



## Neurocognitive Predictors of Individual Differences in Academic Functioning

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### Introduction

- Childhood ADHD is associated with impairments in peer, family, and academic functioning, and these impairments may predict long-term clinical outcomes better than core ADHD behavioral symptoms (Pelham et al., 2005).
- Approximately 33-63% of children with ADHD exhibit significant academic impairment (Mayes & Calhoun, 2006).
- Neurocognitive heterogeneity is a particularly appealing candidate to explain academic heterogeneity in ADHD given converging evidence that (a) neurocognitive abilities predict important academic outcomes in developmental samples (Thorell et al., 2007), (b) many but not all children with ADHD exhibit neurocognitive and/or academic deficits (Rapport et al., 2013), and (c) neurocognitive impairment may explain behavioral and functional impairments in ADHD at the group level (Chacko et al., 2013)
- To this end, ADHD studies suggest associations between academic attainment and global IQ (Alloway & Stein, 2014; Preston et al., 2009), working memory (WM; Alloway & Stein, 2014; Mayes & Calhoun, 2007; Rogers et al., 2011), and processing speed (Jacobson et al., 2011; Mayes & Calhoun, 2007).

### Present Study

- No study to date has concurrently examined the impact of working memory, inhibition, and processing speed on academic attainment while controlling for known risk factors for academic difficulties in ADHD (age, SES, ADHD symptoms, medication, gender).

### Research Questions

- To what extent is SES associated with WM, processing speed, IQ, and academic achievement in children with ADHD?
- Which of these cognitive and environmental factors best predict academic attainment for children with ADHD?

### Participants

- Participants were thirty-six children with ADHD (13 female, 23 male), ages 8-13.

### Measures

- ADHD was diagnosed using DSM-5 criteria based on comprehensive K-SADS diagnostic interviews and multiple parent/teacher ratings (BASC, CSI).

#### IQ

WASI-2 (FSIQ, Verbal Comprehension and Perceptual Reasoning indices)

#### Academic Achievement

KTEA-2 (Reading, Math, Written Expression, and Oral Language)

