

Garden-path misinterpretation in reading while listening

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Reading while listening (RWL) to the same text is a common educational technique thought to improve reading ability and language comprehension among young L1 readers, L2 learners, and those with disabilities, with individuals intuitively reporting that comprehension is sometimes easier in RWL. While some research has found that RWL can improve lexical recognition [1], RWL was also reported to increase cognitive load which worsens comprehension [2]. For sentence comprehension specifically, we hypothesized that the ability to pause, delay, or regress in reading may be disrupted by co-current speech, thus impairing sentence comprehension. Additionally, under the Implicit Prosody Hypothesis [3], readers' self-generated prosody may be disrupted by an overt speech signal. To address these possibilities, we designed a garden-path misinterpretation study using the subordinate object/main clause subject ambiguity to examine whether RWL affects the rate of misinterpretation as a behavioral measure of comprehension.

Methods. We tested 48 participants in a 2 (SENTENCE TYPE: garden-path vs. non-garden-path) by 2 (READING CONDITION: silent reading vs. RWL) study. Silent reading (SR) and RWL stimuli were presented in blocks as a between-subjects factor counterbalancing the presentation ORDER of the blocks (either SR-RWL or RWL-SR). Forty-eight pairs of garden-path/non-garden-path sentences were adapted from previous studies (Table 1) [4, 5]. The audio files for the RWL condition were generated using Apple's macOS Text-To-Speech function with the voice "Tom" at the speech rate of 237 msec/syllable (SD = 25 msec/syllable). For this initial study, punctuation was not included in the speech synthesis, so no auditory cues (extra-long pauses) for an early prosodic break were present. This provides a baseline for further studies which will manipulate the prosody of the synthesized speech. The display time of text in both SR and RWL blocks was matched to the audio duration to control the amount of time that the visual text was displayed between SR and RWL conditions. In each block, 82 sentences including 12 garden-path and 12 non-garden-path sentences were read with a yes/no comprehension question probing the interpretation of that sentence after each sentence. Correct responses for our critical experimental items were "No".

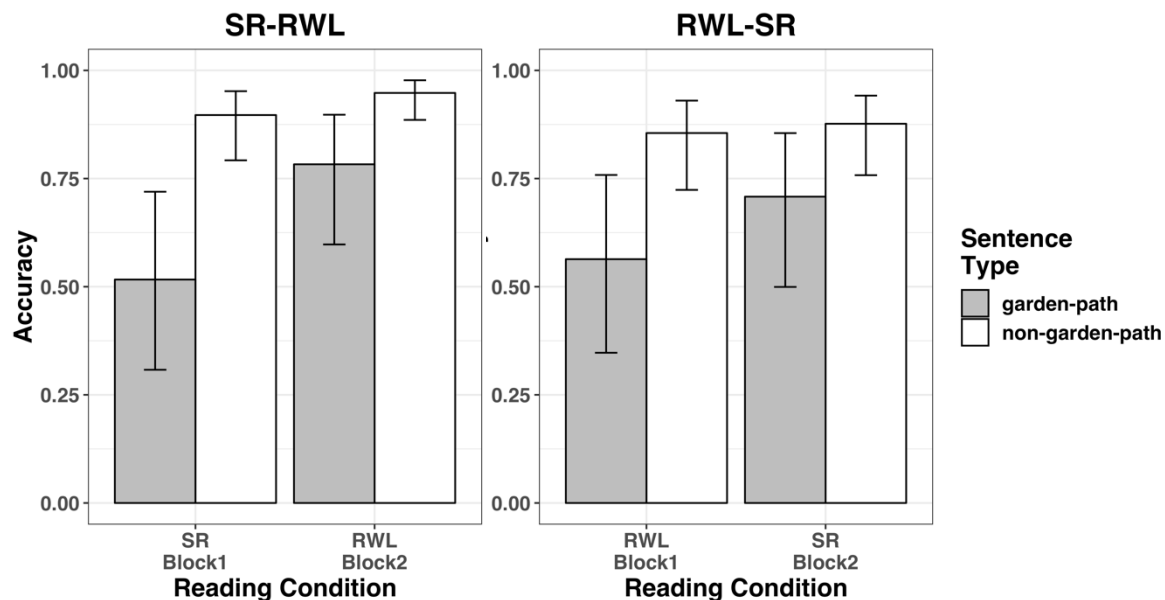
Results. Comprehension accuracy was analyzed in terms of sentence types and reading conditions (Figure 1). Maximal convergent mixed effects modeling revealed a marginally significant three-way interaction between ORDER, READING CONDITION and SENTENCE TYPE ($\beta = -0.115$, $z = -1.836$), though this was driven by significantly larger improvements in accuracy for the SR-RWL group (13.7%) compared to the RWL-SR group (7.2%) between blocks, possibly reflecting a differential adaptation effect [6]. The critical READING CONDITION by SENTENCE TYPE interaction was not significant in the overall modal ($\beta = 0.004$, $z = 0.064$) or between groups (RWL-SR group, $\beta = -0.103$, $z = -1.142$; SR-RWL group, $\beta = 0.086$, $z = 1.049$). Instead, there was a main effect of SENTENCE TYPE ($\beta = -0.789$, $z = -5.621$), demonstrating that participants misinterpreted garden-path sentences more frequently regardless of reading condition. Collapsing across block orders, the RWL reading condition elicited 23% misinterpretation and the SR reading condition elicited 27% misinterpretation.

Discussion. Against our hypotheses, we found that, while our participants displayed the classic misinterpretation effect of garden-path sentences, RWL did not affect this misinterpretation negatively or positively when compared to SR. Instead, RWL-SR group showed less improvement to comprehension accuracy than the SR-RWL group. It may be that RWL in an initial block disrupted the adaptation process within our study. Given that misinterpretation is a relatively late and offline measure of sentence comprehension, participants may be trading off the costs and benefits of RWL in online processing. An eye-tracking study is currently being conducted to investigate whether online reading processes are enhanced/disrupted during RWL. Further studies will also use prosody-rich speech as audio stimuli to compare with the findings from the current study.

Table 1: Stimulus Example

Garden-path	While Anna dressed the girl that was stylish appeared on TV.
Non-garden-path	While Anna dressed, the girl that was stylish appeared on TV.
Comprehension question	Did Anna dress the girl?

Figure 1: Accuracy (the percentage of correct “No” responses) as fitted by the model. Error bars represent 95% confidence intervals.



References

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