# Engaging cognitive control helps children ignore unreliable sentence processing cues

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Children often make early commitments to sentence structure but fail to revise after late-arriving conflicting evidence [1]. While immature cognitive control is thought to contribute to parsing errors [2], correlations between syntactic and Stroop-like tasks remain inconclusive [3-4]. In adults real-time cognitive-control engagement improves revision of sentences like "*Put the frog on the napkin into the box*"[5]. Yet for children, these paradigms lead to less accurate revision [6]. One explanation for this discrepancy is that children's immature cognitive control is easily depleted, leaving fewer resources for revising sentences. Alternatively, cognitive-control engagement may actually help children ignore statistically unreliable parsing cues and attend more to role information from verbs (e.g., "*Put*" requires a location, but relying on this causes mispredictions). To test these hypotheses, we examined comprehension in 5-year-olds using active and passive sentences (1-3; Fig.2) where late-arriving verbs are reliable cues to role assignment. In contrast, an agent-first bias (e.g., assuming NP1s like "*The blicket*…" are doers of events) should hinder comprehension of passives (the bias and verb morphology conflict) [7-9]. If cognitive-control engagement reweights parsing cues, it may enable children to ignore the less reliable agent-first bias (subjects are not always agents) and increase sensitivity to verb morphology. This would improve passive comprehension but worsen actives [8-9]. Alternatively, if immature cognitive control is easily depleted, cognitive-control engagement should decrease comprehension of passives, but actives will be unaffected because they do not require revision.

To engage cognitive control, we interleaved Stroop trials (congruent vs. incongruent; Fig.1) with Sentence trials (actives vs. passives; Fig.2). Across experiments, we examined relative looks to likely agents vs. themes averaged over the 2000ms window after sentence offset, and calculated difference scores to track children's use of verb morphology in distinguishing constructions. Accurate comprehension is reflected by negative scores for actives and positive scores for passives. If cognitive-control engagement depletes revision resources, incongruent Stroops should worsen comprehension of passives (lower bars in Fig.3), but actives will remain unchanged. If cognitive-control engagement helps children ignore the (less reliable) agent-first bias, incongruent Stroops may improve passives by promoting sensitivity to verb morphology instead (higher bars in Fig.3a & 3c) but worsen actives which no longer benefit from agent-first predictions (higher bars). **Experiment 1** (n=32) used displays like Fig.2a and sentences like (1), where novel NP1s often trigger an agent-first bias [4,9]. Incongruent Stroops increased fixation scores for passives and actives relative to Congruent ones (main effects of Sentence & Stroop, $p's<.05$, Fig.3a), suggesting that cognitive-control engagement decreases the agent-first bias.

We conducted two control experiments. To isolate baseline effects of cognitive-control engagement, **Experiment 2** (n=32) used displays like Fig. 2a and sentences like (2), where known NP1s do not trigger an agent-first bias [9]. Both accounts predict symmetrical effects of Stroop conflict across construction. In Fig. 3b, fixation scores converged to zero after Incongruent Stroop, for actives and passives (main effect of Sentence; Stroop x Sentence interaction, $p's<.05$). This suggests that cognitive-control engagement does not directly affect parsing in the absence of unreliable cues. It also points to a baseline performance decrement after doing an incongruent Stroop trial. To rule out novel-word effects, **Experiment 3** (n=28) used displays like Fig. 2b and sentences like (3), where known NP1s (e.g., "*The cat*") induce an agent-first bias when paired with pronoun NP2s [8]. In Fig. 3c, fixation scores after incongruent Stroops increased for actives and were unchanged for passives (Stroop x Sentence interaction, $p<.05$). Like Experiment 1, this suggests that cognitive-control engagement decreases the agent-first bias. Together, these findings suggest that cognitive-control engagement may help children ignore unreliable parsing cues during comprehension. Decreasing parsing via broad-scale heuristics (e.g., agent-first bias) may increase learning of finer-grained features (e.g., verb biases).

**Fig.1 – Dog Stroop [Trial N-1].** On Congruent Stroop trials, children said a dog's name when the name matched its fur color (e.g. a blue dog named "Blue"). On Incongruent Stroop trials, dog names mis-matched their fur color (e.g. a red dog named "Green").


