USE OF THE BEHAVIOR RATING INVENTORY OF EXECUTIVE FUNCTION PARENT FORM FOR CHILDREN WITH ATTENTION-DEFICIT/HYPERACTIVITY DISORDER

A DISSERTATION

SUBMITTED TO THE FACULTY

OF

THE GRADUATE SCHOOL OF APPLIED AND PROFESSIONAL PSYCHOLOGY

OF

RUTGERS,

THE STATE UNIVERSITY OF NEW JERSEY

BY

LIAT ZILBERSTEIN

IN PARTIAL FULFILLMENT OF THE

REQUIREMENTS FOR THE DEGREE

OF

DOCTOR OF PSYCHOLOGY

NEW BRUNSWICK, NEW JERSEY MAY 2017

APPROVED: ________________________

Linda A. Reddy, Ph.D.

____

Adam Lekwa, Ph.D

DEAN: ________________________

Francine Conway, Ph.D.

Abstract

This study assessed the validity of the Behavior Rating Inventory of Executive Functions Parent Form (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000) for children with ADHD and a matched control sample. A sample of 114 children with ADHD (69% with co-morbidity) and 114 matched controls were found to exhibit statistically ($p < .001$) and clinically significant group differences on the BRIEF scales. Discriminant function analyses revealed that the Global Executive Composite accurately identified 78% of the sample (79% of controls and 77% of children with ADHD correctly identified). Results also revealed that the Behavior Regulation and Metacognitive Indexes accurately classified 78% of the sample (77% of controls and 79% of children with ADHD correctly identified), with the Behavior Regulation Index contributing most to the discriminant function. Diagnostic efficiency was examined with a range of cutoff scores. Using the test authors' recommended cut-score of 65, diagnostic efficiency statistics yielded large Overall Correct Classification (OCC) values for the Global Executive Composite, and to a lesser extent the Behavioral Regulation and Metacognitive Indexes. At the recommended cut-score of 65, indexes yielded strong specificity and moderate to weak sensitivity. Indexes yielded strong positive predictive power and moderate negative predictive power. The Global Executive Composite yielded the strongest positive and negative predictive power. Implications of results for practice and research are discussed.

Acknowledgements

First and foremost, I would like to thank Linda Reddy for her dedication to helping me finish this dissertation and complete my graduate studies. Thank you for your guidance, mentorship, and encouragement throughout my years in graduate school and, particularly, in this final concluding chapter. Without you this would not have been possible. To Adam Lekwa, thank you for your invaluable feedback. I appreciate the time and attention you dedicated to reviewing my work. Thank you also to Susan Forman for your support and direction leading up to the culmination of my degree. I would also like to thank Karen Haboush, who is no longer with us, but whose warm presence always made me feel supported. To Sylvia, thank you for answering my many questions right through the very end. To my practicum and internship supervisors, thank you for your time, mentorship, and dedication to my professional growth. A special thanks to Jane Healey for being a wonderful teacher and mentor.

I would like to thank my friends and family who encouraged me to first pursue this degree and who have supported me throughout the many chapters of my journey. Sarah, Kim, and Ariella, thank you for always being there to listen in difficult times and to celebrate in good times. A special thanks to Orit for being my sounding board and for always believing in me. Mom and Dad, thank you for encouraging me to follow my dreams and for always being right behind me. Talia and Noah, your love and friendship mean the world to me. Yoni, more than my brother, you are my trusted friend and colleague, and I am grateful for all that I have learned from you. To my Bubby and Zaidy, your support has been invaluable in achieving this goal.

Thank you to friends and colleagues that I have met along the way. Nicole and Shoshana, I am grateful for your friendship, camaraderie, and for having shared this experience with you.

Collette, Leticia, and Carina, Miami would not have been the same without you. Also, many thanks to my cohort for their fellowship and community.

Finally, to Avram, my partner in all things, and my biggest supporter, thank you for being with me in this journey. I would not be where I am without your unwavering faith in me. I love you always.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Figures Page #

Introduction: ADHD and Executive Dysfunction

Although generally thought of as a behavior disorder, Attention- Deficit/ Hyperactivity Disorder (ADHD) is a neurocognitive disorder with concomitant executive function deficits. While the American Psychiatric Association states in its Diagnostic and Statistical Manual of Mental Disorders (DSM-5) that 5% percent of school-aged children and adolescents have ADHD (American Psychiatric Association, 2013), data collected by the National Survey of Children's Health (NSCH) indicates that 11% of children 4-17 years of age have been diagnosed with ADHD as of 2011, reflecting a substantial increase in prevalence rates (Visser et al., 2014). Neuropsychological and cognitive theories of ADHD primarily focus on the constructs of impulsivity, poor motor and cognitive inhibition/inhibitory control (Barkley 2014; Diamond, 2013; Sonuga-Barke, 2003), and/or impairments in executive functions (Barkley, 2014). The latter have been described as an integrated set of cognitive processes that determine goal directed and purposeful behavior, and which are together involved in the execution of daily life functions, including the ability to formulate goals, initiate tasks, anticipate the consequences of behaviors, plan and organize space, time, and logical sequences, and monitor and adapt behavior according to particular contexts and demands (Cicerone et al., 2000). Collectively, scholars assert that executive functioning impairment is the key neuropsychological process that is characteristic of ADHD (Biederman et al., 2004; Brown, Reichel, & Quinlan, 2009; Koziol & Stevens, 2012). However, given that such impairments are also found in other mental health disorders, research that isolates and differentiates specific executive function deficits for ADHD from other childhood disorders is critical for informing clinical practice (Hale et al., 2009; Reddy, Newman, Pedigo, & Scott, 2010; Reddy, Weisman, & Hale, 2013).

According to Barkley (2012) there are several areas of executive functioning that are impaired as a result of poor self-regulation/self-control. These include self-restraint/behavioral inhibition, internalization of speech (verbal working memory), self-directed sensory-motor action (non-verbal working memory), reconstitution (planning), self-regulation of affect/motivation, and self-awareness/monitoring. Consequently, when individuals experience impairments in these areas it decreases their control of motor functioning, as well as their executive control of behavior. Similarly, Douglas (2005) proposed that children with ADHD have significant self-regulatory difficulties which result from executive function deficits and these cognitive deficits impede their abilities to efficiently and effectively control impulses, plan, organize, and self-monitor. Likewise, Miller and Cohen's Integrative Theory of the Prefrontal Cortex (Miller & Cohen, 2001) posited that the prefrontal cortex, primarily responsible for cognitive control, manages the recruitment of sensory and motor neurons to perform tasks that require initiation, inhibitory control, selective attention, and other executive functions.

While ADHD was previously conceptualized by many as a unitary disorder, research from the last decade has largely supported the conceptualization of ADHD as a condition that arises from one or more different abnormalities in key neural systems (Koziol & Stevens, 2012). The "dual-pathway" model (Sonuga-Barke, 2003; Sonuga-Barke, Bitsakou, and Thompson, 2010) suggests that ADHD is the result of dysregulation of action and thought stemming from poor inhibitory control and/or dysfunction with the motivational/reward system of the brain. Multiple etiology neurocognitive models (Durston, Belle, & Zeeuw, 2010) propose subtypes of ADHD characterized by impairments in "dorsal fronto-striatal", "orbitofronto-striatal", and "fronto-cerebellar" pathways, linked to cognitive control, reward processing, and timing, respectively. In this model, dysfunction in any of these circuits could lead to symptoms of ADHD.

Measures of Executive Functioning

Despite the mounting theoretical and scientific bases for ADHD as a neurocognitive disorder, traditional assessments for children at risk for ADHD almost exclusively rely on parent interview, behavior rating scales, intellectual assessment, and at times, observation (American Academy of Pediatrics, 2000; MTA Cooperative Group, 1999). The utility of behavioral assessments has frequently been studied in reference to their ability to accurately identify children with ADHD (Koonce, 2007; Reddy, Weissman & Hale, 2013). Investigators have reported substantial differences in the behavioral components of ADHD, specifically impulsivity, hyperactivity, and inattention, between children with ADHD and controls (e.g., Doyle, Biederman, Seidman, Weber, & Faraone, 2000). In contrast, other investigators have reported that behavior ratings alone are insufficient for accurate ADHD diagnosis because of differences in children's subcortical circuit functioning and the severity of symptom dimensions across settings (Hale et al., 2009; Reddy, Newman, Pedigo, & Scott, 2010; Wolraich et al., 2004).

Neuropsychological measures for ADHD evaluation and diagnosis seem crucial due to the fact that current research largely identifies frontal-striatal-circuit dysfunction as the cause of ADHD (Bedard et al., 2010; Braet et al., 2011; Brown et al., 2011). Deficits in particular brain regions contribute to functional impairments related to cognitive and behavioral symptoms. These functional impairments may include: inhibitory control, inattention, working memory, processing speed and efficiency, learning, academic performance, and social-emotional functioning. To distinguish ADHD from other childhood mental disorders (that also affect frontal-subcortical circuits) and to differentiate among ADHD subtypes, measures of executive function deficits are necessary (e.g., Hale et al., 2001; Hale et al., 2009; Mahone et al. 2002; Sullivan & Riccio, 2007). However, executive function measures should not be considered a replacement for behavior ratings (Toplak, Bucciarelli, Jain, & Tannock, 2009). Instead, both indirect rating scales as well as direct neuropsychological instruments are necessary for differential diagnosis (Hale et al., 2009; Reddy, Newman, Pedigo, & Scott, 2010) as they provide complementary information for diagnostic decision making for children at risk for ADHD and other related disorders (Hale et al., 2009; Reddy & Hale, 2007; Reddy, Weissman, & Hale, 2013).

Behavior rating inventory of executive function (BRIEF). One assessment tool that attempts to bridge the gap between indirect behavior ratings and direct neuropsychological assessment is the Behavior Rating Inventory of Executive Function (BRIEF, Gioia, Isquith, Guy, & Kenworthy, 2000). The BRIEF is a multidimensional instrument, designed for parents and teachers to assess the executive function behaviors in school-aged children and adolescents. The BRIEF is the first behavior rating scale that measures behavioral manifestations of executive function impairment for children and adolescents at risk for ADHD and ADHD-related disorders (e.g., learning disorders, pervasive developmental disorders, traumatic brain injury, depression). There are eight features of executive functioning that the BRIEF evaluates: ability to shift from one situation to another, inhibit behavior, initiate tasks or activities, modulate emotional responses, manage current and future task demands (plan/organize), organize learning materials, monitor work effort, and hold information in mind to complete a task (working memory). Because the BRIEF is often used in clinical practice as part of a battery of tests used to identify or rule-out ADHD in children, it is crucial to understand its utility in accurately differentiating those with and without the disorder. To that end, it is important to examine the discriminant validity of behavioral and neuropsychological instruments, which is particularly important for examining how well scores from such instruments differentiate between diagnostic groups and inform diagnostic decisions.

