

Facilitatory interference reflects direct-access retrieval

Dan Parker and Adam An (College of William & Mary)

dparker@wm.edu

This project investigates prominent claims about the source of facilitatory interference effects in sentence processing. Facilitatory interference occurs when a distractor eases the processing of an ungrammatical dependency. A common example is agreement attraction, where the processing of an ungrammatical subject-verb relation is eased by a structurally-inappropriate noun that matches the number of the verb [e.g., 1-3]. Previously, it has been argued that such effects are a product of a direct-access retrieval operation [2]. Here, we report the results of two studies, each of which addresses a prominent claim against this account. The studies provide new converging evidence that facilitatory interference reflects direct-access memory retrieval.

Claim 1: Facilitatory interference reflects differences in retrieval speed. A leading hypothesis is that facilitatory interference (e.g., attraction) reflects incorrect retrieval of a feature-matching distractor in memory [2-3]. The ACT-R model of retrieval [4] claims that the differences in RTs associated with facilitatory interference reflect differences in *retrieval speed*. However, this claim is inconsistent with the data showing that retrieval time is constant (“direct-access” retrieval; [5-6]). A problem for both accounts is that the argument for direct-access is based entirely on studies of *inhibitory* interference (when distractors *slow* RTs), and it remains unclear whether cases of facilitatory interference show the same dynamics as inhibitory interference.

To address this issue, **Experiment 1** tested a standard agreement attraction paradigm (item set in Table 1) using a high-powered (N=200) forced-choice speeded acceptability judgment task, and simulated the results using drift diffusion modeling to distinguish between effects arising from differences in retrieval speed vs. differences in memory trace quality/availability ([7] used diffusion modeling to investigate how response bias impacts the amount of attraction, but did not explicitly address the question of retrieval speed). Judgments showed the classic attraction profile: ungrammatical sentences were more likely to be accepted in the presence of a plural attractor (Fig. 1), evidenced by an interaction of grammaticality \times attractor number ($p < 0.01$). Drift Diffusion Modeling (DDM) was then used to jointly model accuracy and RT distributions with three parameters that reflect distinct underlying retrieval processes [8]: *non-decision time* τ (time required for retrieval), *boundary separation* α (retrieval speed), and *drift rate* δ (asymptotic accuracy reflecting memory trace quality). DMM showed a clear effect of attraction on δ (grammaticality \times attractor number $p < 0.01$), but did not show any effects of faster retrieval speed in τ or α , consistent with a direct-access account of retrieval (Fig. 2). These results suggest that the differences in judgments and RTs observed in agreement attraction paradigms likely reflect differences in the relative ease of integrating the (mis)retrieved item back into the current processing stream for further processing, rather than differences in retrieval speed.

Claim 2: Facilitatory interference is a case of encoding interference. Recently, it's been argued that the facilitation associated with (1c) relative to the ungrammatical no-match condition (1d) does not reflect misretrieval of the plural distractor, but rather increased difficulty in (1d) due to feature overwriting in the encoding (both nouns are singular) [9]. If this account is correct, then comparable effects should be observed when number is not a relevant cue for retrieval at the verb, such as when the verb is not marked for number agreement (e.g., *flooded* vs. *flood_{plural}*). However, if the difference in RTs stems from interference at retrieval, we should see a larger effect when a number cue is used in retrieval at the verb. **Experiment 2** tested this prediction with a high-powered (N = 120) 2 (\pm number cue) \times 2 (\pm plural attractor) self-paced reading design (item set in Table 2; [10] tested *grammatical* contexts but did not test the ungrammatical contexts that show attraction). Results showed a clear contrast (Fig 3): reading times for the +cue conditions showed a significantly larger facilitatory attraction effect relative to the -cue conditions (cue \times distractor number: $p < 0.01$). These results suggest that agreement attraction effects cannot be reduced to feature-overwriting in the encoding, favoring a retrieval-based account.

Take-away: Facilitatory interference effects stem from a direct-access retrieval process.

Table 1: Sample item set from Experiment 1. 64 item sets total.

(1a) +Grammatical, plural attractor	The path to the buildings often floods.
(1b) +Grammatical, singular attractor	The path to the building often floods.
(1c) -Grammatical, plural attractor	*The path to the buildings often flood.
(1d) -Grammatical, singular attractor	*The path to the building often flood.

