Working Memory and Information Processing in Attention-Deficit/Hyperactivity Disorder

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Introduction

- The phenotypic behavioral presentation of ADHD may be driven by deficits in executive function(s) (Barkley, 1997; Rapport et al., 2009)
- Two proposed causal mechanisms:
  - Information Processing (IP) (Karalunas & Huang-Pollock, 2013)
  - Working Memory (WM) (Rapport et al., 2008)

IP and WM in ADHD

- Deficits in WM are present in a substantial portion of children with ADHD (Sonuga-Barke et al., 2008)
- Models that isolate performance specifically attributable to information processing speed suggest ADHD-related deficits in processing speed (Huang-Pollock et al., 2012)

Current Study

- Experimentally manipulated IP and WM demands in children with ADHD.
- Evidence for WM deficits in ADHD would include significant reductions in WM performance as IP demands increased
- Evidence for IP impairments in ADHD would include significant slowing of the rate of information accumulation (drift rate) as working memory demands increased

Method

Participants

- 8-13 year old children
- Carefully diagnosed ADHD
- ADHD (n = 46) vs. Non-ADHD (n = 40)

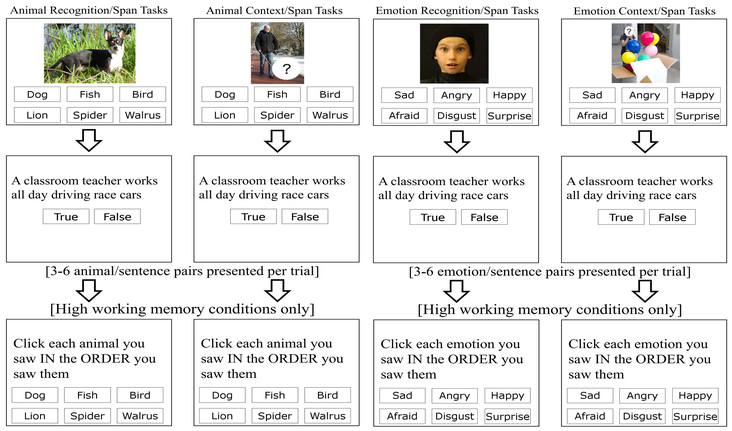
Tasks

- *Animal/Emotion Span*
  - High WM, Low IP
- *Animal/Emotion Context Span*
  - High WM, High IP
- *Animal/Emotion Recognition*
  - Low WM, Low IP
- *Animal/Emotion Context Recognition*
  - Low WM, High IP

Dependent Variables

- WM Capacity
  - Proportion of stimuli correct per trial (% correct)
- IP Speed
  - Drift rate (v) – speed of information uptake

Figure 1. Fully-crossed experimental manipulation of working memory and information processing demands.



Results

- ADHD group demonstrated impairments in:
  - Working Memory Capacity (Cohen's d = 0.74, BF_{10} = 30.92, p = < .001)
  - Information Processing Speed (drift rate; d = 0.64, BF_{10} = 8.98, p = .004)

Bayesian mixed-model ANOVAs

- Main Effects:
  - Increasing information processing demands did not significantly change working memory performance, such that the data were almost equally likely under the null and alternative hypotheses (BF_{10} = 1.60, p > .05)
  - Increasing working memory demands evoked significant decrements in the speed of information accumulation (drift rate; BF_{10} = 6.19, p < .05)
    - Suggest that higher WM demands disrupt IP speed for all children (regardless of ADHD diagnosis)
- Interactions were not significant:
  - Group x WM Capacity
  - Group x IP speed
    - Suggest that neither WM capacity or IP speed is likely to explain baseline impairments in the other process associated with ADHD

Figure 2. Model depicting drift rate via diffusion modeling (Ratcliff et al., 2016).

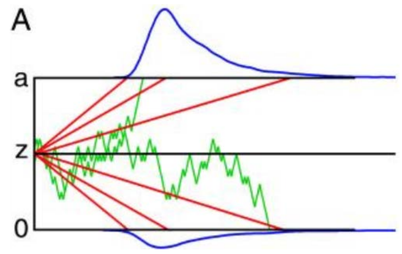
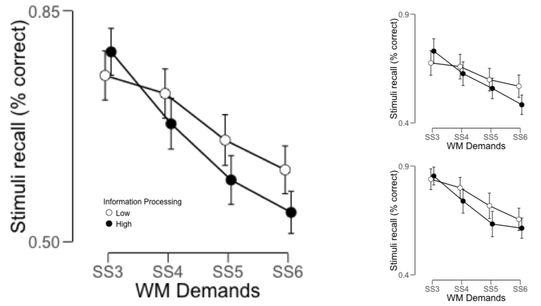


Figure 3. Top: Working memory performance (% stimuli correct per trial). Bottom: Information processing speed (drift rate). Insets reflect performance separately for the ADHD (top right) and Non-ADHD groups (bottom right).



Conclusion

- These results indicate that top-down executive control exerts significant effects on the speed of basic information processing in children
- Evidence suggests that slowed information processing is not a viable explanation for reduced working memory capacity in either ADHD or neurotypical children, although there was insufficient evidence to conclusively rule out such an influence