Literature Review

Discriminant Validity of the BRIEF for Youth with ADHD

The discriminant validity of the BRIEF for youth with ADHD and related disorders has been investigated within a number of studies (e.g., Gioia, Isquith, Kenworthy & Barton, 2002; Hovik et al., 2014; Isquith, Gioia, & Espy, 2004; Linder, Kroyzer, Maeir, Wertman-Elad, and Pollak, 2010; Mahone et al., 2002; Mares, McLuckie, Schwartz, & Saini, 2007; McCandless & Laughlin, 2007; Nguyen et al., 2014; Qian et al., 2010; Reddy, Hale, & Brodzinsky, 2011; Shimoni, Engel-Yeger, & Tirosh, 2012; Skogan et al., 2015; Skogli, Teicher, Andersen, Hovik, & Oie, 2013; Sullivan & Riccio, 2007; Toplack, Bucciarelli, Jain & Tannock, 2009). Overall, results have largely revealed greater executive functioning impairment in those with ADHD relative to those without ADHD or controls. For example, Gioia and colleagues (2002) found that children diagnosed with ADHD-Inattentive Type (IT), ADHD- Combined Type (CT), Autism Spectrum Disorder (ASD) displayed higher scores across all BRIEF-PF and BRIEF-Teacher Form (TF) scales compared to those with reading disabilities, traumatic brain injury, and controls. The authors reported that the ADHD-CT group was rated as most impaired on the Inhibit scale. Similarly, Qian and colleagues (2010) examined group differences between 89 Chinese children and adolescents with ADHD (without comorbidity), 53 with ADHD + ODD, and 116 unmatched controls on the BRIEF-PF and several performance-based tests of executive functioning (e.g., Inhibition: Stroop Color-Word Test; Shifting: Trail-Making Test). The ADHD and ADHD + ODD groups exhibited significantly higher scores on the 8 BRIEF-PF subscales than the control group. In a more recent study, Shimoni, Engel-Yeger, and Tirosh (2012) examined the relationship between specific executive functions (e.g., planning, sequencing, sustained attention, interference, feedback utilization, and set-shifting) as measured by the BRIEF-PF and the Behavior Assessment of Dysexecutive Syndrome for Children (BADS-C), a performance-based instrument. The sample included 50 Israeli boys (8 through 11 years), 25 with ADHD (comprising all three subtypes) and 25 typically-developing controls matched on age, socioeconomic status, place of residence, and religion. Results revealed greater impairment among boys with ADHD compared to matched controls on the BRIEF Global Executive Composite (GEC), Metacognition index (MI), and Behavioral Regulation index (BRI). Consistent with previous studies, the authors found greater impairment in those with ADHD across all subscales, apart from the Shift and Organization of Materials scales.

In another study, Isquith et al. (2004) used a modified version of the BRIEF-PF and TF for 50 preschoolers (2 to 5 years). In contrast to studies that demonstrated greater impairment across all BRIEF-PF subscales, the authors reported that those with ADHD, language disorders, and ASD demonstrated higher scores on the Inhibit, Shift, Emotional Control, Plan/ Organize, and Working Memory scales when compared to controls matched on age, sex, ethnicity, and mother's education level. Mahone et al. (2002) reported that children and adolescents, 6 to 16 years, with ADHD only (n = 18) and ADHD/Tourette Syndrome (n = 17) exhibited greater impairment on the BRIEF-PF GEC, MI, and BRI compared to youth with Tourette Syndrome (n = 21) and unmatched controls (n =20). In contrast to other studies, the authors found that the ADHD only and ADHD/Tourette Syndrome demonstrated greater impairment on only the Inhibit and Working Memory scales.

In addition to greater executive dysfunction in youth, studies have also demonstrated the usefulness of BRIEF indexes and scales, particularly the Working Memory scale, in predicting ADHD and non-ADHD status. An investigation by Linder et al. (2010) using the BRIEF- PF examined 80 youth with ADHD only and 78 without ADHD (ages 7 to 18 years) matched on age and gender. In addition to group score differences on all BRIEF-PF scales, analyses revealed that the eight subscales and the Working Memory subscale alone yielded overall correct classifications of 87.3% and 87.9%, respectively, for all subjects. McCandless and O'Laughlin (2007) also reported statistically significantly higher scores on the MI and BRI for ADHD versus non-ADHD child samples. In their study, discriminant function analyses correctly classified 77.8% of ADHD children and 76% of non-ADHD children. Similar to findings by Linder et al. (2010), the Working Memory scale was particularly useful in distinguishing ADHD participants from their non-ADHD counterparts; however, the Inhibit scale was found to be helpful in differentiating ADHD subtypes. Overall, the authors found the MI to be most useful in determining an ADHD diagnosis and the BRI, and particularly the inhibit scale, most useful in differentiating between ADHD subtypes.

Using a Norwegian version of the BRIEF-PF, Skogli, Teicher, Andersen, Hovik, and Oie (2013) also found significant group differences between participants with ADHD and unmatched controls. Based on a sample of ADHD females (*n*=37), ADHD males (*n*=43), female controls (*n*=18), and male controls (*n*=32), ages 7 to 18 years, results revealed that the BRIEF-PF discriminated males with ADHD from male controls with high accuracy. The BRIEF-PF was less accurate in discriminating ADHD females from female controls. Similar to findings reported by McCandless and O'Laughlin (2006) and Linder et al. (2010), the authors found the Working Memory scale to be the most important variable in distinguishing those with ADHD from controls of both genders. Similarly, Skogan et al. (2015) investigated whether Working Memory and Inhibit subscales of an adapted version of the BRIEF-P could accurately discriminate preschool children with ADHD from their typically developing peers in an unmatched sample of 308 preschool children, ages 37 to 47 months. Discriminant function analyses correctly classified 86.4% of participants - 80.1% of children in the ADHD group and 91.5% of non-ADHD children- based on Working Memory and Inhibit subscale scores simultaneously used as predictors. Nguyen et al. (2014) also found working memory to be an important factor in discriminating children with ADHD from those without the condition. The authors examined the BRIEF-PF and performance-based measures of executive functioning in four groups of children, ages 8-16 years: alcohol-exposed with ADHD (n=80), alcohol exposed without ADHD (n=36), non-exposed children with ADHD (*n*=93), and unmatched controls (*n*=167). While alcohol exposed children (regardless of ADHD diagnosis) demonstrated the greatest executive function impairment, children with ADHD had significantly higher scores compared to controls. Discriminant function analyses using 8 clinical scales accurately classified 71.4% of the entire sample (92.1% control group; 67.1% alcohol exposed/ADHD; 50.6% ADHD only; and 42.9% alcohol exposure only). The Working Memory scale was found to best distinguish controls from those with ADHD (regardless of alcohol exposure) thereby suggesting that children with ADHD have greater problems with working memory.

Reddy, Hale, and Brodzinsky (2011) examined the discriminant validity of the BRIEF-PF for children and adolescents, ages 6 to 16 years, with ADHD and controls matched on age, gender, ethnicity, and parent education level. Results revealed that 58 youths with ADHD and 58 matched controls exhibited statistically and clinically significant group differences (large d-ratios) on the BRIEF scales. Discriminant function analyses indicated that the BRI and MI correctly classified 82% of the sample (86% of controls and 79% of children with ADHD). In contrast to McCandless and O'Laughlin's findings (2007), analyses revealed that the BRI made the most significant contribution to the discriminant function, thus supporting the perspective that response inhibition is the primary deficit in ADHD (Reddy, Hale, & Brodzinsky, 2011). In terms of specific scales, Shift, Emotional Control, and Working Memory were found to contribute more significantly to the function as compared to the other five scales. Davidson, Cherry, and Corkum (2016) examined the validity of the BRIEF-PF and BRIEF-TF compared to performance-based measures of executive functioning for 20 children with ADHD and 20 unmatched controls, 8 to 12 years. The authors assessed four domains of executive functioning (i.e., working memory, planning, inhibition, and set-shifting) and found significantly greater impairments in participants with ADHD compared to controls on both the BRIEF and performance-based measures. However, according to the authors, the BRIEF-PF was particularly useful in discriminating between children with ADHD and controls. Similar to previous studies, the Working Memory and Inhibit scales were found to be most useful in discriminating between groups. However, the authors also found the Plan/Organize scale to be useful in discriminating between groups relative to other scales. Similarly, Toplak, Bucciarelli, Jain, and Tannock (2009) demonstrated that ratings on the Shift and Plan/Organize scales, in addition to the Working Memory and Inhibit scales, were good predictors of ADHD status. They also found that among 46 adolescents with ADHD and 44 unmatched controls, the BRIEF-PF and Teacher Form (TF) were more useful in predicting ADHD status when compared to performance-based measures of executive functioning (i.e., stop task, Trail Making Task A and B, WISC-III Spatial Span and Digit Span, Stockings of Cambridge task).

Sullivan and Riccio (2007) found the BRIEF-PF to be sensitive to executive impairments in children with ADHD and other psychiatric diagnoses relative to unmatched controls. Hovik et al. (2014) also examined executive functioning in children (ages 8 to 17 years) with ADHD (ADHD-Inattentive Presentation, ADHD-Combined Presentation), other psychiatric conditions (Tourette Syndrome [TS] and Autism Spectrum Disorder [ASD]), and typically developing unmatched controls using a Norwegian version of the BRIEF-PF with participants, ages 8 to 17 years. While findings revealed significantly greater impairment on all scales and indexes for each clinical group when compared with controls, specific patterns of executive dysfunction were found for each group. The TS and ADHD-Combined Presentation groups had more impairment on the Inhibit scale than the other clinical groups. Alternatively, when compared to the TS group, the ADHD-Inattentive group had greater impairment on the Plan/Organize scale and the ADHD-Combined Presentation group had significantly greater impairment on the MI as well as the Plan/Organize and Organization of Materials scales. The Inhibit scale differentiated between children with TS and those with ADHD-Combined Presentation, with the latter demonstrating more problems with inhibition. A global analysis did not discriminate between groups. While executive functioning impairments were present in all clinical groups in the study, the authors demonstrated that areas of deficit may differ based on the neurodevelopmental condition and the GEC may be less useful in discriminating those with ADHD from individuals with other psychiatric conditions.

Taken together, BRIEF validity studies to date suggest that the BRIEF is a useful evidence-based instrument for assessing children’s global behaviors indicative of executive functioning (i.e., behavioral regulation and metacognition) and narrower behaviors (i.e., organizing learn materials, ability to initiate tasks, monitor task completion) of executive functioning across settings. Validity studies using the BRIEF-PF demonstrate greater impairment in ADHD versus non-ADHD samples across indexes (i.e., BRI and MI) and scales, with Working Memory and Inhibit scales consistently demonstrating the greatest contribution in differentiating ADHD from non-ADHD participants. Taken together, there is some evidence to suggest that on the BRIEF-PF, the BRI is more accurate than the MI in classifying ADHD.

