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## Executive function domains among children with ADHD: Do they differ between parents and teachers ratings?

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### Abstract

The purpose of this study was to evaluate parents and teachers behavior rating measures of executive functions (EFs) in everyday activities in ADHD children, predominantly inattentive (ADHD-PI) and combined type (ADHD-CT), relative to their typically developing peers. Sixteen children with ADHD combined type and fourteen with ADHD predominantly inattentive type were age- and gender-matched to thirteen typically developing peers. Both parents and teachers of the participants completed the BRIEF. As expected, the executive functioning of children with ADHD were rated significantly worse than those of controls by both parents and teachers. Thus, parent and teachers reported more EF impairments in the ADHD groups, predominantly inattentive and combined types, than in the control group. Also, ADHD-CT was rated by parents and teachers as lower than the ADHD-PI group on several scales. Significant associations were obtained between parent and teacher ratings in each group. For the ADHD groups, compared with parents, teachers rated children as having more problems in the majority of the scales. Parent and teacher perceptions of executive functioning in children with ADHD align with prior findings of executive deficits that have been documented on neuropsychological assessments and experimental tasks. These findings highlight the diagnostic utility of behavioral ratings of executive function; however, behavioral ratings should not be assumed to be a proxy for performance on measures of executive function in clinical practice.

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## Introduction

Attention-deficit hyperactivity disorder (ADHD) is the most frequent neurodevelopmental alteration in children, with a prevalence estimated in 4% (APA, 2000). This disorder is characterized by persistent patterns of inattention and (or) hyperactivity and impulsivity. The current diagnostic classification of ADHD relies predominantly on the presence of symptoms associated with these 3 behavioral constructs, but ADHD children exhibit another impairment with executive functions (EFs). Thus, the explanatory model of ADHD based on executive dysfunction accepted that the symptoms of inattention, hyperactivity, and lack of impulse control, which characterize the disorder, are caused by underlying deficits in the EF (Barkley, 1997a, 1997b; Pennington & Ozonoff, 1996). The executive function construct generally involves a series of components -planning, flexibility, inhibition, attentional control, and verbal and visuospatial working memory- that work independently in many ways but are closely related (Biederman, Petty, Fried, et al., 2008). The executive functions (EF) are related to “*planning or programming future actions, holding those plans or programs on-line until executed, and inhibiting irrelevant actions*” (Pennington & Ozonoff, 1996, p. 55). The idea that the frontal cortex is involved in ADHD receives support from structural (Casey et al., 1997) and functional neuroimaging research, involving the striatal-thalamocortical circuits (Castellanos & Tannock, 2002).

Neuropsychological studies have reported impairments of various executive functions among children with ADHD. A meta-analysis of 83 studies of EFs in ADHD (Willcutt et al., 2005) found that children and adolescents with ADHD exhibited significant deficits compared to those without ADHD in neuropsychological measures of EF (inhibitory control, vigilance, planning, verbal and spatial working memory, and cognitive flexibility), with effect sizes ranging from 0.46 to 0.69. In a recent review, Doyle (2006) concluded that consistent evidence shows the existence of EF alterations in ADHD, specifically in the components of inhibitory control, planning and working memory. However, most traditional tests of neuropsychological function do not correlate well with real-world or ecological functional outcomes (Gioia et al., 2000; Nichols & Waschbusch, 2004; Vrizen & Pigott, 2003).

Another method of measuring EF has been through the use of behavioral rating scales, particularly the Behavior Rating Inventory of Executive Function –BRIEF- (Gioia et al., 2000). The BRIEF was designed to evaluate a child’s executive functioning within their natural environments (i.e., home and school) in order to provide information regarding a child’s behaviors in their everyday life (Donders, 2002). The BRIEF uses parent and teacher ratings to sample children’s everyday executive skills.

Most studies using the BRIEF to examine the EFs of children diagnosed with ADHD have limited their scope to parent ratings. The first two studies that have used both parent and teacher versions of the BRIEF to investigate EFs within an ADHD sample found contradictory results. Kenealy (2002) found low agreement between parent and teacher ratings, with teachers responding less EF impairments than parents. Blake-Greenberg (2003) also found large discrepancies between parents and teachers, and reported parent ratings to be lower. The scope of these studies did not include a comparison of the children’s EF across home and school. Mares, McLuckie, Schwartz, & Saini (2007) comparing parent and teacher reports of EFs as measured by the BRIEF, found low agreement between parents and teachers, while teachers reported more variety and severity of EFs impairments in ADHD group than did parents.

