Executive Function Predicts Academic Achievement in Attention-Deficit/Hyperactivity Disorder

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Abstract

The current study sought to identify the executive function (EF) skills that best predict performance within each area of academic achievement in a sample of children diagnosed with attention-deficit/hyperactivity disorder (ADHD). Overall, it was anticipated that stronger EF abilities would predict better academic performance across multiple areas, but that EF skills would contribute differentially to each area.

Introduction

Attention-deficit/hyperactivity disorder (ADHD) has recently been characterized as a disorder of executive function (EF), which includes working memory, strategic planning, and behavioral inhibition (Weyandt, 2005). Certain EF subcomponents associated with ADHD have been shown to contribute to inattention and distractibility in the classroom, adversely affecting academic achievement (Molfese et al., 2010). Clark, Pritchard, and Woodward (2010) examined the relationship between EF and academic achievement in a general preschool population, linking set shifting, inhibitory control, and a unitary EF construct to early achievement in mathematics. In the general school population, EF has been linked to overall academic achievement, phonological awareness, letter-word identification, and math skills (Best, Miller, & Naglieri, 2011; Willoughby, Blair, Wirth, & Greenberg, 2011). While the link between EF and academic achievement has been well established, few studies have examined the specific EF skills that predict academic achievement within a sample of children with ADHD. Most applicably, Miller, Nevado-Montenegro, and Hinshaw (2012) found that global EF and working memory were the best predictors of academic achievement and reading achievement in young adult women with ADHD.

Method

Data were culled from a mixed clinical sample of neuropsychological case studies conducted by trainees in the KIDS, Inc. Post-Graduate School Neuropsychology Training Program. This dataset comprises a variety of clinical diagnoses, including autism spectrum disorder, severe emotional disturbance, learning disability, and others. Only cases with the primary diagnosis of ADHD were utilized. This sample consisted of 115 participants between the ages of 6 and 18 (M = 11.05, SD = 2.97). Composite scores on the Behavior Rating Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000) and Woodcock Johnson Tests of Achievement Normative Update, Third Edition (WJ III ACH; Woodcock, McGrew, & Mather, 2001) were utilized. Independent/predictor variables were comprised of parent ratings of children's EF skills as measured by the following clinical scales on the BRIEF: Inhibit, Shift, Emotional Control, Initiate, Working Memory, Plan/Organize, Organization of Materials, and Monitor. The dependent/outcome variables were comprised of children's performance in eight areas of academic achievement as measured by the following selected composite scores on the WJ III ACH: Basic Reading Skills, Reading Comprehension, Math Calculation Skills, Math Reasoning, Written Expression, Listening Comprehension, Oral Expression, and Academic Fluency.

Results

Eight stepwise regression analyses were conducted to determine the EF skills that best predict performance within eight areas of academic achievement. No significant predictors were included in the final regression models for Academic Fluency or Math Reasoning, suggesting that none of the clinical scales on the BRIEF significantly predict performance in those areas of achievement beyond chance alone.

Verbal Comprehension and Expression. Organization (β = .305, p = .004) and Inhibit (β = -.295, p = .005) explained 16.4% of the variance in Listening Comprehension, R^2 = .164, F (2, 81) = 7.97, p = .001. Inhibit (β = -.379, p < .001) and Initiate (β = .323, p = .002) explained 19.6% variance in Oral Expression R^2 = .196, F (2, 81) = 9.843, p < .001.

Writing Achievement. Working Memory (β = -.336, p = .003), Inhibit (β = -.367, p = .002), and Emotional Control (β = .369, p = .003) explained 22.6% variance in Written Expression R^2 = .226, F (3, 80) = 7.78, p < .001.

Mathematics Achievement. Inhibit (β = -.367, p = .001) explained 13.5% variance in Math Calculation R^2 = .135, F (1, 82) = 12.75, p = .001.

Reading Achievement. Inhibit (β = -.601, p < .001) and Monitor (β = .328, p = .005) explained 25.7% variance in Basic Reading Skills R^2 = .257, F (2, 81) = 14.03, p < .001. Inhibit (β = -.742 p < .001), Emotional Control (β = .307, p = .004), and Shift (β = .244, p = .020) explained 36.1% variance in Reading Comprehension R^2 = .361, F (3, 80) = 15.03, p < .001.

Listening Comprehension: Predictor Variables	R^2	Beta
Organization of Materials	.078	.305
Inhibit	.164	-.295

Oral Expression: Predictor Variables	R^2	Beta
Inhibit	.096	-.379
Initiate	.196	.323

Written Expression: Predictor Variables	R^2	Beta
Working Memory	.089	-.336
Inhibit	.133	-.367
Emotional Control	.226	.369

Math Calculation: Predictor Variables	R^2	Beta
Inhibit	.135	-.367

Basic Reading Skills: Predictor Variables	R^2	Beta
Inhibit	.181	-.601
Monitor	.257	.328

Reading Comprehension: Predictor Variables	R^2	Beta
Inhibit	.233	-.760
Emotional Control	.310	.322
Shift	.361	.254

Conclusions

- Executive function contributes to performance in reading and writing to a greater extent than to mathematics or oral expression.
- Inhibition predicts performance across most areas of achievement. According to Barkley (1997), response inhibition is a key deficit in ADHD, which may explain the role of response inhibition in academic functioning within this population.
- Given that deficits in certain EF skills (i.e., emotion regulation, shifting, monitoring, organization of materials, and initiating) predicted positive academic outcomes, these skills may not be essential to academic success.
- Factors besides EF, such as fluid reasoning and processing speed, may be key in mathematical reasoning and academic fluency.
- EF interventions may improve achievement. For example, targeting impulsive responding in children with ADHD may improve reading and writing skills.
- Limitations to this study include its reliance on behavioral indicators of EF and the potential for overall intelligence to explain the observed relationships.