To date, only four studies have examined the BRIEF-PF using a matched sample (Isquith, Gioia, & Espy, 2004; Linder et al., 2010; Reddy, Hale, & Brodzinsky, 2011; Shimoni, Engel-Yeger, & Tirosh, 2012). These studies varied in terms of sample size, participant age range (e.g., children and adolescents, preschoolers), and matching variables. Regarding the latter, Reddy, Hale, and Brodzinksy (2011) used matching variables of age, gender, ethnicity, and parent education. Similarly, Isquith, Gioia, and Espy (2004) matched participants based on age, sex, ethnicity, and mother education. Shimoni, Engel-Yeger, & Tirosh (2012) matched participants based on age, socioeconomic status, place of residence, and religion, while Linder et al.(2010) used only age and gender to match participants. Only one of these four studies (i.e., Shimoni et al., 2012) focused on a child only sample (ages 8 through 11), and two (i.e., Isquith, Gioia, and Espy, 2004; Shimoni et al., 2012) used sample sizes of only 50 participants total.

Study Rationale

In the literature, there is lack of BRIEF-PF studies using a more substantive sample focused specifically on elementary school age children with ADHD and matched controls. Additionally, of the studies examining the validity of the BRIEF-PF for youth with ADHD and related disorders, no study has examined diagnostic efficiency statistics with a range of cut scores. Diagnostic efficiency statistics are crucial in understanding an instrument’s utility as a screening and/or diagnostic tool. Specifically, the sensitivity of an instrument, which reflects the probability that a test will be positive among those with a given condition, and the specificity, which reflects the probability that a test will be negative among those who do not have the given condition are of value in terms of first identifying those with a possible condition. As a screening measure, it is important to know the extent to which the BRIEF-PF can flag those with possible ADHD while simultaneously excluding those who do not have ADHD. In terms of an instrument's usefulness as a diagnostic measure, adequate positive and negative predictive power are essential. Positive and negative predictive power provide a metric for understanding the chances of having a condition given a positive test results and, likewise, the chances of not having a condition given a negative test result: Positive Predictive Power (PPP) reflects the probability of having a disorder given an abnormal test result and Negative Predictive Power (NPP) reflects the probability of not having a disorder given a normal test result. These statistics are important when considering the potential for under-diagnosis, and in particular, over-diagnosis of ADHD in children today. Indeed, over-diagnosis of ADHD is a highly debated issue among researchers and practitioners alike in the face of drastically increasing rates of ADHD in children in the last decade (Visser et al., 2014), in part, due to variations in how it is measured (Centers for Disease Control and Prevention, 2017).

Current Study Objectives and Hypotheses

Building on this line of research, the present study examined the discriminant validity of the BRIEF-PF with school-aged children independently diagnosed with ADHD in comparison to matched controls. The current study was the first to use a robust sample to focus on elementary school-age children, matched on age, gender, ethnicity, and parent education. Research has demonstrated that variables of age, gender, ethnicity and parent education significantly contribute to cognitive functioning and behavior (Lezak, 1995). As such, the use of these four demographic variables (i.e., age, gender, ethnicity, parent education) – which are hallmark variables for standardization - helped to ensure that results were not confounded by the variables on which the groups were matched. As a metric to determine diagnostic efficiency of the BRIEF-PF, scale scores as well as the recommended cutoff score (i.e., T=65) reported in the BRIEFs technical manual were used. The study examined how well cutoff scores predicted ADHD and non-ADHD children. Using cutoff scores is a methodology most often used by practitioners in the field for making decision about individual cases. In addition, examination of the classification efficiency of an instrument's cutoff score can provide crucial information about the discriminant validity of that instrument (Kessel & Zimmerman, 1993).

Three research questions were addressed:

1. How well does the BRIEF-PF differentiate between children with ADHD and matched controls?
2. Do the BRIEF-PF scales predict group membership and yield adequate overall correct classification (OCC) between groups?
3. Which indexes and scales make the largest contribution to the discriminant function?
4. Do the BRIEF-PF GEC, BRI and MI yield acceptable sensitivity, specificity, Positive Predictive Power, and Negative Predictive Power at the test authors' recommended cutoff T-score of 65?

It was hypothesized that:

1. The BRIEF-PF scales would yield statistically significant and clinical meaning differences (d-ratios) between groups.

2. The BRIEF GEC, BRI, and MI would yield adequate overall correct classification (OCC).
3. The BRI and Working Memory and Inhibit scales would make larger contributions overall to the discriminant function.
4. The BRIEF would yield adequate sensitivity, specificity, PPP and NPP.

Method

Participants

The sample of 228 children ranged in age from 6 to 12 years, with a mean of 10.24 years (*SD* = 2.8 months). The ADHD (*n* = 114) and control samples (*n* = 114) were matched on three demographic variables (i.e., age, gender, and ethnicity). Children with ADHD were 75.4% male, 71% Caucasian, 17.5% African American, 9.6% Hispanic/Latino, .9% Asian, and .9% listed as other, with a mean age of 10.24 (SD=2.8). Similarly, the control sample consisted of approximately 75.4% males, 71.6% Caucasian, 17.5 African American, and 7.9% Hispanic/Latino, with a mean age of 10.23 years (*SD* = 2.8 months).

Seven inclusion and exclusion criteria were used to select children for the ADHD sample. Inclusion criteria were: (a) primary diagnosis of ADHD by a licensed psychologist, psychiatrist, developmental pediatrician, and/or pediatric neurologist (it must be noted that the BRIEF was not used as an assessment in the diagnosis of ADHD); (b) met the DSM-IV-TR diagnostic criteria for ADHD (American Psychiatric Association, 2000) diagnosis prior to this study; and (c) enrolled full-time in school. Exclusion criteria included: (a) parents who were presently separated or in divorce process; (b) children who had experienced a significant loss (e.g., death of parent, sibling) within the past 12 months; (c) children who had been physically and/or sexually abused within the past 18 months; and (d) children diagnosed with brain injury or seizure disorder. Within the ADHD sample, subtypes included Combined Type (CT), Inattentive Type (IT), and Hyperactive/Impulsive Type (HIT).

Using the DSM-IV-TR, it was determined that comorbidity was present in approximately 69% of the ADHD sample for the following psychiatric diagnoses: 53% Oppositional Defiant Disorder (ODD), 15.5% Separation Anxiety Disorder, 13% Anxiety Disorder NOS, 15.5% Learning Disabled (LD), 7% Dysthymia, 4% Major Depressive Disorder, and 4% Conduct Disorder (CD), Childhood Onset. Approximately 64% of the ADHD sample received special education services (e.g., speech and language therapy, occupational therapy, academic remediation, classroom behavioral managements) provided under either Individuals with Disabilities Education Act or Americans with Disabilities Act/Section 504. The control sample did not have any psychiatric diagnoses and was not receiving any special educational and/or psychiatric services. Controls were selected from the standardization sample of the BRIEF based on the four matching variables. The BRIEF-PF was independently completed and not used in diagnostic decision making.

Instrumentation

The BRIEF-PF (Gioia, Isquith, Guy, & Kenworthy, 2000) completed by parents, includes 86 items that fall onto eight scales designed to assess aspects of executive functioning behavior in children and adolescents. The eight scales include Inhibit, Shift, Emotional Control, Initiate, Working Memory, Plan/Organize, Organization of Materials, and Monitor. The BRIEF-PF yields two indexes, Behavioral Regulation (BRI) and Metacognition (MI), as well as an overall Global Executive Composite (GEC) score. The BRI is comprised of the Inhibit, Shift, and Emotions Control scales, and represents the ability to shift cognitive set and regulate emotion through inhibitory control. The MI is comprised of the Initiate, Working Memory, Plan/Organize, Organization of Materials, and Monitor scales, and represents the ability to initiate, plan, organize, and sustain future-oriented problem solving in working memory (Gioia et al., 2000). As noted in the technical manual, the BRIEF-PF has good reliability and validity. Overall, the BRIEF-PF yields high internal consistency estimates (i.e., .80 to .98), good test-retest reliability (.76 to .85), and moderate inter-rater reliability between parent and teacher ratings for the normative group (Gioia et al., 2000). Ratings within each scale are summed and the total raw score is transformed into an age- and gender-corrected T-score relative to the published normative data. Higher T-scores indicate more executive dysfunction, and a cutoff T-score > 65 is considered clinically significant (1.5 standard deviations above the normative mean).

Gioia and colleagues (2000) determined construct validity through correlations with the ADHD Rating Scale IV (DuPaul et al., 1998). The BRI was found to correlate at .67 with the ADHD Rating Scale IV Inattention Index and correlated at .70 with the ADHD Rating Scale IV Hyperactivity Index ($p < .01$). The BRIEF Global Executive Composite correlated with the Inattention and Hyperactivity Indexes at .63 and .60, respectively. BRIEF scales also correlated with Child Behavior Checklist scales (CBCL, Achenbach, 2001). For example, the BRIEF Initiate Scale correlated with the CBCL Withdrawn ($r = .50$, $p < .01$), Anxious/Depressed ($r = .52$, $p < .01$), and Attention Problems ($r = .50$, $p < .01$) scales. The BRIEF Working Memory Scale correlated ($r = .60$, $p < .01$) with the CBCL Attention Problems Scale. The BRIEF Parent Form BRI correlated with the BASC Aggression ($r = .76$, $p < .01$) and Hyperactivity ($r = .63$, $p < .01$) Scales. The BASC Attention Problems scale correlated with the BRIEF Initiate ($r = .64$, $p < .01$), Working Memory ($r = .69$, $p < .01$), Plan/Organize ($r = .62$, $p < .01$) and Monitor ($r = .54$, $p < .01$) scales. Overall, the BRIEF and BASC teacher forms correlated as well. Most of the BRIEF Scales correlated with the BASC Aggression ($r = .49$-$.85$, $p < .05$), Conduct Problems (r

= .52-.80, $p < .01$), Hyperactivity ($r = .47$-.81, $p < .05$), and Attention Problems ($r = .47$-.65, $p < .05$) scales ($r = .67$, $p < .01$) (Gioia et al., 2000).

Procedure

The BRIEF-PF was administered by doctoral students who were trained and supervised by a licensed psychologist faculty member on the administration and scoring of the BRIEF. All graduate-level examiners attended a three-hour training focused on the theory of the BRIEF, utility of the test, test administration, and test response scoring. In addition, all examiners completed graduate level courses on cognitive and behavioral assessment and had administered and scored at least three BRIEF protocols prior to evaluation. Graduate-level examiners scored all test protocols. Test protocols were then reviewed by the supervising faculty member who verified accuracy of scoring. Raw scores were converted to standard scores by using standard scoring procedures (Gioia et al., 2000).