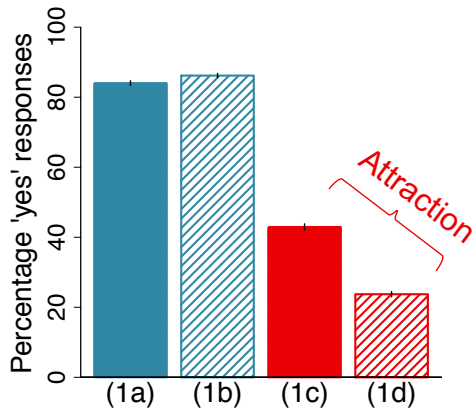


Figure 1. Speeded acceptability judgments from Experiment 1.

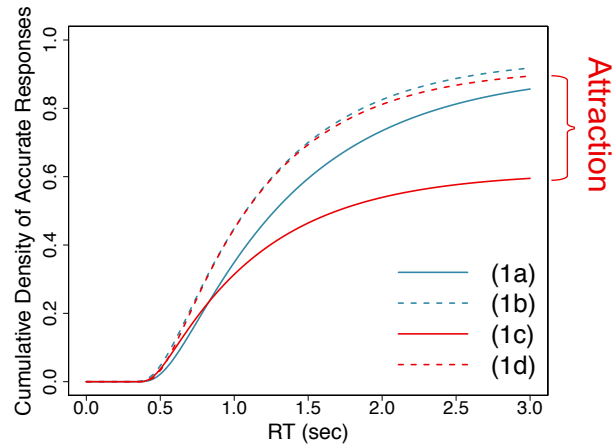
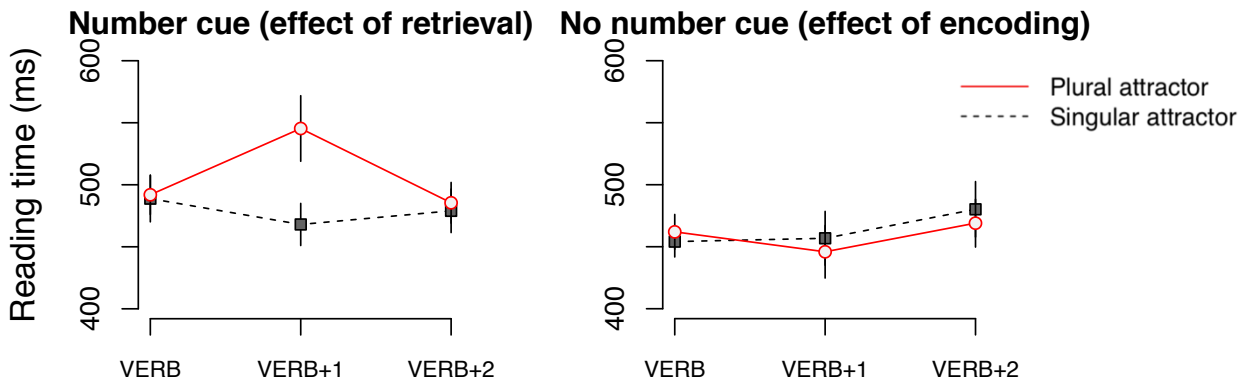


Figure 2. DDM estimates from Experiment 1.

Table 2: Sample item set from Experiment 2. 24 item sets total.

(2a) +Cue, plural attractor	*The path to the buildings often flood after a rainfall ...
(2b) +Cue, singular attractor	*The path to the building often flood after a rainfall ...
(2c) -Cue, plural attractor	The path to the buildings often flooded after a rainfall ...
(2d) -Cue, singular attractor	The path to the building often flooded after a rainfall ...

Figure 3. Self-paced reading times at the critical verb region from Experiment 2.



References: [1] Pearlmutter et al. 1999. *JML*. [2] Wagers et al. 2009. *JML*. [3] Dillon et al., 2013, *JML*. [4] Lewis & Vasishth. 2005. *CS*. [5] McElree. 2000. *JPR*. [6] McElree et al. 2003. *JML*. [7] Hammerly et al. 2018. Unpublished ms. [8] Chen & Husband. 2018. *LSA proceedings*. [9] Vasishth et al. 2017. *ICCM proceedings*. [10] Villata et al., 2018. *Frontiers*.