Early retrieval interference in syntax-guided antecedent search

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Recently Phillips, Wagers & Lau (2009) have claimed that reflexives are immune to interference from structurally inaccessible antecedents (e.g. 'Fred' in (1a) as against the accessible antecedent 'soldier') because antecedents are retrieved using only structural cues without considering the person, gender and number features. The support for this claim is derived mainly from studies reported in Nicol & Swinney (1989), Sturt (2003) and Xiang, Dillon, & Phillips (2009). They found either no effect of interference or a late effect. However, the absence of effect in these studies can be attributed to different factors— Xiang et al. (2009) excluded the crucial baseline condition (1b), Nicol & Swinney (1989) used a cross-modal priming study which can mask the early retrieval interference effect due to the complexity of dual-task, and though Sturt (2003) used an eye-tracking study it may have lacked statistical power (n=24) to detect the effect. In contrast, Badecker and Straub (2002) using a self-paced reading study found slower reading times in the presence of a gender matching NP in a grammatically inaccessible position. But, since the effect appeared two words beyond the reflexive, it cannot be attributed to the earliest stages of reference processing.

We present a computational model based on the principles of the cue-based retrieval theory (Lewis & Vasishth, 2005) which predicts an interference effect in reflexive binding. We also report an eye-tracking study that confirms the predictions. The computational model was implemented to establish precise predictions of the cue-based retrieval theory for the four conditions (2x2 design; factors: accessible NP match/mismatch for gender x inaccessible NP match/mismatch for gender) listed in (1). The predictions are summarized in table (1). The simulations predict the interference effect in terms of: (i) processing time at the reflexive, which includes antecedent retrieval time and (ii) percentage of errors in the retrieval of the grammatical antecedent for the reflexive. Main effects of both factors are predicted. Prediction (ii) matches the error rates in Sturt 2003 and our web-based replication of the same study (table (1)).

We ran an eye-tracking study (n=40) with the same manipulations as in the simulations mentioned above, to evaluate the predictions of the model. Unlike Badecker & Straub (2002) we employed eye-tracking to distinguish between early and late effects on reading. We found an early effect of interference from the inaccessible antecedent in terms of first-pass regression probability; i.e. a gender match between the reflexive and the inaccessible NP (1a and 1c) induced a significantly higher ($p=0.042$) number of first-pass regressions from the reflexive in the sentence. The effect of the stereotypical gender of the grammatical antecedent was observed only in late eye-tracking measures like re-reading time and total reading time.

In sum, the results (i) challenge the claim that the antecedent of a reflexive is accessed using only structural cues, and show that the interference induced by the intervening noun occurs very early during dependency resolution, and (ii) present an implemented computational model that predicts the interference effect.

(1) a. Accessible-match/inaccessible-match:
The tough soldier that Fred treated in the military hospital introduced himself to all the nurses.

b. Accessible-match/inaccessible-mismatch:
The tough soldier that Katie treated in the military hospital introduced himself to all the nurses.

c. Accessible-mismatch/inaccessible-match:
The tough soldier that Katie treated in the military hospital introduced herself to all the nurses.

d. Accessible-mismatch/inaccessible-mismatch:
The tough soldier that Fred treated in the military hospital introduced herself to all the nurses.

Table 1: time = processing time (ms) at reflexive, %error = percentage of errors in attaching correct antecedent, FPRP = first-pass regression probability, TRT = total reading time (ms)

	model		eye-tracking		web-study
	time	%error	%FPRP	TRT	%error
cond-a	398	13.4	13.1	411	11.1
cond-b	380	3.1	6.6	389	7.1
cond-c	478	38.5	11.2	473	21.9
cond-d	509	12.9	10.5	468	9.5

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