Parents were offered free testing to assist them in learning more about their children's cognitive functioning, and were provided with a summary of the scores as well as verbal feedback about the test results. Informed consent was obtained from all parents. Assent was obtained from all children.

Treatment of Data

SPSS software was used to conduct statistical analyses, apart from diagnostic efficiency statistics which were calculated using Microsoft Excel software. Descriptive statistics were computed to explore differences between ADHD and the control sample on all BRIEF scales. To determine whether there were statistically and clinically significant differences between group scale scores, *t*-tests for independent samples and d-ratios to determine effect sizes were computed. To rule out multicollinearity, intercorrelations between the Parent BRIEF scales were computed. Additionally, three separate discriminant function analyses were computed for the GEC, MI and BRI, and 8 subscales to measure group membership and the extent that participants in each group were correctly classified. Additionally, OCC (overall correct classification) and structural coefficients (*r*) were computed to assess the individual discriminating power of each of the two indexes and 8 subscales to determine which scales contributed most significantly to the function. Structural coefficients were computed to gain a better understanding of the discriminating power that might be shared with other variables between the two groups. Structural coefficients provide a simple bivariate correlation between the dependent variable (i.e., scale) and the canonical discriminant function. A large r suggests that a particular variable (i.e., scale) yields separation comparable to that obtained by the first discriminant function (Huberty, 1984).

Given that examination of the classification efficiency of an instrument's cutoff score can provide important information about the discriminant validity, five diagnostic efficiency statistics were computed to examine the BRIEF PF's ability to discriminate between ADHD and matched controls at the test authors' recommended cutoff T score of 65. OCC using a cutoff T-score of 65 was computed to provide a measure of the cutoff scores' capacity to correctly classify ADHD participants and controls. In addition, the sensitivity and specificity were calculated. To determine the probability of a diagnosis being present or absent given a specific test score - such as one might do in a clinical setting - measures of predictive power were assessed. Both the PPP and NPP were calculated. In order for a test to distinguish individuals with a given diagnosis from the sample, both PPP and NPP must be adequate and reflect a probability that is greater than chance (Doyle et al., 2000).

Results

Mean Scores

As shown in Table 1, ADHD and control sample descriptive data suggests scale score differences on all BRIEF scales. For the ADHD sample, all scale scores were above the standardization sample (i.e., *M* = 50; *SD* = 15). *T*-scores were in the clinically-elevated range (65 or greater) for the Global Executive Composite, MI, and Working Memory scale. All other composite and subtest *T*-scores were approaching the recommended cutoff score of 65, with the exception of the Shift and Organization of Materials scales. In contrast, the control sample yielded scale scores that were approximately in the average range.

To determine the statistically and clinically significant differences between group scale scores, *t*-tests for independent samples and d-ratios to determine effect sizes were computed. A conservative significance level of $p < .001$ was used to control for experiment-wise error. Significant differences between the ADHD and control samples were found on all scales. The BRIEF Indexes and scales with the exception of the Organization of Materials scale (i.e., .68) yielded large effect sizes (.85 to 1.63), reflecting higher *t*-scores for the ADHD group as compared to the control group (Cohen, 1988).

As shown in Table 2, the vast majority of intercorrelations between the Parent BRIEF scales were below the recommended maximum limit of .90 (Tabachnick & Fidell, 1996), suggesting overall multicollinearity was not an issue. Those intercorrelations above .90 were between the BRI and Emotional Control scale, MI and Plan/Organize scale, and GEC and MI. It is possible that higher intercorrelations were found between these scales because each scale loads on each composite respectively (e.g., the MI loads on the GEC).

Classification Accuracy

Discriminant function analysis. As shown on Table 3, three direct discriminant function analyses were computed on the GEC, the two indexes (BRI & MI), and eight scales to predict group membership. For the GEC, controls were correctly classified 79% of the time (*n* = 90), while the ADHD sample was correctly classified 77% of the time (*n* = 88). The overall correct classification (OCC) was 78% (50% accuracy by chance). For the BRI and MI, the control sample was correctly classified 77% of the time (*n* = 88), the ADHD sample were correctly classified 79% of the time (*n* = 90). The OCC was 78% (50% accuracy by chance). Structural coefficients were computed to assess the individual discriminating power of each of the two indices (Huberty, 1984). The BRI yielded a large positive *r* value (.90), suggesting that the BRI contributed most to the discriminant function.

For the eight scales, 89% of the control sample was correctly classified (*n* = 101), while 83% of the ADHD sample was correctly identified (*n* = 95). The OCC was 86% (50% accuracy by chance). Structural coefficients were variable for the eight BRIEF scales with Working Memory yielding a large positive *r* value (.79), suggesting that this scale contributed the most to the function.

Diagnostic efficiency statistics. While discriminant function analysis provides a means of answering questions about classification accuracy, the information produced by such an analysis is not a method used by practitioners in the field to make diagnostic decisions. Instead, practitioners rely on recommended cutoff scores provided in an instrument's manual. It is therefore useful to also examine the classification efficiency of specific cutoff scores, which can provide important information about the discriminant validity of an instrument (Kessel & Zimmerman, 1993; Reddy, Pfeiffer, & Files-Hall, 2007). As demonstrated in Table 4, five diagnostic efficiency statistics (i.e., sensitivity, specificity, positive predictive power, negative predictive power, and overall correct classification) were calculated to better understand the BRIEF-PFs ability to discriminate between children with ADHD and matched controls. In principle, a "Gold Standard" should never make a classification error. In practice, however, that is often not the case and the "Gold Standard", therefore, is regarded as the "best test under reasonable conditions." (Maxim, Niebo, Utell, 2014). For the purposes of this discussion, values equal to or greater than 60% were used as a general criterion for diagnostic efficiency (Biederman et al., 1993; Doyle et al., 2000).

As demonstrated in Table 4 and Figure 1, at the recommended cutoff T-score of 65 (1.5 SD above the mean), the GEC produced a relatively large OCC value (80%), indicating that the measure accurately discriminates between child ADHD and matched control samples. At a cutoff T-score of 60, the OCC was also 80%. Cutoffs of 55 and 50 as well as 70 and 75 yielded moderate and substantial decreases in OCC values, respectively. These findings suggested that a GEC cutoff T-score between 60 and 65 was most useful in discriminating ADHD participants from controls. Indeed, the GEC produced a larger OCC value than both the BRI and MI. At the recommended cutoff T-score of 65, the MI produced an OCC value of 75%; this value represented a decrease from the OCC produced at a cutoff of 60 (79%). OCC values for the MI consistently decreased with cutoffs both below and above a cutoff T-score of 60. The BRI followed a similar pattern in which it produced its largest OCC value (75%) at a cutoff T- score of 60 and slightly smaller OCC values with cutoffs both below and above a T-score of 60. However, these declines were more significant above a cutoff T-score of 70, and to a lesser extent, below a T-score of 50. Sensitivity and specificity across cutoff scores are presented in Table 4 as well as Figure 2.

Results show that sensitivity and specificity were inversely proportional; as sensitivity increased, specificity decreased, and vice versa. For the GEC, sensitivity and specificity crossed between a T-score of 55 and a T-score of 60 (between .5 and 1 SD). At a cutoff T-score of 65, specificity was strong (95%), but sensitivity was at 65%. At a cutoff score of 60, values were closer to each other with sensitivity at 76% and specificity at 83%. Additionally, at a cutoff T-score of 60, sensitivity and specificity were closest to OCC values. As shown in Figure 2, the lower the cutoff T-score, the lower the specificity, or the ability of the GEC to identify children who did not have ADHD. Likewise, the higher the cutoff score, the lower the sensitivity, or the GECs ability to correctly identify children that had ADHD.

For the BRI, sensitivity and specificity crossed between T-score cutoffs of 55 and 60 (between 0.5 and 1 SD). At a cutoff T-score of 60 sensitivity was at 67% and specificity at 82%. However, sensitivity decreased steadily above a cutoff T-score of 60, while specificity increased steadily reaching 100% at a cutoff T-score of 70. Specificity for the BRI at a cutoff T-score of 65 was strong (93%). Similarly, at a cutoff T-score of 65, MI sensitivity (59%) was less robust than at a cutoff T-score of 60 (76%). MI specificity at a cutoff T-score of 65 was strong (90%). It decreased at cutoff T-score of 60 (80%). For the MI, sensitivity and specificity intersected between T-score cutoff of 55 and 60. Overall, across all indexes, as the T-score cutoff moved from 60 to 65, there was an increasingly large gap between sensitivity and specificity. At a cutoff T-score of 60, the GEC and MI had better sensitivity than the BRI, while specificity was relatively consistent among the three indexes. At a cutoff T-score of 65, the GEC had moderate sensitivity (65%), while the MI (59%) and BRI (54%) were somewhat weaker in comparison. While indexes and the composite all yielded strong specificity, the GEC produced the strongest specificity (95%), followed by the BRI (93%) and MI (90%).

PPP and NPP results are presented in Table 4 and graphically in Figure 3. The GEC yielded a PPP of 93% at a cutoff T-score of 65. This rate decreased at a cutoff T-score of 60 (82%) and even further at a cutoff T-score of 55. With a cutoff T-score of 70, the GEC was able to predict those with ADHD with 100% accuracy. The GEC predicted control participants (NPP) at a cutoff T-score of 65 with 73% accuracy. As the T-score cutoff decreased, NPP increased, reaching 89% at a cutoff T-score of 50. For the GEC, PPP and NPP intersected between T-scores of 55 and 60.

The PPP for the MI at a cutoff T-score of 65 was 86% and 79% at a cutoff T-score of 60. NPP was at 77% at a cutoff T-score of 60 and 68% at a cutoff T-score of 65. NPP and PPP intersected between cutoff T-scores of 55 and 60. As the cutoff increased beyond 60, values for NPP and PPP increasingly diverged. The BRIs NPP and PPP intersected between T-score cutoffs of 55 and 60. At a cutoff T-score of 60, the BRI yielded PPP at 79% and NPP 71%. At a cutoff T-score of 65, PPP was at 88% while NPP decreased to 67%.

Comparing the GEC, BRI, and MI revealed that across cutoff scores, the GEC produced the highest PPP. NPP was comparable across higher cutoff scores (70 and above). However, as cutoffs declined, the BRI yielded the lowest NPP. As demonstrated in Figures 2 and 3, there was a large gap both for sensitivity and specificity and NPP and PPP as cutoffs moved from T-scores of 60 to 65 – though to a lesser extent for PPP/ NPP than for sensitivity/specificity.