Another group of studies comparing ADHD, predominantly inattentive (ADHD-PI) and combined type (ADHD-CT) on the BRIEF scales, found that parents perceived more problems on the inhibit scale in the ADHD-CT (Gioia, Isquith, Kenworthy, & Barton, 2002; Riccio, Homack, Jarratt, and Wolfe, 2006). The more recent study of Semrud-Clikeman, Walkowiak, Wilkinson, and Butcher (2010) show that parents rated ADHD-CT with more difficulties in behavioral regulation, emotional control, on the ability to shift tasks and to inhibit compared to the ADHD-PI group.

The main purpose of this study was to evaluate group differences on behavior rating measures of EF in children with ADHD-CT, ADHD-PI and controls by comparing means of parent and teacher reports in the BRIEF scales.

## Methods

### 1.1. Participants

Boys and girls were selected from five primary schools of Valencia (Spain). A total of 154 children were initially invited to participate in this study, but only those who had written informed parental consent and those whose teachers wanted to participate were included. Because all the children were recruited in state and regular schools, none of them had mental retardation or severe intellectual deficits. The final sample included a total of 60 children who were assessed. The age distribution was as follows: 4 boys were 7 years old; 8 boys were 8 years old; 4 boys and 12 girls were 9 years old; 12 boys were 10 years old and 16 boys and 4 girls were 11 years old. The sample was divided into three groups: a group with combined subtype ADHD-CT (N=16), another group with inattentive subtype ADHD-PI (N=14); and a control group (N=30). Both ADHD groups were clinically diagnosed in childhood by a clinical psychologist. All participants meet a strict agreement between parents and a teacher about the presence of at least six symptoms of inattention (ADHD-PI) and at least six symptoms of hyperactivity/impulsivity (ADHD-CT). Also, meet the following criteria: (a) the symptoms had been evident for more than one year; (b) the problem had appeared before the age of 7.

### 1.2. Measures

The Behavior Rating Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy & Kenworthy, 2000) is a questionnaire completed by parents or teachers to reflect the frequency with which a child aged 5–18 years exhibits specific behaviors related to executive functioning (EF). The parent and teacher forms each contain 86 items, which yield 8 nonoverlapping but correlated clinical scales, and 2 validity scales. By circling “never,” “sometimes” or “often,” the raters indicate whether the youth has experienced problems over the last 6 months with a given behavior as described in a particular item. These theoretically derived scales are as follows: (a) Inhibit: Measures the ability to transition between tasks and mindsets—which is related to controlling impulses; (b) Shift: Measures the ability to transition between tasks and mindsets—which is related to solving problems flexibly, switch or alternate attention, and change focus from one mindset or topic to another; (c) Emotional Control: Measures the ability to modulate emotional responses appropriately; (d) Initiate: Measures the ability to begin a task or activity and independently generate ideas; (e) Working Memory: Measures the ability to hold relevant information in mind for the purpose of completing a task and stay with an activity; (f) Plan-Organize: Measures the ability to plan ahead and organize for future events and goals; (g) Organization of Materials: Measures the ability to keep workspace and materials organized; (h) Monitor: Measures the ability to monitor one’s behavior and performance. Across the scales, higher ratings are indicative of greater perceived impairment.

The questionnaire was filled out in most cases by both parents in an office of the University of Valencia. A clinical psychologist was present to clarify possible questions related to the questionnaire. In addition, the children’s classroom teachers were contacted by phone, for the purpose of asking them to collaborate by filling out the teacher versions of the BRIEF. They received a stamped addressed envelope at school for returning the complete questionnaire.

## Results

To compare the three groups, without and with ADHD (PI and CT), an analysis of variance was performed for each of the measures (ANOVAs). Significant univariate effects were followed by post hoc comparisons (Scheffé test) between each pair of groups to determine which groups of means were significantly different from the others. Later, a Pearson correlation analysis was performed to identify the agreement between parent and teacher ratings for all the scales of the BRIEF. The paired-samples *t*-test was used to examine differences between the BRIEF scales of parent and teacher ratings.