**Fig. 2 –Eye-tracking displays and sentences [Trial N].** After Stroop trials, these displays were presented (Fig.2=Exps.1&2, Fig.2b=Exp.3). Concurrently, children heard a corresponding sentence (1-3). Their fixations to the agent and theme were measured. In Exp.1, looks to the theme-agent=better passive interpretations. In Exps2&3, agent-theme looks=better passive interpretations.

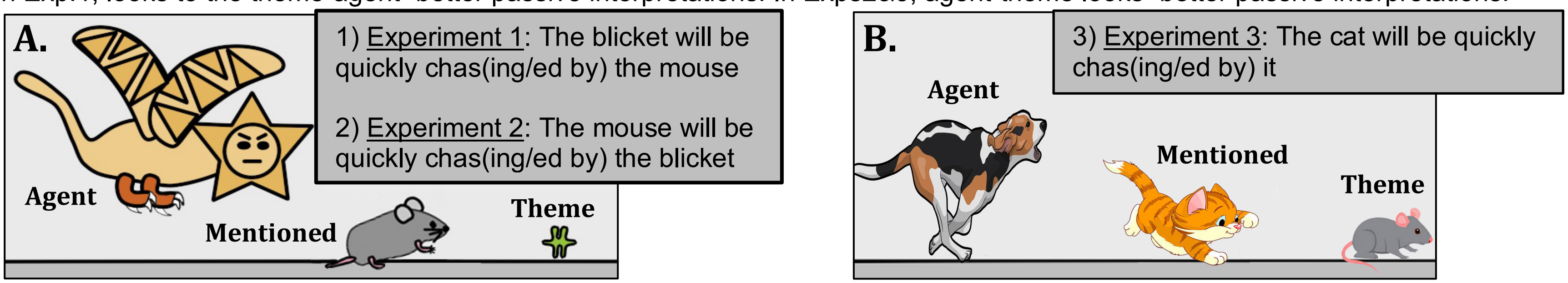
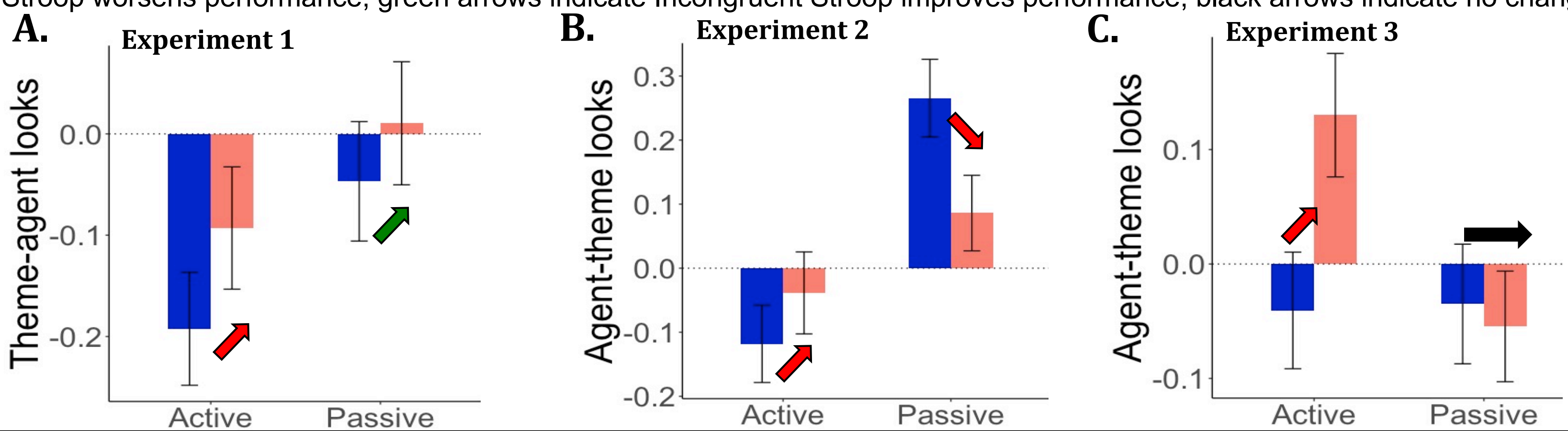



**Fig. 3 –Results.** Positive values indicate more accurate looks for passives, negative values = more accurate actives. Blue bars = Sentences after Congruent Stroop, salmon bars = Sentences after Incongruent Stroop. Red arrows indicate where incongruent Stroop worsens performance, green arrows indicate Incongruent Stroop improves performance, black arrows indicate no change.

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