Discussion

ADHD is a neurocognitive disorder characterized by impairments in executive functioning (Barkley, 2014; Biederman et al., 2004; Brown, Reichel, & Quinlan, 2009). Despite the neuropsychological nature of the disorder, diagnostic models continue to focus on the behavioral manifestations of ADHD (e.g., inattention, hyperactivity, impulsivity; Koonce, 2007;

Reddy, Hale, & Brodzinsky, 2011). Children are referred primarily due to significant behavioral problems at school and at home (Pelham, Fabiano, & Massetti, 2005), not their cognitive deficits (Rapport, Orban, Kofler, Friedman, 2013). In recent years, researchers have begun to consider methods of behavioral and neuropsychological assessment to be complementary, rather than conflicting, in diagnostic decision making (Reddy, Weissman, & Hale, 2013; Toplak, Bucciarelli, Jain, & Tannock, 2009). Bridging these models of assessment, the BRIEF was developed as the first measure to assess the behavioral manifestations of executive dysfunction characteristic of ADHD. It therefore serves as a useful addition to existing diagnostic instruments used to evaluate children with or suspected of having ADHD.

The purpose of this investigation was to provide more knowledge on the ability of the BRIEF-PF to reliably and practically differentiate school-aged youth with ADHD from matched controls. Research has demonstrated that variables of age, gender, ethnicity, and parent education level significantly affect cognitive functioning and behavior (Lezak, 1995). Thus, the use of a matched control sample in the current study suggests that results were not influenced by these matching variables. Overall, study results indicate that ADHD youth displayed more symptom impairment in executive functioning behaviors than matched controls on all indexes and subscales of the BRIEF-PF. Findings from this investigation are consistent with previous research on the BRIEF-PF using matched samples of school aged children (Hovik et al., 2014; Isquith et al., 2004; Linder et al, 2010; Nguyen et al., 2014; Reddy, Hale, Brodzinsky, 2011) and unmatched samples (Gioia et al., 2002; Mares et al. 2007; Qian et al., 2010; Skogli et al., 2013; Sullivan & Riccio, 2007;). Clinically elevated T-scores (i.e., > 65) were found for the GEC, MI, and Working Memory scale. These three scales all produced large effect sizes. As expected, an elevated GEC was found for children with ADHD (Barkley, 1997; 1998). Likewise, the Working

Memory scale, which captures a person's ability to hold information in mind to complete a task, is considered a key component of executive functioning with impairment typical of children with ADHD (Pennington, 1997). The MI incorporates the working memory construct along with others to provide a measure of one's ability to sustain ideas and activities in working memory and to plan and organize problem-solving approaches (Gioia et al., 2000).

These findings are consistent with results of previous BRIEF-PF research that suggest greater impairment on the Working Memory and GEC scales of the BRIEF (Gioia et al., 2002; Linder et al., 2010; McCandless & O'Laughlin, 2007; Skogli et al., 2013). For example, Mares et al. (2007) reported clinically elevated GEC and Working memory scores for 240 ADHD children and Jarrat, Riccio, and Siekierski (2005) found that effect sizes were greatest for the Working Memory scale and the GEC. Other studies using the BRIEF-PF found greater GEC and Working Memory scores for children with ADHD (Gioia et al., 2002; Linder et al., 2010; Mahone et al, 2002; McCandless & O'Laughlin, 2006; Toplak et al., 2009).

Contrary to the hypothesis, while the BRI produced a statistically significant difference between ADHD participants and matched controls, the average BRI T-score for children with ADHD did not pass the clinical threshold of 65, albeit by a small margin, and it produced a group effect size smaller than the MI. These findings are consistent with results reported by Mares et al. (2007) who indicated a clinically elevated MI, (as opposed to BRI) on the BRIEF-PF. Likewise, while Linder et al. (2010) did not find the MI to be in the clinically elevated range, it produced the second largest group effect size. Jarratt, Riccio, and Siekierski (2005) found both the MI and BRI to be clinically elevated on the BRIEF-PF, with the MI index yielding the second largest effect size. Similarly, Sullivan and Riccio (2007) found clinically elevated MI and BRI scores on both forms with the MI producing the second largest effect size on the BRIEF-PF.

McCandless and O'Laughlin (2006) reported clinically elevated MI scores on both the Parent and Teacher forms for the ADHD-IT and ADHD-CT groups as opposed to the BRI, which was only clinically elevated on both forms for the ADHD-CT.

Overall, discriminant function analyses of the GEC and Indexes correctly classified youth with ADHD from matched controls approximately 78% of the time. The BRI index contributed the most to the discriminate function. The subscales of the BRIEF-PF were found to have stronger predictive power than the GEC, BRI and MI indexes as evidenced by the *OCC* rate of 86%. These findings parallel those of Linder et al. (2010), who also used a matched samples paradigm with the BRIEF-PF. Their study revealed a correct categorization rate of 87.3% when using all eight subscales. Interestingly, their study found the Working Memory subscale to predict group allocation 87.9% of the time. Overall the eight subscales were found to predict group ADHD versus non-ADHD status, with the Working Memory subscale contributing the most to the discriminate function (*r* of .79).

Contrary to previous research, the current study did not find the Inhibit subscale to contribute significantly to the discriminant function of the BRIEF. Instead, the current study found the BRI and the Working Memory subscale to have the greatest discriminative function. Indeed, Gioia et al. (2000) and Mahone et al. (2002) found the Working Memory and Inhibit scales (representing only a portion of the BRI) to be strong discriminants between ADHD and non-ADHD. Additional discriminant validity research has indicated both the MI index, (and in particular, the Working Memory subscale) and Inhibit subscale, as useful for classification and subtype prediction (Mares et al., 2007; McCandless & O'Laughlin, 2006; Pratt, 2000; Sullivan & Riccio, 2007). Contrary to the current results, behavioral inhibition has traditionally been viewed as the prevailing executive function impairment in ADHD, from which stem other related difficulties (Barkley 1997). Previous studies have confirmed the Inhibit subscale as a predictor and classification tool for ADHD status, the Inattentive Type. Despite these results, research, however, has also confirmed the MI index and the Working Memory subscale to be predictors as well (Mares et al., 2007; McCandless & O'Laughlin, 2006; Pratt, 2000; Sullivan & Riccio, 2007). These slight differences in the current study's discriminant validity analyses could be attributed to the use of a matched sample paradigm as well as a larger clinical/control group respective to the previously mentioned studies.

In sum, these findings reveal the GEC, BRI, and MI indexes to have strong predictive power for discriminating between ADHD and non-ADHD children. Thus, findings from the investigation support the clinical utility of the BRIEF Parent Form in differentiating between ADHD and controls, and are consistent with previous findings (Isquith et al., 2004; Jarratt et al., 2005; Toplak et al., 2009). Taken together, the current study along with previous research demonstrating Inhibit/BRI and Working Memory/MI as predictors for ADHD, highlights the complex nature of executive functioning and its visible impairments in ADHD. Indeed, the data contradict a singular executive functioning deficit and instead support an integrative theory of executive functioning (Miller & Cohen, 2001). With this complexity in mind, reliance on a singular method (i.e., behavior ratings versus neuropsychological testing) for diagnosis is inadequate for accurate classification. Diagnostic procedures should include multiple methods sensitive to contextual differences (i.e., ecologically based and clinical settings), the utilization of direct and indirect behavior ratings, and performance evaluative measures. Taken together information gleaned from comprehensive assessment techniques, incorporating neuropsychological and behavioral rating methods, stand a greater chance of accurate classification.

Also lending credence to a multidimensional approach to ADHD classification is the current data on diagnostic efficiency of the BRIEF-PF. The results reflect that use of specific cutoffs depending upon the setting and purpose of administration. In educational settings in which practitioners aim to screen students for further assessment and in which it is crucial to flag those at-risk of having ADHD, sensitivity is of the outmost importance. Such is the case even if it is at the cost of lower specificity where children without ADHD may be identified. In the same vein, low specificity can also cause a problem of over-identifying individuals unnecessarily. In this case, one may consider using a cutoff T-score of 55, in which sensitivity was at its highest for this sample. At the authors recommended cutoff of 65, sensitivity was weak to moderate at best. However, given that ADHD participants in this sample had access to special education services at the time data was collected, it is possible that their functioning was less impaired than if they had not received any services.

In settings in which the goal is to rule-out or confirm an ADHD diagnosis, and in which the BRIEF-PF is used as part of a larger test battery to inform diagnostic decisions, practitioners should be most concerned with minimizing the chances of a false positive or false negative. In this case, large values of positive and negative predictive power aligned with specific cut scores are critically important. In this study, we found a cutoff of 60 provided the greatest chance of accurate classification of ADHD and non-ADHD, with a balance of the highest PPP and NPP. In diagnostic decision making, where there is a concern of over-diagnosis, practitioners want to be sure that PPP is strong. This is particularly true given the competitive educational climate in which parents and children are seeking diagnoses in order to obtain testing accommodations. It is equally important not to under-diagnose and unintentionally withhold diagnosis from a child who may experience further detriment without the provision of appropriate behavioral and pharmacological intervention and/or school-based services.

Current diagnostic efficiency results, in comparison to those reported in the BRIEF technical manual (Gioia et al., 2000) indicate that a lower threshold - between 55 and 60 across indexes - yields an optimal balance of sensitivity and specificity. Alternatively, the BRIEF technical manual indicates that at a T-score of 70, the Working Memory scale correctly identified 74% of children with ADHD, Inattentive Type, 77% of children with ADHD, Combined Type, and 87% of controls. Likewise, the Inhibit scale correctly identified 85% of children with ADHD, Combined Type, 48% of children with ADHD, Inattentive Type, and 87% of controls (Gioia et al., 2000). The difference in findings in this study (i.e., the current study's threshold being a lot lower than what was reported in the manual) may be explained by the fact that the BRIEF test authors utilized the BRIEF Working Memory and Inhibit scales instead of index scores (i.e., BRI, MI, and GEC), as done in the current study, to compute diagnostic efficiency statistics. Nonetheless, their reported results may provide an incomplete picture of the extent to which the full measure accurately classified ADHD participants and controls based on specific cutoff scores. Differences in results may be due to the fact that many ADHD participants in the sample were receiving special education services and their symptomology may have improved as a result of services compared to those in the BRIEF standardization sample who had never been referred for special education. Therefore, it is possible that a lower cut score threshold would be necessary in identifying those with ADHD and that sensitivity and specificity along with overall diagnostic efficiency is underestimated entirely in the current sample. Finally, differences in sample size (228 in the current study versus the 130 used for calculations of sensitivity and sensitivity in the BRIEF technical manual) and further, differentiating ADHD subtypes in determining diagnostic efficiency, may explain discrepancies in the results. Test authors suggest that using Working Memory and Inhibit scales to consider or rule out ADHD diagnosis and can add valuable information to an interview and/or a more comprehensive assessment of ADHD (Gioia et al., 2000). However, it is important to note that test authors did not report PPP and NPP.

