



## Executive dysfunctions among boys with Attention Deficit Hyperactivity Disorder (ADHD): Performance-based test and parents report

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### ABSTRACT

Difficulty in executive functions (EF) is a core symptom of ADHD. Yet, the EF assessments are still in controversy. It is still unclear whether the everyday implementation of EF can be assessed under laboratory conditions. Therefore, the purposes of the present study are: (a) to examine EF among boys with ADHD both in everyday behavior (as reported by parents) and in a performance-based test. (b) To examine correlations between the two tests. Both the Behavior Assessment of Dysexecutive Functions for Children (BADS-C) and the Behavior Rating Inventory of Executive Functions (BRIEF) were independently applied to 25 boys aged 8–11 years with ADHD and 25 age-matched typical boys. Results of the two assessments were compared between the two groups to indicate differences in EF. Correlations between the two assessments for all participants were evaluated. Overall, significant differences in EF were found between the two groups on both assessments. Significant correlations were found between BADS-C and BRIEF, specifically in metacognition but not in behavioral regulation. Findings indicate that poor EF manifests itself in everyday behavior. These difficulties are found in metacognitive and behavioral regulation components. Nevertheless, applying a valid ecological assessment of behavior regulation merits future research.

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## 1. Introduction

'Executive functions' (EF) refers to the mental skills required to proceed towards future goals in terms of self-awareness, metacognition and attention skills (Welsh & Pennington, 1988; Welsh, Pennington, & Grossier, 1991). Difficulties in EF are related to various frontal and prefrontal lobe disorders (Alvarez & Emory, 2006; Fuster, 2002; Stuss, 1992; Stuss & Alexander, 2000). Therefore, one would expect to find high rates of EF difficulties among children with ADHD (Barkley, 2006; Barkley & Murphy, 2010; Nigg, Stavro, et al., 2005; Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005). ADHD is a neural developmental disorder characterized by non-adaptive levels of sustained attention, impulsiveness and hyperactivity (DSM-IV, 2001). Inherent in this description are difficulties in EF, particularly self-regulation difficulties and uninhibited behavior.

Since Barkley (1997) first published the model of inhibitory control as the basis of executive dysfunction (EDF) in ADHD, this issue has been extensively investigated. Some have argued that inefficient regulatory control or delay aversion explain attention disorders and EF difficulties (Sonuga-Barke, 2005; Sonuga-Barke, Sergeant, Nigg, & Willcutt, 2008; Thorell, 2007),

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whereas others claimed that EDF are caused by energetic factors (Sergeant, 2000). Studies further examined whether EDF are a co-morbidity or a core symptom in ADHD (Barkley, Murphy, & Fischer, 2008; Beiderman et al., 2006; Nigg, Willcutt, Doyle, & Sonuga-Barke, 2005). Either way, most studies found EDF to be a main component of ADHD (Barkley, 2006; Castellanos & Tannock, 2002; Pennington & Ozonoff, 1996; Willcutt, Doyle, et al., 2005; Willcutt, Pennington, Olson, Chhabildas, & Huslander, 2005).

Difficulties in EF have far-reaching everyday implications and influence academic achievement, social competence and professional occupation (Barkley & Murphy, 2010; Canu, Newman, Morrow, & Pope, 2008; Graaf, Kessler, Fayyad, Have, Alonso, Angermayer, Borges et al., 2008; Hale et al., 2011; Masetti et al., 2008; Rogers, Hwang, Toplak, Weiss, & Tannock, 2011). Given that children with ADHD often show poor skills in these areas, assessing EF is most relevant for clinicians and for research purposes. Moreover, assessments should have a wide perspective and include everyday behavior contexts along with specific skill measurements.

