Expectations modulate memory retrieval during sentence comprehension

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Memory retrieval and probabilistic expectations are recognized factors in sentence comprehension that capture two different critical aspects of processing difficulty: the cost of retrieving and integrating previously processed elements with the new input words [1,2] and the cost of incorrect predictions about upcoming words or structures in a sentence [3,4]. Although these two factors have independently received substantial support from the extant literature, how they interact remains poorly understood. This study investigated memory retrieval, more specifically retrieval interference, and lexical-semantic expectations in two reading experiments, pitting these factors against each other to observe how they interact.

Experiment 1. Participants included 103 young adults (34 females) between 20 and 40 years of age (M = 31.4; SD = 5) recruited through Amazon Mturk. All participants were native speakers of American English and reported no history of cognitive or language delay.

Method. Memory interference was manipulated using the dual-task self-paced reading paradigm [5]. Interference was determined by whether three words in a memory list learned before reading were (interference) or were not (no interference) plausible objects for the main verb (Table 1). The no load conditions had no memory list, removing the possibility for retrieval interference. The effect of expectation was isolated by manipulating the predictability of the main verb in the context of the stimulus sentence (cloze probability) [6]. This manipulation was fully crossed with load and interference, that is, each level of load and interference had low-to-high predictability trials (Table 1).

Experiment 2. Participants included 98 young adults (41 females) between 20 and 40 years of age (M = 33; SD = 4.7) recruited through Amazon MTurk. Participants were native speakers of American English and reported no history of cognitive or language delay.

Method. This experiment embedded the memory nouns into the sentences, thus obtaining a task that resembles a more natural reading context. The three memory nouns were incorporated into the stimulus sentence so that they preceded the exact same cleft construction adopted in experiment 1. As in experiment 1, load and interference were crossed; a continuum of predictability values was used. Two examples, one for low and one for high expectation, are reported in Table 2.

Results and Discussion. Overall, results of the two experiments replicated established memory interference and expectation effects. Retrieval interference had a negative effect on performance, on later measures (response accuracy and response time) in experiment 1 (Figure 1) and on earlier measure (reading time at the critical and spillover regions) in experiment 2, which is in line with previous work [7,8]. Expectation had graded facilitatory effects on both reading time and responses to the comprehension questions in both experiment 1 and 2 [9,10]. Most importantly, we found some evidence for reduced or canceled memory interference effects in the high expectation conditions. The latter finding is in line with those of a few other studies that more or less directly showed evidence for an interaction between memory retrieval and expectations [11,12,13,14].

Overall, our findings are consistent with the hypothesis that as the relevance of a specific element increases in a given sentential context, the cued information is probabilistically pre-activated. If we think of memory retrieval as a gradual accumulation of information in the focus of attention — similarly to evidence accumulation processes in sequential-sampling models of decision making [15] — expectation would exercise its effect via an advanced accumulation of evidence before the memory retrieval operation is initiated. Such a head start for selection of information would reduce retrieval interference by boosting the availability of the target word relative to its competitors.

Table 1. Example of stimulus sentences for experiment 1. Slashes indicate regions of presentation. In bold, critical verb. Underlined, plausible objects for the critical verb. In italics and underlined, target object for the critical verb.

Condition	Memory list	Sentence	
Low expectation a. NoLoad b. Load-NoInt c. Load-Int	earthquake-mood-well furniture-spoons-seating	It was the <u>bouquet</u> / that the young guest / who came / from Australia / arranged / during the morning.	
High expectation			
d. NoLoad e. Load-NoInt	 battery-stamp-green	It was the <u>phone</u> / that the diligent receptionist / who lived / in Florida / answered / earlier today.	
f. Load-Int	survey-message-appeal	Florida / allswered / earlier today.	

Table 2. Example of stimulus sentences for experiment 2. Slashes indicate regions of presentation. In bold, critical verb. Underlined, plausible objects for the critical verb. In italics and underlined, target object for the critical verb.

Condition	Sentence		
Low expectation			
a. NoLoad	It was the <u>bouquet</u> / that the young guest / who came / from Australia / arranged / during the morning.		
b. Load-NoInt	The earthquake, / the mood, / and the well	/ were talked about / at the party / together with the bouquet / that the young	
c. Load-Int	The furniture, /the spoons, /and the seating	guest / who came /from Australia / arranged / during the morning.	
High expectation			
d. NoLoad	It was the <u>phone</u> / that the diligent receptionist / who lived / in Florida / answered / earlier today.		
e. Load-NoInt	The battery, / the stamp, / and the green	/ were discussed / at the meeting / together with the <i>phone</i> / that the diligent	
f. Load-Int	The <u>survey</u> , / the <u>message</u> , / and the <u>appeal</u>	receptionist / who lived / in Florida / answered / earlier today.	

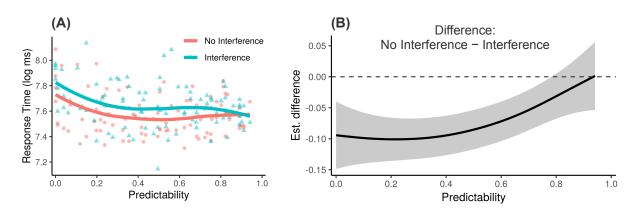


Figure 1. Experiment 1, comprehension questions response time. (A) Data aggregated by item and condition and loess smooth lines shown for illustration purposes. (B) Estimated difference (GAMM) on log scale between conditions as a function of predictability. Gray bands represent 95% CI.

References

[1] Lewis & Vasishth, 2005; [2] Lewis, Vasishth, & Van Dyke, 2006; [3] Hale, 2001; [4] Levy, 2008; [5] Gordon, Hendrick, & Levine, 2002; [6] Taylor, 1953; [7] Van Dyke & Lewis, 2003; [8] Van Dyke & McEiree, 2006; [9] Ehrlich & Rayner, 1981; [10] Staub, 2011; [11] Bartek, 2011; [12] Schoknecht, Roehm, Schlesewsky, & Bornkessel-Schlesewsky, 2019; [13] Husain, Vasishth, & Srinivasan, 2014; [14] Campanelli, Van Dyke, & Marton, 2018; [15] Ratcliff & McKoon, 2008.