Compared to the Conners Parent Rating Scale, Revised, a commonly used instrument in screening and diagnosis of children at risk for ADHD, current results using the BRIEF-PF are somewhat inferior. The Conners' authors report strong values across measures of sensitivity (.92), specificity (.95), OCC (.93), PPP (.94), and NPP (.93) (Conners, Sitarenios, Parker, & Epstein, 1998) in a sample of ADHD and Non-ADHD children. While current results of BRIEF-PF are suggestive of diagnostic efficiency (Biederman et al., 1993; Doyle et al., 2000), values are not consistently strong. While both the BRIEF-PF and Conners' Parent Rating Scale, Revised are commonly used in screening and diagnosis of children at risk for ADHD, the instruments offer assessment of different dimensions of the condition and therefore should be considered complementary.

Strengths and Limitations

The present study has several strengths and weaknesses. First, this study included a large sample with a matched control sample. Research has shown that variables of age, gender, ethnicity, and parent education level significantly contribute to cognitive functioning and behavior for children and adolescents (Lezak, 1995). The current study included comprehensive inclusion and exclusion criteria. The clinical group contained a comorbidity rate of 69%, which is considered a strength given high rates of comorbidity among those with ADHD in the population. Previous matched samples research on the BRIEF-PF used different exclusion criteria. Linder et al. (2010) excluded clinical group cases with a history or current diagnosis of a secondary serious neurological or psychiatric disorder; however, they did not screen the control group for psychiatric diagnosis or learning disabilities other than ADHD status. Comparatively, Gioia et al (2002) used subjects with only a singular diagnosis of ADHD; they do not mention if controls were screened for additional diagnosis. Both studies reported results similar to the current study. Furthermore, the clinical and control groups had a greater number of males (76%) describing their ethnicity as Caucasian (71%). Gender effects have been well documented for children with ADHD status (Biederman et al., 2002; Hinshaw et al., 2006) although findings on the BRIEF-PF have been consistent across genders. Additionally, past BRIEF-PF research have demonstrated similar demographics. Although the current study examined the discriminant validity of the BRIEF-PF, there was no distinction between ADHD subtypes. Previous studies have found differences between the predictive power of the subscales on BRIEF-PF for ADHD subtype membership (Mares et al., 2007; McCandless & O'Laughlin, 2006; Pratt, 2000; Sullivan & Riccio, 2007). Therefore, based on the current study we cannot speculate on features particular to ADHD subtypes. Findings from this study should be interpreted with caution when using the BRIEF-PF for differential diagnosis with minority populations, children whose parents have less formal education, and subtypes of ADHD. In addition, previous research has linked executive functioning with intellectual functioning (Jarratt et al., 2005). Intellectual functioning was not controlled for in this study. Additionally, results of this study may also show better discrimination than in clinical practice as this study aimed to distinguish between ADHD children and healthy controls, rather than psychiatric controls.

Future research that examines differences on the BRIEF-PF between gender, various ethnicities and parent educational levels, and ADHD subtypes is warranted. In addition, it would also be helpful to examine the clinical utility of the BRIEF teacher and self-report forms with ADHD participants and matched controls.

Concluding Thoughts

In sum, results from this study add to the literature by providing further evidence for the discriminant validity of the BRIEF-PF with children with ADHD. The BRIEF-PF is a useful tool in differential diagnosis of ADHD in school-age children and is a valid measure of executive dysfunction common in children with ADHD. As the first study to assess the diagnostic efficiency of the BRIEF-PF among school-age children with ADHD and a matched control sample, results suggest that the BRIEF-PF demonstrates sufficient diagnostic efficiency and provides practitioners with a useful diagnostic tool in clinical practice to use in conjunction with complementary assessment tools and as a useful screener in educational settings. The BRIEF can be used as part of a multi-tiered approach, both as universal screening tool in identifying children with ADHD and/or as part of a more targeted approach in developing supports and interventions for children with executive functioning weaknesses. In terms of the former, the BRIEF is a unique and complementary tool in that it has the potential to identify those with problems that are less overt (i.e., working memory, planning) and may be particularly helpful in identifying children who do not present with behavioral problems characterized by hyperactivity and disinhibition. It must be noted that at the authors' recommended cutoff of 65, current results suggest that as a screening tool, the BRIEF-PF, may under-identify those with possible ADHD.

APPENDIX A: TABLES AND FIGURES

Table 1
BRIEF Parent Form Scale Scores for ADHD and Control Sample

Scale	ADHD N=114		Control N=114		*t*	*d-ratio*
	M	SD	M	SD		
Global Executive Composite	66.25	10.39	50.80	8.45	12.31*	1.63
Behavior Regulation Index	64.75	12.62	49.72	9.12	10.31*	1.37
Metacognition Index	66.12	10.01	51.94	9.00	11.25*	1.49
Inhibit	64.29	13.02	52.60	11.96	7.06*	0.94
Shift	61.65	11.71	48.41	7.19	10.29*	1.36
Emotional Control	62.57	12.51	48.44	8.63	9.93*	1.31
Plan/Organize	64.73	11.52	51.92	9.35	9.22*	1.22
Initiate	62.81	9.96	54.49	9.71	6.38*	0.85
Working Memory	67.44	10.16	48.95	9.10	14.47*	1.92
Monitor	64.22	10.64	48.91	9.12	11.67*	1.55
Organization of Materials	58.61	11.30	51.65	9.03	5.13*	0.68

Note. * $p < .001$

Table 2
BRIEF Parent Form Intercorrelations

Scale	Inhibit	Shift	EC	Initiate	WM	P/O	OM	M	BRI	MI	GEC
Inhibit	---	.61	.70	..67	..49	.51	.46	.55	.88	.62	.80
Shift		---	.75	.55	.59	.54	.41	.61	.85	.63	.77
Emotional Control			---	.55	.52	.44	.37	.58	.92	.56	.77
Initiate				---	.64	.70	.61	.60	.66	.82	.80
Working Memory					---	.76	.62	.68	.59	.89	.83
Plan/Organize						---	.67	.66	.55	.91	.81
Organization of Materials							---	.52	.46	.78	.68
Monitor								----	.65	.81	.80
BRI [a]									---	.67	.87
MI										---	.93
GEC											---

[a] BRI -Behavior Regulation Index; MI -Metacognition Index; GEC -Global Executive Composite

Table 3
BRIEF Parent Form Discriminant Function Analyses Results

	True Negative	True Positive	*r* [a]	OCC	X^2	ג
Global Executive Composite	.79	.77	(1.0) [b]	.78	115.74*	.59
Indices	.77	.79		.78	117.93*	.59
Behavioral Regulation Index			.90			
Metacognition Index			.82			
Scales	.89	.83		.86	202.40*	.40
Inhibit			.39			
Shift			.56			
Emotional Control			.54			
Plan/Organize			.50			
Initiate			.35			
Working Memory			.79			
Monitor			.64			
Organization of Materials			.28			

Note. * = p <.001; [a] = structural coefficients; [b] parentheses signify *r* value for independent discriminant function; OCC – overall correct classification

Table 4

BRIEF Parent Form Diagnostic Efficiency Statistics

Cutoff Score	Positive Predictive Power	Negative Predictive Power	Sensitivity	Specificity	OCC
GEC					
≥50	65%	89%	94%	49%	71%
≥55	72%	81%	84%	68%	76%
≥60	82%	78%	76%	83%	80%
≥65	93%	73%	65%	95%	80%
≥70	100%	62%	39%	100%	69%
≥75	100%	55%	17%	100%	58%
BRI					
≥50	66%	84%	89%	54%	71%
≥55	73%	74%	75%	72%	73%
≥60	79%	71%	67%	82%	75%
≥65	88%	67%	54%	93%	73%
≥70	100%	61%	35%	100%	68%
≥75	100%	56%	22%	100%	61%
MI					
≥50	63%	88%	94%	45%	69%
≥55	69%	81%	86%	61%	74%
≥60	79%	77%	76%	80%	78%
≥65	86%	69%	59%	90%	75%
≥70	96%	62%	40%	98%	69%
≥75	100%	56%	23%	100%	61%

GEC -Global Executive Composite; BRI -Behavior Regulation Index; MI -Metacognition Index;