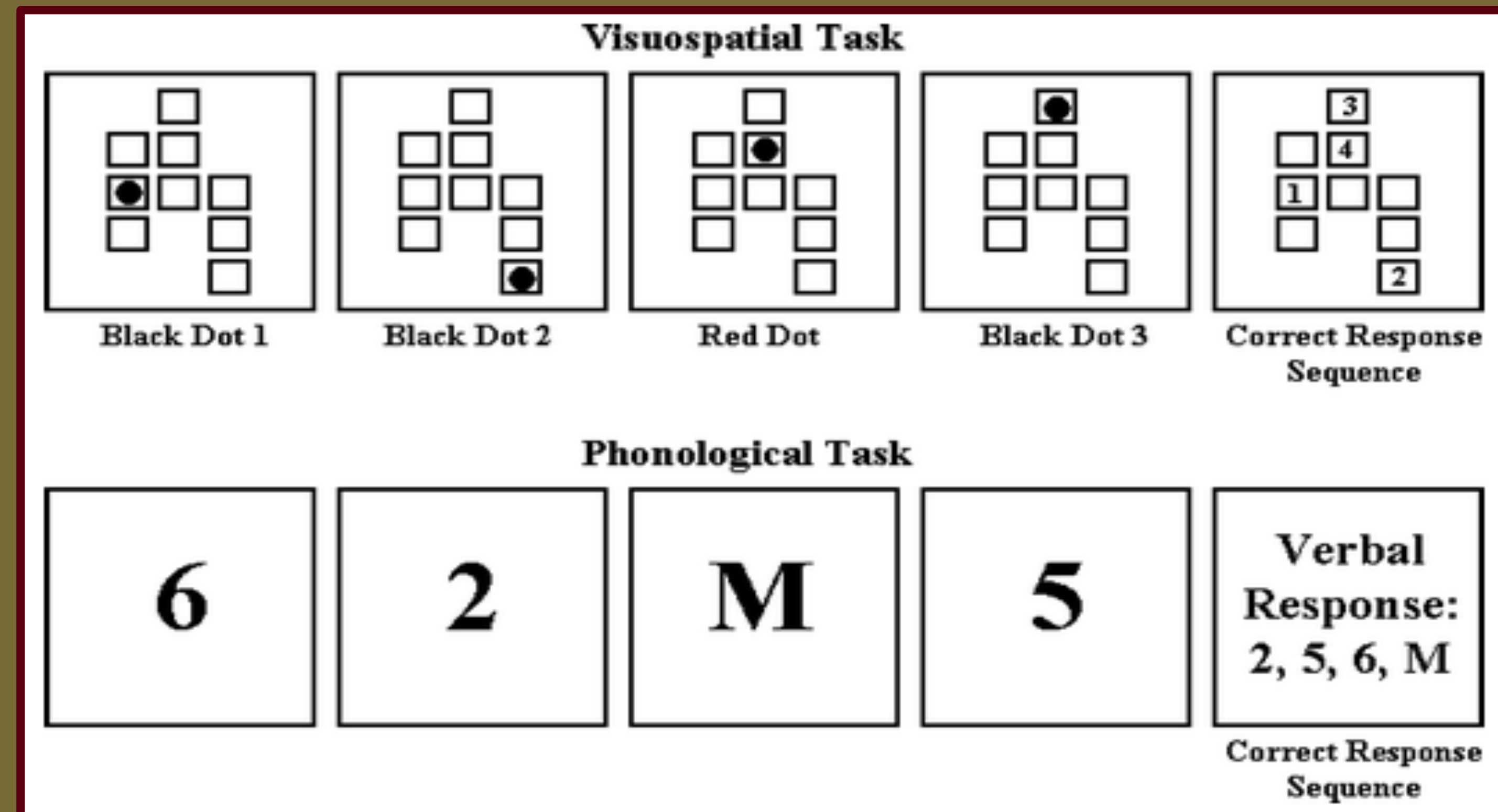
#### Executive Function Tasks

The Phonological WM (PHWM) and Visuospatial WM (VSWM) tasks are identical to those described by Rapport et al. 2008, with 12 trials per set size (3-6) presented in mixed sequence.

Stop-Signal Tasks. Behavioral inhibition and processing speed was indexed by stop-signal delay (SSD) and mean reaction time (MRT), respectively, from each of the task's 4 blocks (32 trials/blocks), as described in Alderson et al., 2007.

