. However, comparing early/late trials shows that, compared with L1 listeners, L2 listeners showed less (if any) sensitivity to location information in early trials but similarly high sensitivity in late trials, suggesting task-specific adjustments over the course of the experiment.

Discussion. We replicated [1] with improved materials. We also showed how repeated exposure to experimental manipulations risks changing participants' responses over the course of an experiment. The advent of web-based eye-tracking invites a reconsideration of how we collect eye movement data. Rather than maximizing how many responses an individual can give us, the current results suggest benefits to using fewer items in a given experimental session and increasing participant numbers instead.

(1) Location Advantage = ($Count_{LocationMatch}$ + $Count_{Location\&ClassifierMatch}$ – $Count_{ClassifierMatch}$ – $Count_{Distractor}$) / ($Count_{Total}$)

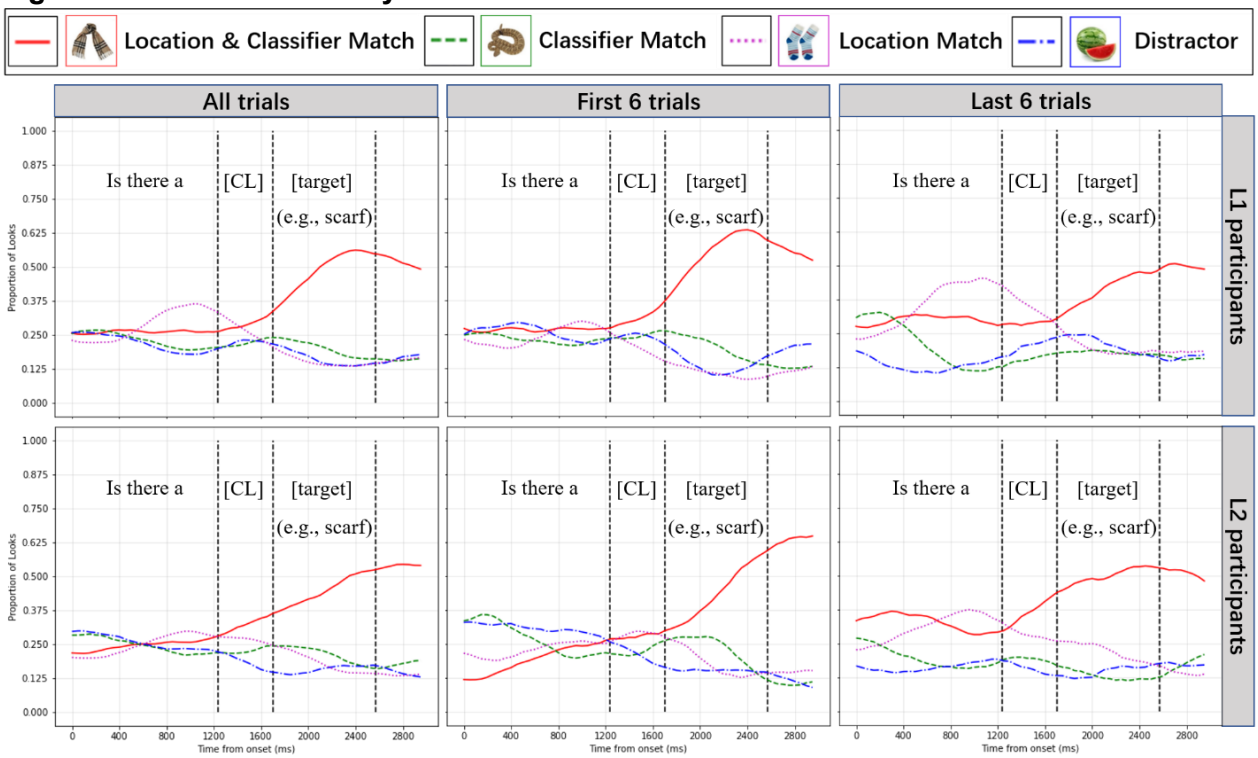
Note: Considering that a 200-ms delay is expected between hearing the acoustic stimuli and executing eye movements accordingly, Location Advantage was calculated within 200 ms after the onset of the location till 200 ms after the onset of the classifier, covering a time window of 1250 ms (25 50-ms time bins).

Table 1. Fixed Effects of Location Advantage from the Linear Mixed-Effect Regression

	All trials	First 6 trials	Last 6 trials
GroupL2	–0.11 (.14)	**–0.23 (.06)**	–0.03 (.79)
ConditionMismatch	0.01 (.97)	0.15 (.19)	–0.25 (.15)
GroupL2:ConditionMismatch	0.02 (.87)	0.17 (.31)	–0.14 (.38)

Note: Formula: LocAdv ~ Group * Condition + (1 | Participant) + (1 | Trial)

Figure 1. Time-Course Analysis of Looks to Four AOIs in Match Trials



Note: "CL" = "Classifier", e.g., classifier *tiáo* which modifies long, thin objects or animals.

Reference

[1] Wiener, S., & Rohde, H. (2018). *Immediate integration of real-world knowledge and classifier cues during Mandarin sentence processing*. Talk at the 30th North American Conference on Chinese Linguistics (NACCL). Columbus, OH.