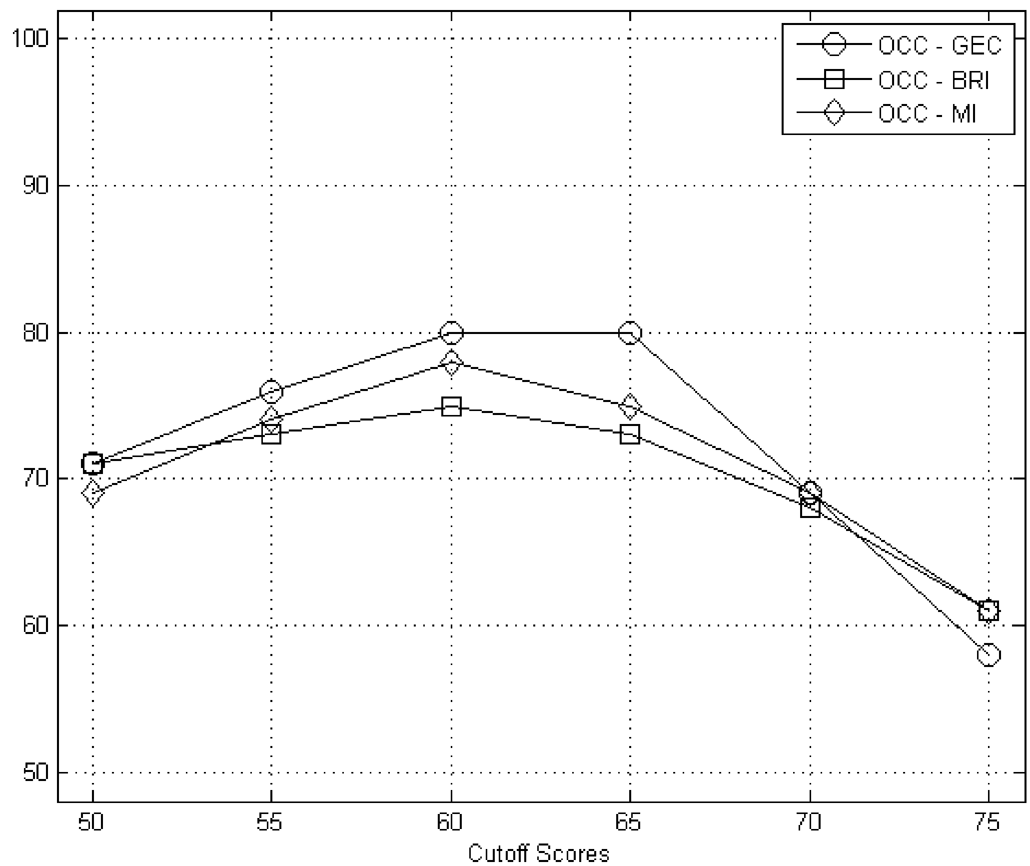

Figure 1. Overall Correct Classification

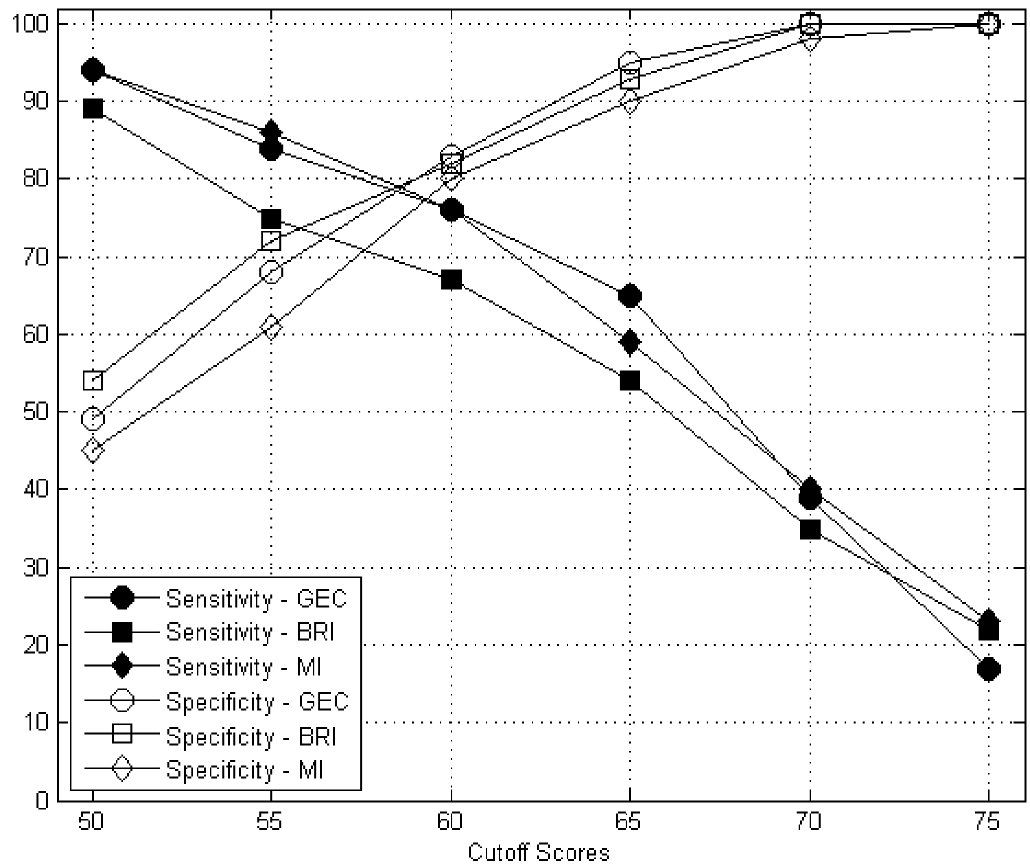

Figure 2. Sensitivity and Specificity

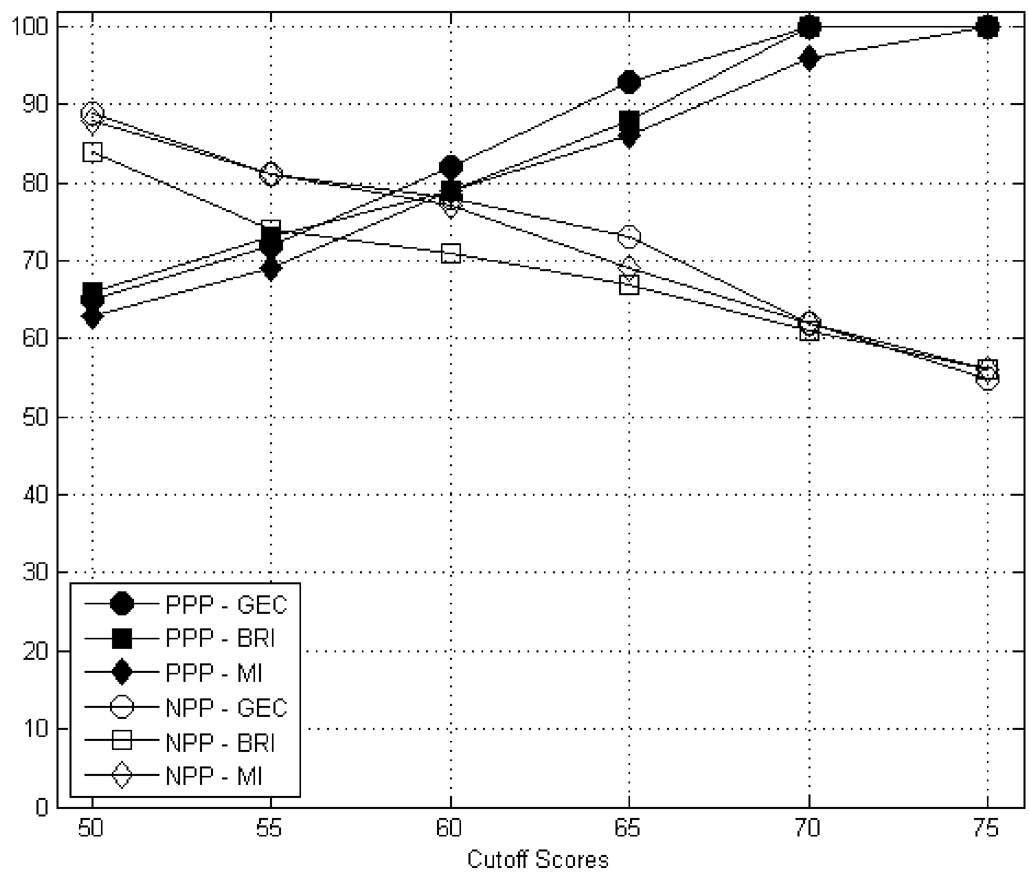

Figure 3. Positive and Negative Predictive Power

References

Achenbach, T.M., & Rescorla, L.A. (2001). *Manual of the Achenbach System of Empirically Based Assessment - Child Behavior Checklist, Teacher Report Form, and Youth Report.* Burlington, VT: University of Vermont, Research Center for Children, Youth, and Families.

American Academy of Pediatrics (2000). Clinical practice guideline: Diagnosis and evaluation of the child with Attention-Deficit/Hyperactivity Disorder. *Pediatrics, 105,* 1158-1170.

American Psychiatric Association (2013). *Diagnostic and statistical manual of mental disorders*, 5th ed.Washington DC: Author.

Barkley, R. A. (1997). *ADHD and the Nature of Self Control*. New York: The Guilford Press.

Barkley, R.A. (1998). *Attention-deficit hyperactivity disorder: A hand-book for diagnosis and treatment.* (2nd ed.). New York: Guilford.

Barkley, R. A. (2012). *Executive functions: What they are, how they work, and why they evolved*. Guilford Press.

Barkley, R. A. (Ed.). (2014). *Attention-deficit hyperactivity disorder: A handbook for diagnosis and treatment*. Guilford Publications.

Bédard, A. C., Schulz, K. P., Cook, E. H., Fan, J., Clerkin, S. M., Ivanov, I., ... & Newcorn, J. H. (2010). Dopamine transporter gene variation modulates activation of striatum in youth with ADHD. *Neuroimage*, *53*(3), 935-942.

Biederman, J., Mick, E., Faraone, S. V., Braaten, E., Doyle, A., Spencer, T., ... & Johnson, M. A. (2002). Influence of gender on attention deficit hyperactivity disorder in children referred to a psychiatric clinic. *American Journal of psychiatry*, *159*(1), 36-42.

Braet, W., Johnson, K. A., Tobin, C. T., Acheson, R., McDonnell, C., Hawi, Z., ... & Robertson, I. H. (2011). fMRI activation during response inhibition and error processing: the role of the DAT1 gene in typically developing adolescents and those diagnosed with ADHD. *Neuropsychologia*, *49*(7), 1641-1650.

Brown, A. B., Biederman, J., Valera, E., Makris, N., Doyle, A., Whitfield-Gabrieli, S., ... & Seidman, L. (2011). Relationship of DAT1 and adult ADHD to task-positive and task-negative working memory networks. *Psychiatry Research: Neuroimaging*, *193*(1), 7-16.

Brown, T. E., Reichel, P. C., & Quinlan, D. M. (2009). Executive function impairments in high IQ adults with ADHD. *Journal of Attention Disorders*, *13*(2), 161-167.

Castellanos, F. X. & Tannock, R. (2002). Neuroscience of attention-deficit/hyperactivity disorder: The search for endophenotypes. *Nature Reviews Neuroscience, 8*, 617-628.

Centers for Disease Control and Prevention. (February, 2017). Attention-deficit/hyperactivity disorder. retrieved from: https://www.cdc.gov/ncbddd/adhd/data.html

Cicerone, K. D., Dahlberg, C., Kalmar, K., Langenbahn, D. M., Malec, J. F., Bergquist, T. F., ... & Herzog, J. (2000). Evidence-based cognitive rehabilitation: recommendations for clinical practice. *Archives of physical medicine and rehabilitation*, *81*(12), 1596-1615.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences (2nd Ed.).* Hillsdale, NJ: Erlbaum.

Conners, K. (1997). *Conners' Parent and Teacher Rating Scale-Revised.* North Tonawanda, NY: Multi-Health Systems.

Conners, C. K., Sitarenios, G., Parker, J. D., & Epstein, J. N. (1998). The revised Conners' Parent Rating Scale (CPRS-R): factor structure, reliability, and criterion validity. *Journal of abnormal child psychology*, *26*(4), 257-268.

Davidson, F., Cherry, K., & Corkum, P. (2016). Validating the Behavior Rating Inventory of Executive Functioning for Children With ADHD and Their Typically Developing Peers. *Applied Neuropsychology: Child*, *5*(2), 127-137.

Diamond, A. (2013). Executive functions. *Annual review of psychology*, *64*, 135-168.

Douglas, V. I. (2005). Cognitive deficits in children with attention deficit hyperactivity disorder: A long–term follow-up. *Canadian Psychology, 46*, 23-31.

Doyle, A. E., Biederman, J., Seidman, L. J., Weber, W., & Faraone, S. V. (2000). Diagnositc efficiency of neuropsychological test scores for discriminating boys with and without ADHD. *Journal of Consulting and Clinical Psychology*, *68*, 477-488.

