Memory for the Discourse Context Following Disfluency

Yu Zhou & Sarah Brown-Schmidt (Vanderbilt University)

Disfluency is a common feature in natural speech and includes features such as pauses, elongated words, and fillers such as *um* and *uh* (Fox Tree, 1995). Repair disfluencies occur when a speaker replaces one word (the reparandum) with another (the repair). For example, in "*The chef reached for some salt...uh, I mean, some ketchup*", the reparandum [*salt*] is replaced by the repair [*ketchup*]. Studies of the online processing of repair disfluencies reveal that listeners tend to look at a semantically related item (e.g., *pepper*) when processing the disfluent phrase (*uh I mean..*), suggesting listeners are predicting the repair (Lowder & Ferreira, 2016); further this work shows listeners are more likely to fixate an image associated with the predicted word, e.g., "*pepper*" for disfluent constructions vs. conjunctions (e.g., *salt and some ketchup*). While this work did not probe if these prediction-related processing differences led to the differential encoding of the different items in memory, various findings indicate that predicted words and meanings are retained in memory, even when the sentence deviates from those predictions, shaping enduring representations of the described event (Christianson et al., 2001; Lau & Ferreira, 2005), and resulting in false recognition of those predicted (but never heard) meanings (Hubbard et al., 2019). Further, temporarily activated (but never heard) meanings are more likely to be remembered when periods of ambiguity are longer due to slow speech (Lord & Brown-Schmidt, 2022). Together, these findings lead to the (yet untested) prediction that when processing repair disfluency, the predicted (e.g., *pepper*) and repaired (e.g., *salt*) items should be retained in memory over time, particularly when the period of predictive processing is long.

Method. We tested the memory this prediction in a pre-registered study where participants heard sentences in English with repairs or coordination constructions, and varied the duration of the predictive period. Using a paradigm adapted from Lowder and Ferreira (2016), ps (N = 64) listened to 40 critical sentences (with 16 interspersed filler sentences) containing repair disfluencies (short: "uh"; long: "uh, I mean") and coordination phrases (short: "and"; long: "as well as") while viewing four images on screen (e.g., *salt, pepper, ketchup, milk*; **Fig1)**. Following this language task, a surprise 2AFC memory test probed memory for all 160 images; on each trial, participants were shown two images (one old, one new) and were asked to click the old one they had seen in language task.

Results. A mixed-effects logistic regression analysis was fit in glmer with random effects determined by buildmer; fixed effects were contrast coded including Helmert contrasts for item type (repair, reparandum, critical distractor, unrelated distractor) with the binary memory accuracy data as dependent (**Fig2**). As predicted, the repair (e.g., *ketchup*) was remembered better than the reparandum and distractors (b = -0.46, p<.0001), and the reparandum (e.g., *salt*) was remembered better than the distractors (b = -.31, p<.001). Critically, the critical (unnamed) distractor item (e.g., *pepper*) was remembered better than the unrelated distractor (e.g., *milk*, b = .44, p<.0001). These differences in memory among the candidate referents did not significantly interact with sentence form (coordination vs. disfluency) or editing period length.

Conclusion. We present novel evidence that when processing repairs (e.g., *salt, uh I mean some ketchup*), and coordination constructions (e.g., *salt as well as some ketchup*), that predicted but never perceived items (e.g., *pepper*) are retained in memory over time relative to similar objects that are not predicted during the unfolding sentence (e.g., *milk*). We find no evidence for a stronger memory boost with longer ambiguities, a finding that might be attributable to the fact that periods of ambiguity were relatively short, ranging from 1-2 seconds. We speculate that slower (faster) speech and longer (shorter) periods of temporary ambiguity might be necessary to observe a timing-related modulation of the memory boost for predicted items in these contexts. We find a similar boost in memory for the predicted (e.g., *pepper*) over unrelated control item (e.g., *milk*) for disfluent and coordination constructions. While disfluency aids prediction and shapes memory, coordination appears to function similarly.