### 1.3. Differences between groups on the scales of the BRIEF perceived by parents and teachers

In relation to parents ratings, the ANOVAs showed (see Table 1) that there were significant differences in all eight scales of the BRIEF: inhibit,  $F_{(2,57)} = 282.869, p < .000$ ; shift,  $F_{(2,57)} = 33.849, p < .000$ ; emotional control,  $F_{(2,57)} = 132.802, p < .000$ ; initiate,  $F_{(2,57)} = 98.863, p < .000$ ; working memory,  $F_{(2,57)} = 464.588, p < .000$ ; plan-organize,  $F_{(2,57)} = 186.180, p < .000$ ; organization of materials,  $F_{(2,57)} = 66.451, p < .000$ ; monitor,  $F_{(2,57)} = 89.150, p < .000$ . Post hoc analysis (Scheffé test) found that ADHD groups, predominantly inattentive and combined types, to be poorer than the control group in all eight scales. Also, ADHD-CT was rated by parents as lower than the ADHD-PI group on inhibit, shift, emotional control, planning/organization, organization of materials and monitor.

Table 1. Means and standard deviations by group in parents and teachers ratings

		ADHD-PI		ADHD-CT		Control group	
		Parent	Teacher	Parent	Teacher	Parent	Teacher
Inhibit	M	14.29	14.00	27.13	28.37	10.27	10.30
	SD	2.87	2.66	1.96	2.06	2.18	1.46
Shift	M	14.14	17.14	16.62	19.12	11.57	11.50
	SD	2.51	2.44	2.63	1.67	1.25	1.33
Emotional Control	M	15.71	15.43	22.37	22.25	9.57	9.63
	SD	3.54	4.83	3.14	1.98	1.48	1.37
Initiate	M	14.14	15.71	15.62	16.37	8.83	9.06
	SD	2.25	2.05	1.78	2.96	1.34	1.26
Working Memory	M	24.57	24.57	24.62	26.37	10.26	10.60
	SD	2.98	2.87	1.54	2.42	1.14	1.22
Plan-Organize	M	22.71	23.57	26.75	24.62	11.80	11.87
	SD	1.73	2.14	3.78	2.47	2.32	2.16
Organization of Materials	M	17.14	18.43	14.12	15.50	8.30	8.57
	SD	3.48	4.03	3.03	3.54	1.56	1.57
Monitor	M	16.71	18.43	20.75	23.87	10.57	10.47
	SD	2.81	2.59	3.00	2.45	2.13	1.70

In relation to teachers ratings (see table 1), the ANOVAs also showed (see table 1) that there were significant differences in all eight scales of the BRIEF: inhibit,  $F_{(2,57)} = 454.972, p < .000$ ; shift,  $F_{(2,57)} = 117.139, p < .000$ ; emotional control,  $F_{(2,57)} = 114.865, p < .000$ ; initiate,  $F_{(2,57)} = 90.507, p < .000$ ; working memory,  $F_{(2,57)} = 402.832, p < .000$ ; plan-organize,  $F_{(2,57)} = 225.235, p < .000$ ; organization of materials,  $F_{(2,57)} = 66.431, p < .000$ ; monitor,  $F_{(2,57)} = 217.896, p < .000$ . Post hoc analysis (Scheffé test) found that teachers for all scales rated the control group better compared to the ADHD groups. Like parents, teachers rated ADHD-CT lower than the ADHD-PI group on inhibit, shift, emotional control, organization of materials and monitor.

### 1.4. Agreement between parent and teacher ratings on all the scales of the BRIEF

We computed Pearson correlation coefficients to examine the agreement between parent and teacher ratings for all the scales of the BRIEF (see Table 2).

Table 2. Correlation coefficients between parents and teachers ratings

	ADHD-PI		ADHD-CT		Control group	
	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>	<i>r</i>	<i>p</i>
Inhibit	.444	.112	.944	.000	.330	.075
Shift	.298	.301	.710	.002	.859	.000
Emotional Control	.817	.000	.498	.050	.851	.000
Initiate	.842	.000	.734	.001	.845	.000
Working Memory	.677	.008	-.138	.609	.796	.000
Plan-Organize	.755	.002	.288	.279	.969	.000
Organization of Materials	.970	.000	.652	.006	.817	.000
Monitor	.925	.000	.668	.005	.870	.000

In the ADHD-I group, correlations of parent and teacher reached a statistical significant level in all scales except inhibit and shift. For the ADHD groups, correlations between parent and teachers were positive and significant in all scales except working memory and planning/organization. Finally, in the control group there were significant correlations between parent and teacher in all scales except inhibition. In general, the results suggested that there was high agreement between parent and teachers in this sample when children's behavior was rated on scales measuring executive functions.

