Modelling Memory Retrieval Processes with Drift Diffusion
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Memory Retrieval Mechanisms
Speed-accuracy trade-off designs have provided a critical empirical cornerstone in our understanding of the architecture of memory retrieval in sentence processing.
- Much of the evidence in this domain comes from Multiple Response SAT (MR-SAT), a methodology that dissociates memory access from retrieval speed and availability.
- If there is a retrieval process → availability should be reduced as distance increases;
- If it via direct access → retrieval speed should not be affected as distance increases.
- If via serial search → retrieval speed should be slowed as distance increases.
- MR-SAT has been key in arguing that sentence processing is mainly subserved by a retrieval mechanism (Foraker & McElree, 2006; Martin & McElree, 2008, 2011).

Diffusion Modelling
Alternative methodology, Diffusion Modelling (DDM):
- DDM has been used to analyse two alternative forced choice experimental designs (Ratcliff 1978; Ratcliff et al., 2016; McElree & Doob 1989).
- Modelling memory retrieval processes with DDM may have advantages in requiring fewer response time measurements to recover meaningful parameters.
- DDM jointly models accuracy and response time distributions with parameters that reflect distinct underlying memory retrieval processes.
- α, decision time, the encoding and motor response time (similar to the SAT intercept);
- δ, drift rate, the tendency of the diffusion process to drift towards one response alternative over the other (with positive values drifting upwards, similar to the SAT asymptote);
- β, response bias, which is held constant in the modelling of these studies.

Methods
Spedted acceptability judgement (N = 64) on MTurk:
- An experimenter-paced, phrase-by-phrase sentence reading task RSVP presentation.
- Followed by an end of sentence acceptability judgment with binary choices.
- DDM analysis:
  - We used the RWeiner package in R to fit a Weiner drift diffusion model for each condition for our participants (Wabersich & Vandekerckhove, 2014).
  - Responses were coded for accuracy, permitting us to hold β constant at 0.5.
  - The by-participant parameter fits were submitted for analysis using mixed-effects modelling with maximal random intercepts and slopes by participant.

Experiment 1: Sluicing
Martin & McElree (2011): Distance had no effect on the time for memory access in the processing of sluicing constructions.
- Antecedents are retrieved via a cue-based direct-access mechanism.
- We replicated this study by manipulating Distance and Acceptability of sluicing constructions:
  - Near-Grammatical:
    - Michael studied and slept.
    - If the editor resigned too.
  - Near-Ungrammatical:
    - The guild worried that Sally heard about Mary’s picture of himself.

Experiment 2: Reflexives in Picture NPs
Reflexives have stood out as one case where memory retrieval may be guided by structural information:
- Previous experimental work showed that reflexives can be bound from outside a picture noun phrase (PNP), even if there is a possessor in the PNP (Audschell & Keller, 2001).
- These binding possibilities may be explained by the comprehenders initially searching for a possible binder inside the PNP, and only later attempting to search outside the PNP.
- We manipulated Distance and Gender of the PNP reflexive dependency:
  - Near-Different Gender: The guild worried that Sally heard about John’s picture of himself.
  - Near-Same Gender: The guild worried that Sally heard about Sally’s picture of himself.

Experiment 3: Anaphoric Trigger too
What about anaphoric presupposition triggers?
- Triggers like again and also have been shown to be rapidly sensitive to presupposition violation and are used incrementally during online comprehension to predict upcoming linguistic content (Tiemann et al., 2011; Schwartz & Tiemann, 2012; Romoli et al., 2014).
- The fact that retrieval processes occur so rapidly is consistent with the hypothesis that parsers have direct access to presupposed content.
- Meanwhile, Kim (2014) reported in a visual world eye-tracking experiment that participants preferred satisfying the presupposition of also using material that was linearly and hierarchically closer to the trigger in the discourse.
- Such locality biases in processing potentially point toward a search-based retrieval mechanism that grants local targets a temporal advantage.

Discussion
Advantage of using DDM:
- We have shown that modeling memory retrieval processes with DDM (1) provides convergent evidence to SAT, and (2) may have advantages in requiring fewer response time measurements to recover meaningful parameters.
- This gives us more opportunities to extend our understanding to new phenomena.
- Our findings of a serial search process for Reflexives in PNP's (Exp 2) suggests that we need to take a more careful look at the memory process underlying this particular type of dependency.