A Validation of the Bidirectional Self-Paced-Reading Paradigm

Subhekshya Shrestha, Ming Xiang
The University of Chicago

Background: In two experiments we evaluate the Bidirectional Self-Paced Reading (BSPR) paradigm developed in recent studies (Paape & Vashishth 2022, 2022; Witzel & Witzel, 2023; Graham & Witzel 2023). Experiment 1 replicates results from the traditional Self-Paced Reading (SPR) studies in Huang et al. (2023), focusing on garden path (GP) ambiguity, relative clause (RC) processing and subject-verb agreement. Experiment 2 replicates results from an eye-tracking reading experiment in Rayner et al. (2011), focusing on the predictability effect in sentential context. Our results indicate that BSPR is a valid behavioral paradigm, with some advantages over the traditional SPR paradigm as it can capture effects on the critical region (and spillover regions) over various reading measures.

Experiment 1 (n = 75) tested GP ambiguities (3 ambiguity types: direct object/zero complement (NP/Z), direct object/sentential complement (NP/S), matrix verb/reduced relative clause (MV/RR)), subject and object RCs (SRC/ORC), and subject-verb agreement. The stimuli were adapted from Huang et al. (2023) (Table 1). **Experiment 2** (n = 58) manipulated contextual predictability for the target words (predictable vs. unpredictable), and length of the target words (long, mid-length, short). The stimuli were adapted from Rayner et al. (2011) (Table 2). **Procedure and analysis** Adapting the implementation from Paape and Vashishth (2022), the BSPR paradigm was set up on PCIbex. In each trial, participants read a sentence incrementally in a self-paced manner and can move back and forth freely in the sentence. Comprehension questions appeared for all trials in Exp. 1 and 75% of trials in Exp. 2. Data analysis focused on three measures: Right-Bounded Reading Time (RBRT) -- RT on a word before participants moved to the next word; Regressive Rereading Time (RegRRT) -- backward rereading time on a word; Total Reading Time (TRT) - cumulative total RT on a word. A linear mixed effects model was conducted over target and spillover regions for each construction. All RTs were log transformed. RTs in Expt 2 were also residualized over word position.

Results We found robust effects for GP constructions tested in Exp. 1 (Figures 1-3). NP/Z sentences showed an ambiguity effect (longer RTs on the ambiguous condition, all ps<0.05) in both target and spill-over regions for RBRT and TFT. MV/RR sentences demonstrated a significant ambiguity effect on all RTs (ps<0.05) for both target and spillover regions. NP/S sentences showed an ambiguity effect on the target for all three RTs (ps<0.05). For the RCs, there was a reliable cost for the ORC relative to the SRC condition for all RTs on the embedded verb (ps<0.05) (Figure 4). For subject-verb agreement, RBRT showed a grammaticality effect on the target verb (longer RTs for the ungrammatical condition, p<0.05) (Figure 5). Since the relevant effects reported in the original self-paced-reading study (Huang et al. 2023) were primarily found on spillover regions, our results suggest BSPR has advantages over traditional SPR in capturing critical effects on the target region. The findings from Exp. 2, however, only nearly replicated the basic predictability effect from Rayner et al. (2011) on the target with RBRT (p=.06) (Figure 6).

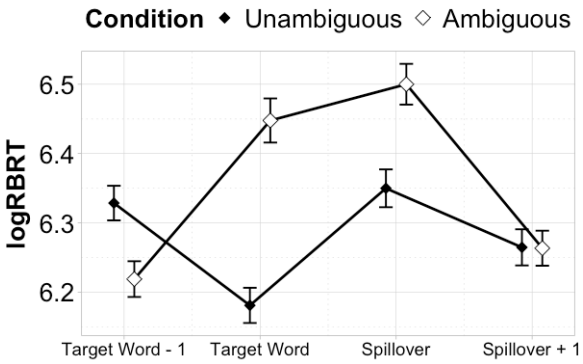
Table 1 Experiment 1 stimuli (Huang et al. 2011). Critical target region in bold font

Type (No. of items)	Example
NP/Z (24)	Because the suspect changed(,) the file **deserved** further…
NP/S (24)	The suspect showed (that) the file **deserved** further…
MV/RR (24)	The suspect (who was) sent the file **deserved** further…
SRC/ORC (24)	SRC: The farmer that **approached** the customer lifted… ORC: The farmer that the customer **approached** lifted…
Agreement (18)	When the magician moves, the cards **disappear(s)**...