DuPaul, G. J., Power, T. J., Anastopoulas, A. D., & Reid, R. (1998). *ADHD Rating Scale IV: Checklist, Norms, and Clinical Interpretation*. New York: The Guilford Press.

Durston, S., van Belle, J., & de Zeeuw, P. (2011). Differentiating frontostriatal and fronto-cerebellar circuits in attention-deficit/hyperactivity disorder. *Biological psychiatry*, *69*(12), 1178-1184.

Gioia, G. A. & Isquith, P. K. (2002). New perspectives on educating children with ADHD: Contributions of the executive functions. *Journal of Health Care Law and Policy, 124*, 1-26.

Gioia, G. A., Isquith, P. K., Guy, S. C., & Kenworthy, L. (2000). *Behavior Rating Inventory of Executive Function: Professional Manual.* Lutz, FL: Psychological Assessment Resources, Inc.

Gioia, G. A., Isquith, P. K., Kenworthy, L., & Barton, R. M. (2002). Profiles of everyday executive functions in acquired and developmental disorders. *Child Neuropsychology, 8*(2), 121-137.

Hale, J. B., Reddy, L. A., Decker, S. L., Thompson, R., Henzel, J., Teodori, A., & Denckla, M. B. (2009). Development and validation of an executive function and behavior rating screening battery sensitive to ADHD. *Journal of Clinical and Experimental Neuropsychology*, *1*, 1-16.

Hale, J. B., How, S. K., DeWitt, M. B., & Coury, D. L. (2001). Discriminant validity of the Conners' scales for ADHD subtypes. *Current Psychology, 20*, 231-249.

Hale, J.B., Reddy, L. A., Wilcox, G., McLaughlin, A., Hain, L., Stern, A., Henzel, J., & Eusebio, E (2009). Best practices in assessing and intervening with ADHD/ADHD children and children with other frontal-striatal circuit disorders. . In D.C. Miller (Ed). *Best Practices in School Neuropsychology.* John Wiley, Inc.: NY

Hovik, K. T., Egeland, J., Isquith, P. K., Gioia, G., Skogli, E. W., Andersen, P. N., & Øie, M. (2014). Distinct patterns of everyday executive function problems distinguish children with tourette syndrome from children with ADHD or autism spectrum disorders. *Journal of attention disorders*, 1087054714550336.

Huberty, C. J. (1984). Issues in the use and interpretation of discriminant analysis. *Psychological Bulletin, 95*, 156-171.

Isquith, P. K., Gioia, G. A., Espy, K. A. (2004). Executive function in preschool children: Examination through everyday behavior. *Developmental Neuropsychology, 26*, 403-422.

Jarrat, K. P., Riccio, C. A. & Siekierski, B. M. (2005). Assessment of attention deficit hyperactivity disorder (ADHD) using the BASC and BRIEF. *Applied*

Neuropsychology, 12, 83-93.

Kessel, J. B., & Zimmerman, M. (1993). Reporting errors in studies of the diagnostic performance of self-administered questionnaires: extent of the problem, recommendations for standardized presentation of results, and implications for the peer review process. *Psychological Assessment*, *5*(4), 395.

Koonce, D. A. (2007). Attention deficit hyperactivity disorder assessment practices by practicing school psychologists. *Journal of Psychoeducational Assessment*, *25*(4), 319-333.

Koziol, L. F., & Stevens, M. C. (2012). Neuropsychological assessment and the paradox of ADHD. *Applied Neuropsychology: Child*, *1*(2), 79-89.

Lezak, M. D. (1995). *Neuropsychological assessment* (3rd ed.). New York: Oxford University Press.

Linder, N., Kroyzer, N., Maeir, A., Wertman-Elad, R., & Pollak, Y. (2010). Do ADHD and executive dysfunctions, measured by the Hebrew version of Behavioral Rating Inventory of Executive Functions (BRIEF), completely overlap?, *Child Neuropsychology, 16*(5), 494-502.

Mahone, M. E., Cirino, P. T., Cutting, L. E., Cerrone, P. M., Hagelthorn, K. M., Hiemenz, J. R., et al. (2002). Validity of the behavior rating inventory of executive function in children with ADHD and/or Tourette syndrome. *Archives of Clinical Neuropsychology, 17,* 643-662.

Mares, D., McLuckie, A., Schwartz, M., & Saini, M. (2007). Executive function impairments in children with attention-deficit hyperactivity disorder: Do they differ between school and home environments? *The Canadian Journal of Psychiatry, 52,* 527-534.

Maxim, L. D., Niebo, R., & Utell, M. J. (2014). Screening tests: a review with examples. *Inhalation toxicology*, *26*(13), 811-828.

McAuley, T., Chen, S., Goos, L., Schachar, R., & Crosbie, J. (2010). Is the behavior rating inventory of executive function more strongly associated with measures of impairment or executive function? *Journal of the International Neuropsychological Society, 16*, 495-505.

McCandless, S., & O'Laughlin, L. (2007). The clinical utility of the behavior rating inventory of executive function (BRIEF) in the diagnosis of ADHD. *Journal of Attention Disorders, 10,* 381-389.

Miller, E. K. & Cohen, J. D. (2001). An integrative theory of prefrontal cortex function. *Annual Review of Neuroscience*, *24*, 167-202.

MTA Cooperative Group (1999). A 14-month randomized clinical trial of treatment strategies for Attention-Deficit/Hyperactivity Disorder. *Biological Psychiatry*, *52*, 185-194.

Nguyen, T. T., Glass, L., Coles, C. D., Kable, J. A., May, P. A., Kalberg, W. O., ... & Mattson, S. N. (2014). The Clinical utility and specificity of parent report of executive function among children with prenatal alcohol exposure. *Journal of the International Neuropsychological Society*, *20*(07), 704-716.

Pelham, Jr, W. E., Fabiano, G. A., & Massetti, G. M. (2005). Evidence-based assessment of attention deficit hyperactivity disorder in children and adolescents. *Journal of Clinical Child and Adolescent Psychology*, *34*(3), 449-476.

Pennington, B.F. (1997). Dimensions of executive function in normal and abnormal development. In N.A. Krasnegor, G.R. Lyon, & P.S. Goldman-Rakic (Eds.), *Development of the prefrontal cortex: Evolution, neurobiollogy, and behavior* (pp. 265-281). Baltimore, MD: Brookes Publishing.

Pratt, B. M. (2000). The comparative development of executive function in elementary school children with reading disorder and attention-deficit/hyperactivity disorder. *Dissertation Abstracts Interntaional, 60*(9-B), 4933. (UMI No.AAI9945862).

Qian, Y., Shuai, L., Cao, Q., Chan, R. C., & Wang, Y. (2010). Do executive function deficits differentiate between children with Attention Deficit Hyperactivity Disorder (ADHD) and ADHD comorbid with Oppositional Defiant Disorder? A cross-cultural study using performance – based tests and the Behavior Rating Inventory of Executive Function. *The Clinical Neuropsychologist, 24*, 793-810.

Rapport, M. D., Orban, S. A., Kofler, M. J., & Friedman, L. M. (2013). Do programs designed to train working memory, other executive functions, and attention benefit children with ADHD? A meta-analytic review of cognitive, academic, and behavioral outcomes. *Clinical psychology review*, *33*(8), 1237-1252.

Reddy, L. A., & Hale, J. (2007). Inattentiveness. In A.R. Eisen (Ed). *Treating childhood behavioral and emotional problems: A step-by-step evidence-based approach.* (pp.156-211) Guilford Publications, Inc.: NY

Reddy, L. A., Newman, E., Pedigo, T. K., & Scott, V. (2010). Concurrent validity of the Pediatric Attention Disorders Diagnostic Screener for children with ADHD. *Child Neuropsychology*, *16*(5), 478-493.

Reddy, L. A., Pfeiffer, S. I., & Files-Hall, T. M. (2007). Use of the devereux scales of mental disorders for children and adolescents with emotional disturbance. *Journal of Psychoeducational Assessment*, *25*(4), 356-372.

Reddy, L. A., Weissman, A., & Hale, J. B. (2013). Neuropsychological assessment and intervention for emotional and behavior disordered youth: An integrated step-by-step evidence-based approach. *Washington, DC: American Psychological Association*.

Shimoni, M. A., Engel-Yeger, B., & Tirosh, E. (2012). Executive dysfunctions among boys with Attention Deficit Hyperactivity Disorder (ADHD): Performance-based test and parents report. *Research in developmental disabilities*, *33*(3), 858-865.

Skogli, E. W., Teicher, M. H., Andersen, P. N., Hovik, K. T., & Øie, M. (2013). ADHD in girls and boys–gender differences in co-existing symptoms and executive function measures. *BMC psychiatry*, *13*(1), 1.

Skogan, A. H., Zeiner, P., Egeland, J., Urnes, A. G., Reichborn-Kjennerud, T., & Aase, H. (2015). Parent ratings of executive function in young preschool children with symptoms of attention-deficit/-hyperactivity disorder. *Behavioral and Brain Functions*, *11*(1), 1.

Sonuga-Barke, E. J. (2003). The dual pathway model of AD/HD: an elaboration of neuro-developmental characteristics. *Neuroscience & Biobehavioral Reviews*, *27*(7), 593-604.

Sonuga-Barke, E., Bitsakou, P., & Thompson, M. (2010). Beyond the dual pathway model: evidence for the dissociation of timing, inhibitory, and delay-related impairments in attention-deficit/hyperactivity disorder. *Journal of the American Academy of Child & Adolescent Psychiatry*, *49*(4), 345-355.

Sullivan, J. R. & Riccio, C. A. (2007). Diagnostic group differences in parent and teacher ratings on the BRIEF and Conners scales. *Journal of Attention Disorders*, *11*, 398-406.

Tabachnick, B. G., & Fidell, L. S. (1996). Using multivariate statistics (3rd edition). New York: Harper Collins.

Toplak, M. E., Bucciarelli, S. M., Jain, U., & Tannock, R. (2009). Executive functions: Performance-based measures and the Behavior Rating Inventory of Executive Function (BRIEF) in adolescents with Attention-Deficit/Hyperactivity Disorder. *Child Neuropsychology, 15, 53-72.*

Visser, S. N., Danielson, M. L., Bitsko, R. H., Holbrook, J. R., Kogan, M. D., Ghandour, R. M., ... & Blumberg, S. J. (2014). Trends in the parent-report of health care provider-diagnosed and medicated attention-deficit/hyperactivity disorder: United States, 2003–2011. *Journal of the American Academy of Child & Adolescent Psychiatry*, *53*(1), 34-46.

Wolraich. M. L., Lambert, E. W., Bickman, L., Simmons, T., Doffing, M. A., & Worley, K. A. (2004). Assessing the impact of parent and teacher agreement on diagnosing attention-deficit hyperactivity disorder. *Journal of Developmental & Behavioral Pediatrics, 25*, 41-47.