Figure1: Example study trial. Participants saw 4 images: the reparandum (e.g., *salt*), a semantically related item (e.g., *pepper*), the repair (e.g., *ketchup*), and a distractor (e.g., *milk*). We counterbalanced across lists which version of the sentence participants heard:
The meat was pretty bland, so the chef reached for some salt ***uh I mean*** *some ketchup/salt* ***uh*** *some ketchup/salt* ***as well as*** *some ketchup/salt* ***and*** *some ketchup, which made it much more flavorful.*

Figure 2: Example 2AFC memory trial. Participants were shown an old image (left, presented during the reference task) alongside a similar, new image (right) and were asked to click on the image they had seen in the language task (which items were old/ new was counterbalanced across lists).

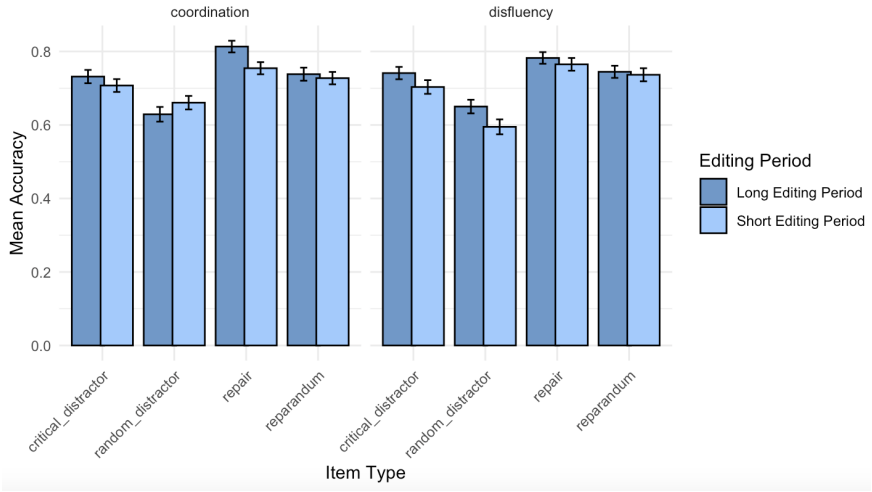

Figure 3: Accuracy on the 2AFC memory test by item type and condition. Repair items (e.g., *ketchup*) were remembered the best, followed by reparandum (e.g., *salt*) and semantically related items (e.g., *pepper*), while distractors (e.g., *milk*) were remembered the least.

References

Christianson, K., Hollingworth, A., Halliwell, J.F., & Ferreira, F. (2001). Thematic roles assigned along the garden path linger. *Cognitive Psychology, 42*(4), 368–407.

Fox Tree, J. E. (1995). The effects of false starts and repetitions on the processing of subsequent words in spontaneous speech. *Journal of memory and language*, *34*(6), 709-738.

Hubbard, R. J., Rommers, J., Jacobs, C. L., & Federmeier, K. D. (2019). Downstream Behavioral and Electrophysiological Consequences of Word Prediction on Recognition Memory. *Frontiers in human neuroscience*, 13, 291.

Lau, E. F., & Ferreira, F. (2005). Lingering effects of disfluent material on comprehension of garden path sentences. *Language and Cognitive Processes*, *20*(5), 633-666.

Lord, K., & Brown-Schmidt, S. (2022). Temporary ambiguity and memory for the context of spoken language. *Psychonomic Bulletin & Review*, 29(4), 1440-1450.

Lowder, M. W., & Ferreira, F. (2016). Prediction in the processing of repair disfluencies: Evidence from the visual-world paradigm. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *42*(9), 1400.

Rommers, J., & Federmeier, K. D. (2018). Predictability's aftermath: Downstream consequences of word predictability as revealed by repetition effects. *Cortex*, *101*, 16-30.