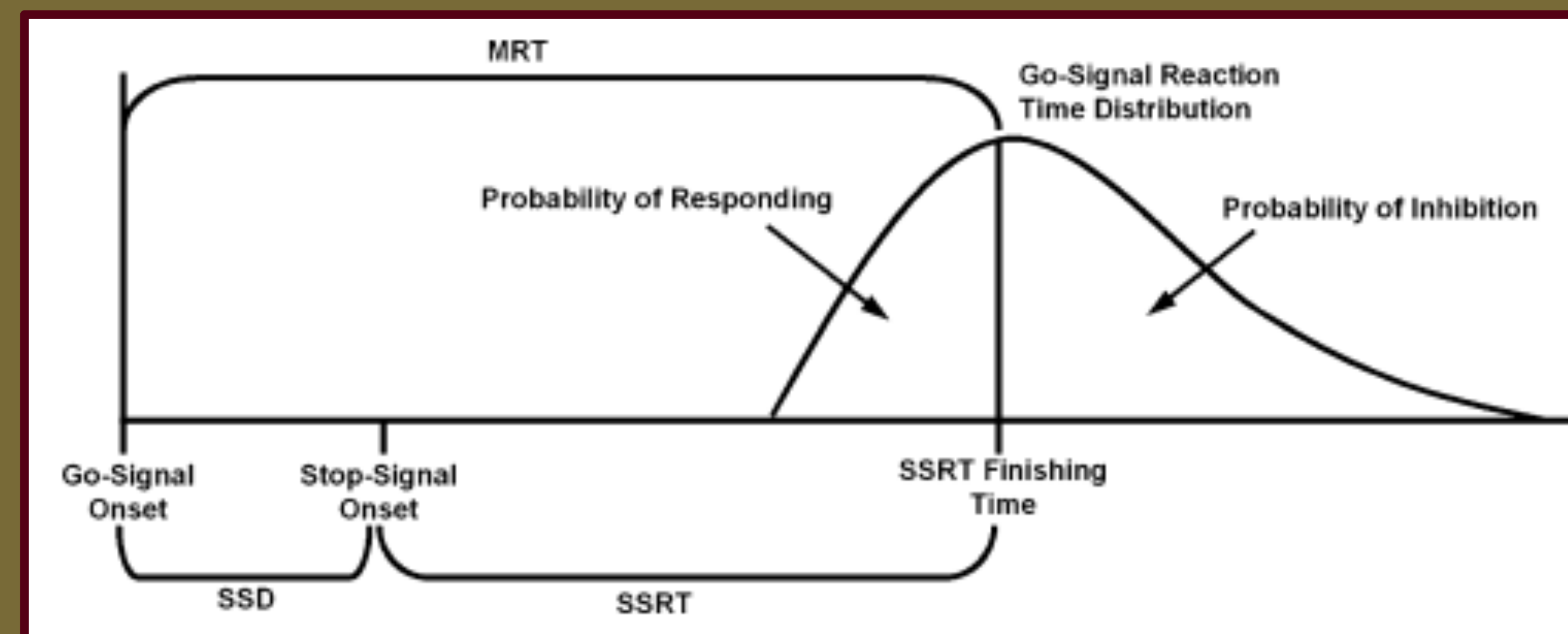
#### Socioeconomic Status

SES was assessed based on both parents' education and occupation (Hollingshead, 1975).



**Figure 1**

Examples of the VS (top) and PH (bottom) tasks as they appear to participants, as well as the correct responses.



**Figure 2**

Relations between mean reaction time (MRT), stop-signal delay (SSD), and stop-signal reaction time (SSRT).

### Results

- Bias-corrected bootstrapping indicated that SES was significantly related to IQ ( $r = .33$ ) and achievement ( $r = .38$ ), but not PHWM, VSWM, inhibition, or processing speed (all  $p > .05$ ).
- Achievement was related significantly to VSWM ( $r = .39$ ), PHWM ( $r = .42$ ), and IQ ( $r = .46$ ), but not inhibition or processing speed (both  $p > .05$ ).
- Stepwise regression revealed that IQ, PHWM, and VSWM each uniquely predicted achievement ( $R^2 = .53, p = .001$ ).
- SES, inhibition, and processing speed did not contribute significantly (all  $p > .36$ ).
- IQ explained 20% of individual differences in achievement ( $\Delta R^2 = .20$ ), relative to 28% for the WM variables (PHWM:  $\Delta R^2 = .15$ ; VSWM:  $\Delta R^2 = .13$ , all  $p < .01$ ).

### Discussion

- Collectively, these findings add to our understanding of neurocognitive heterogeneity in ADHD and reveal that these individual differences play an important role in academic outcomes.
- VS and PH WM abilities predicted heterogeneity in all assessed academic areas, and global intelligence additionally predicted specific academic skills (reading, oral language).
- Interestingly, both SES-related (IQ) and SES-unrelated (WM) cognitive functions appear important for understanding heterogeneity in academic attainment among children with ADHD.
- The data are cross-sectional, therefore we could not examine predictors of long-term achievement or potential cumulative impact of low SES on cognitive functioning over time (Turkheimer et al., 2003).
- Results add to a growing body of evidence implicating working memory deficits in ADHD behavioral symptoms and functional impairments

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