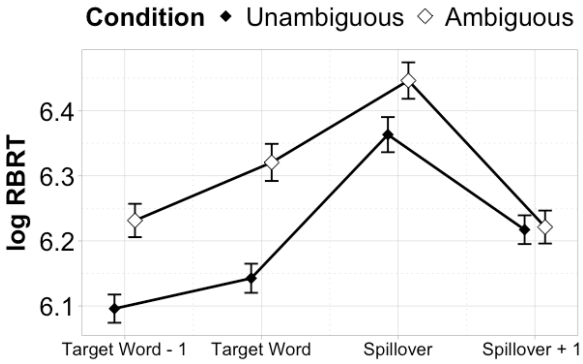
Table 2 Experiment 2 stimuli (Rayner et al. 2011), only the 'long' target word conditions are shown. Short target words are 4-6 letters and mid-length words are 7-9 letters.

Long (10 –12 letters)	Predictable	Megan decided one day to stop eating meat.	She officially declared herself a ***vegetarian*** at lunch today.
	Unpredictable	Megan went to grab lunch with some coworkers.	

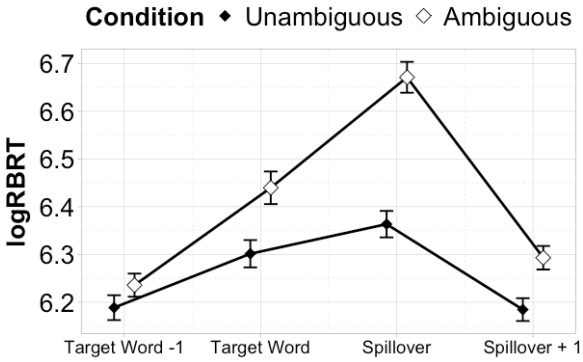
(Figure 1) RBRT for NP/Z sentences



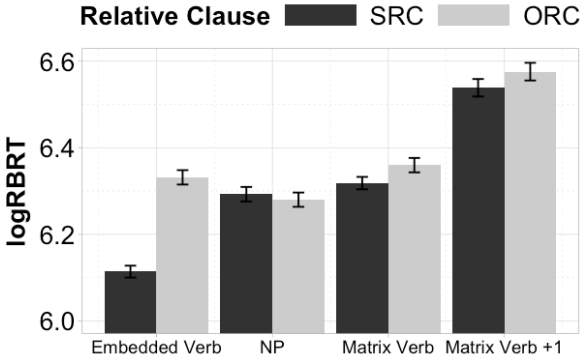
(Figure 2) RBRT for NP/S sentences



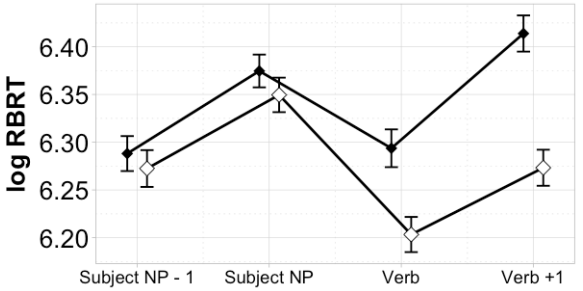
(Figure 3) RBRT for MV/RR sentences



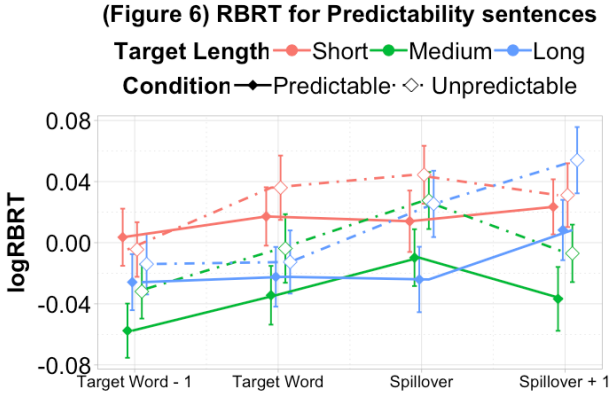
(Figure 4) RBRT for RC sentences



(Figure 5) RBRT for Agreement sentences



(Figure 6) RBRT for Predictability sentences



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