To address this issue, two types of EF assessments are in use: performance-based assessments (PBT) and everyday function assessments. PBT include tests that are administered under laboratory conditions and relate to specific EF skills. Among these tests are the commonly used Continuous Performance Tests (CPT) (Conners, 1997), Wisconsin Card Sorting Test (WCST) (Kimberg, D'Esposito, & Farah, 1997), Tower of Hanoi (Borys, Spitz, & Dorans, 1982), Walk Don't Walk (Manly, Robertson, Anderson, & Nimmo-Smith, 1999), Trail-Making tests (Dellis, Kaplan, & Kramer, 2001) and others. These PBTs are beneficial for identifying specific executive difficulties and are used in various studies that compare EF between typical children and children with ADHD (Frazier, Demareem, & Youngstrom, 2004; Hervey, Epstein, & Curry, 2004). However, they lack ecological validity and do not express everyday EF. Designed to be administered under laboratory conditions, they lack different attributes that are inherent to the routine use of EF, such as motivation, emotion control and sustained attention in natural distractions.

On the other hand, everyday function assessments evaluate everyday demands of EF in the natural setting. Parents, teachers, caregivers, or the person with the disorder are asked to describe the behavior related to EF. These assessments are rooted in the "client/family-centered approach," according to which the perception of abilities and disabilities should be understood from the individual's point of view (Law, Baptiste, & Mills, 1998; Woodside, Rosenbaum, King, & King, 2001). Among these assessments, especially those referring to children's assessments are parent and teacher questionnaires and check-lists.

Referring to the way EF deficits are expressed in daily life scenarios is of supreme importance and fits the ICF framework (WHO, 2000). Accordingly, disabilities should be related to the everyday context rather than to the specific skill deficits. Anchored in this updated framework, the Behavioral Rating Inventory of Executive Functions (BRIEF) (Gioia, Isquick, Guy, & Kenworthy, 2000) was designed to test EF in everyday life situations as perceived by parents and teachers. Using various questionnaire assessments, EF were found to discriminate between children with ADHD and typical children (Jarratt, Riccio, Siekierski, 2005; McCandless & O'Laughlin, 2007). Nevertheless, family and parent perceptions of the child's disabilities are essential for diagnostic and intervention purposes, and cannot rely solely on potentially biased parent or teacher reports.

Although various studies found poor EF among people with ADHD (Berlin, Bohlin, Nyberg & Janols, 2004; Nigg, Stavro, et al., 2005; Sergeant, Geurtz, & Oosterlaan, 2002; Shallice et al., 2002; Willcutt, Pennington, et al., 2005), to the best of our knowledge, only few studies have compared executive skills and their everyday expression. The existing studies show low correlations between PBT meant to test executive skills and questionnaires that examine everyday functions (Bodnar, Prahme, Cutting, Dencla, & Mahone, 2007; Mahone et al., 2002). Yet, the assessments in these studies include a diversity of EF tests, each directed to specific executive skills.

The present study is designed to overcome the limitations of previously used EF assessments by using an ecologically valid, comprehensive test together with a validated standardized parent report. In particular, this study aimed to: (a) compare EF of children with ADHD and typical children; and (b) examine the relationships between executive skills (as performed by the children) and executive everyday functions (as reported by the parents). Our hypotheses were that using the Behavioral Assessment of Dysexecutive Functions for Children (BADS-C) and the BRIEF would reveal significant low executive skills and functions among the boys with ADHD compared to typical boys and that the BADS-C and BRIEF scores of all study participants would be significantly correlated in some aspects and complementary in others.

## 2. Method

### 2.1. Participants

A total of 50 Israeli boys aged 8–11 years (age range in months 96–130; mean 110.0; SD 10.09) participated in the study. The study group comprised 25 boys with ADHD with either: hyperactive-impulsive, inattentive or combined type. Participants were recruited from several clinics in the north of Israel through convenience sampling. Diagnosis of ADHD subtype was made by neurologists according to the DSM-IV criteria, and severity was assessed using other clinical assessments such as the Conners Rating Scales-Revised CPRS-R (Conners, 1997). The group included 25 typically developing boys who were recruited as a convenience sample.

All participants attended mainstream elementary schools, were Hebrew speaking, and came from diverse socioeconomic backgrounds. The study group and the control group were matched by age, socioeconomic background, place of residence and religion. Boys with known chronic health conditions (except for ADHD) or with another associated formally diagnosed

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