Maze Correlates of N400 Responses in English Argument Structure Processing

Montana Thommes[1], Dawn Lau[1], Thea Kendall-Green[1] & Lisa Levinson[1]

[1]University of Michigan

Can more accessible and affordable behavioral tasks like maze provide insight into subtle differences in the timing of argument structure processing previously observed in ERP studies?

Background: Recent work on argument structure processing has aimed at modeling the intricate interactions between memory and prediction and how these unfold over time. [1] propose a **slow prediction** hypothesis to explain the lack of N400 effects in argument reversal stimuli (Table 1: 1-2), where verb prediction hinges on the specific structural role of the arguments. This is in contrast with cases of argument substitution (Table 1: 3-4), where a different discourse-compatible noun is swapped for the first argument. [2] proposed that results from studies manipulating the SOA between arguments and the verb in Mandarin stimuli support this as well, whereby specific structure modulates the N400, but only when there is a delay in verb presentation.

Current Study: This study tests the slow prediction hypothesis on [1]'s exp 1 English stimuli (1-4) by lengthening argument-verb SOA via the maze task[5] rather than with intervening linguistic content. [3] explores the possibility that the inherently slower SOAs in the maze task may combine with slower participant responses to reveal stronger effects of prediction in the domain of morphosyntactic pre-activation. Since RTs are at least 700 ms in maze, the SOA between the last argument noun and critical verb is at least 1600ms (compare 1800 ms in [2]). This study tested whether the RTs for reversal sentences exhibit the same contrasts observed in the substitution condition where an N400 was present in the ERP study. The slow prediction hypothesis predicts that RT latencies associated with a cloze-associated N400 effect should be observed in both substitution and reversal conditions. As in [1], we also included "control comparison" stimuli to elicit a more "classic" N400-associated effect (see Table 2).

Methods: 79 US-based English-reading participants completed an online Ibex-based [6] A-maze [7] task. The experimental (120 pairs, 60 each stimulus type) and control comparison (60 pairs) stimuli were split into 4 counterbalanced lists to shorten experiment length.

Results: LME models [8] were fit testing for pairwise effects on RTs of the categorical cloze condition within stimulus type, and for an interaction between cloze and stimulus type. As predicted, a pairwise effect cloze was significant in both substitution (β = 234 ms, se = 15 ms, p < .001) and reversal (β = 180 ms, se = 16 ms, p < .001) conditions (vs. substitution only in [1]). There was also a much smaller interaction effect (β = 52 ms, se = 21 ms, p = .015). See Figure 1. In the control comparisons, a significant effect was observed for related (β = 115 ms, se = 12 ms, p < .001) and unrelated (β = 361 ms, se = 12 ms, p < .001) vs. "best" cloze completions.

Discussion: Slower RTs in the argument reversal condition, where N400s are absent, are consistent with the slow prediction hypothesis. This effect suggests that the maze task allows slower argument-related predictive processes to emerge. Of course simple analysis of RTs grouped into categorical conditions obscures differences between the components observed in EEG. [1] observed P600 effects across stimulus types, along with the N400 for substitution stimuli. Although this appears similar to the interaction effect observed here, if the predictive processing were relegated to the 50ms interaction, it would be out of scale with the larger N400-associated RT effects in the control comparisons. Additional data collection and analyses of continuous variables for cloze, GPT-2 surprisal, and plausibility are in progress to further explore the continuous correlations between stimuli variables and the characteristics of associated maze and EEG responses.

Table 1: Chow et al 2016 Experiment 1 Sample Stimuli

	Sentence	StimType	Cloze
(1)	The restaurant owner forgot which <u>customer </u>the <u>waitress </u>had **served** during dinner yesterday.	reversal	high
(2)	The restaurant owner forgot which <u>waitress </u>the <u>customer </u>had **served** during dinner yesterday.	reversal	low
(3)	The superintendent overheard which <u>tenant </u>the <u>landlord </u>had **evicted** at the end of May.	substitution	high
(4)	The superintendent overheard which <u>realtor </u>the <u>landlord </u>had **evicted** at the end of May.	substitution	low

Table 2: Kutas 1993 (Filler) Sample Stimuli

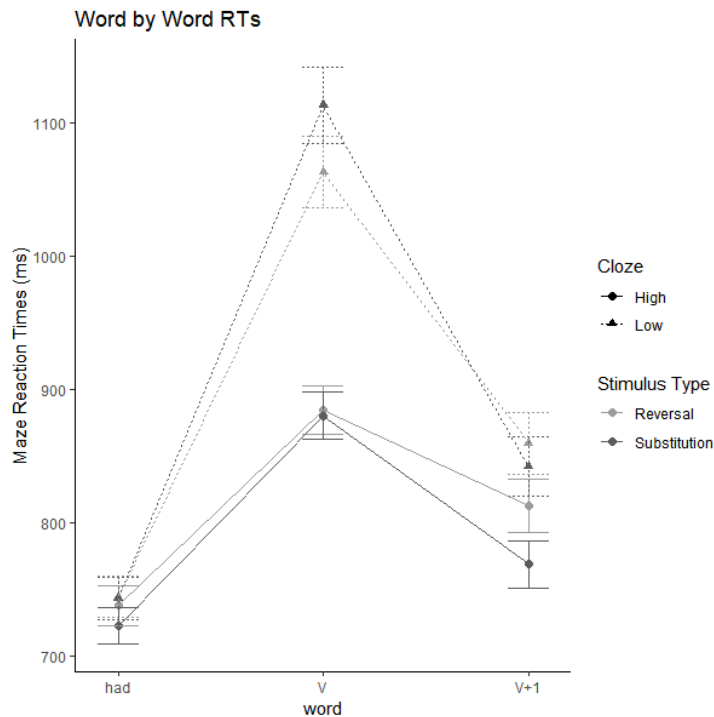|	Sentence	Completion Type
(5)	She put on her high heeled **shoes**.	Best cloze
(6)	She put on her high heeled **boots**.	Related to best cloze
(7)	They went as far as they **dared**.	Best cloze
(8)	They went as far as they **could**.	Unrelated to best cloze

Figure 1: Maze RTs 1 word before through 1 word after the critical verb.

Selected References: [1] Chow, W.-Y., Smith, C., Lau, E., & Phillips, C. Language, Cognition and Neuroscience, 2016. [2] Chow, W.-Y., Lau, E., Wang, S., & Phillips, C. Language, Cognition and Neuroscience, 2018. [3] Husband, E. M. Glossa Psycholinguistics, 2022. [4] Kutas, M. Language and Cognitive Processes, 1993. [5] K. I. Forster, C. Guerrera, and L. Elliot, Behavior Research Methods, 2009. [6] A. Drummond, Ibex farm. Online server, 2013. [7] V. Boyce, R. Futrell, and R. P. Levy, Journal of Memory and Language, 2020. [8] D. Bates and M. Maechler, 2009.