### 1.5. Differences between parent and teacher ratings on all the scales of the BRIEF

We examined differences between the BRIEF ratings of parents and teachers, using paired-samples *t*-tests. The results of the *t*-tests carried out to compare scores of parents and teachers in each group are shown in Table 3. In the ADHD-PI group, compared with parents, teachers rated children as having more problems in all the scales except in inhibit, emotional control and working memory (see Tables 1 and 3). For the ADHD-CT group, teachers rated more difficulties in inhibit, shift, working memory and monitor, whereas in planning/organization parents rated more difficulties. However, we didn't find any differences in the control group between parents and teachers.

Table 3. Paired-sample *t* test between parents and teachers ratings

	ADHD-PI		ADHD-CT		Control group	
	<i>t</i> (13)	<i>p</i>	<i>t</i> (15)	<i>p</i>	<i>t</i> (29)	<i>p</i>
Inhibit	.366	.72	-7.319	.000	-.083	.934
Shift	-3.824	.002	-5.371	.000	.528	.601
Emotional Control	.380	.71	.182	.858	-.465	.645
Initiate	-4.810	.000	-1.464	.164	-1.756	.090
Working Memory	.000	1	-2.300	.036	-2.408	.063
Plan-Organize	-2.280	.040	2.191	.045	-.626	.536
Organization of Materials	-4.500	.001	-1.980	.066	-1.547	.133
Monitor	-6.000	.000	-5.490	.000	.516	.610

## Conclusion and Discussion

This study examined executive functioning in children with ADHD-CT, ADHD-PI and controls by means of parent and teacher reports. As expected, consistent with previous findings (Blake-Greenberg, 2003 ; Gioia, et al., 2002; Kenealy, 2002; Mares et al., 2007; Riccio et al., 2010; Semrud-Clikeman et al., 2010), teachers and parents identified more marked EFs impairments in children with ADHD than their peers in all eight scales of the BRIEF.

Also, as has been found in other studies (Gioia, et al., 2002; Riccio et al., 2010) ADHD-CT was rated by parents and teachers as lower than the ADHD-PI group on several scales. Parents and teachers rated ADHD-CT lower than the ADHD-PI group on inhibit, shift, organization of materials and monitor, while teachers perceived ADHD-CT as less emotional control than ADHD-PI in line with another studies (Semrud-Clikeman et al., 2010). Emotional control is an area that can be difficult for children with ADHD-CT (Mahone & Hoffman, 2007; Martel & Nigg, 2006). In contrast children with ADHD-PI may be seen as more lethargic and less reactive to situations that are frustrating (Martel and Nigg, 2006).

The general literature on the agreement between raters on the BRIEF scales shows large discrepancies between parents and teachers (Kenealy, 2002; Blake-Greenberg, 2003; Mares et al., 2007), whereas our results suggested that there were high agreement between parent and teachers when children's behavior was rated on scales measuring executive functions in each group of ADHD-CT and ADHD-PI, and controls. The discrepancy between results may be due to the disparities of the samples of ADHD in those studies. For example, in the study of Mares et al. (2007) the ADHD sample was composed of children with combined type, predominantly inattentive type, and hyperactivity-impulsive type.

In line with previous studies (Blake-Greenberg, 2003; Mares et al., 2007) in our study, compared to parents, teachers rated ADHD groups (PI and CT) as having more problems in the majority of the scales. However, a few researchers have reported the opposite finding, showing lower teachers ratings (Kenealy, 2002; Gioia, et al., 2002). More studies are needed to understand the source of these differences.

Discrepancies between raters may be the result of cross-situational differences in children's behavior or of differences in raters' perceptions and expectations. The finding that teachers reported more EFs impairments than did parents may suggest that teachers' training and familiarity with age-appropriate behavior enables them to more readily recognize difficulties within the EF domain. In addition, the school environment may be more structured and less flexible than the home environment that can be more accommodating and tolerant of deficits associated with executive functioning impairment (Mares et al., 2007).

Parent and teacher perceptions of executive functioning in children with ADHD align with prior findings of executive deficits that have been documented on neuropsychological assessments and experimental tasks. However, behavioral ratings should not be assumed to be a proxy for performance on measures of executive function in clinical practice due to the fact that experimental tasks and rating scales do not yield comparable results (Nichols & Waschbusch, 2004; Vrizen & Pigott, 2003).

These findings highlight the diagnostic utility of behavioral ratings of parent and teachers of EFs, and point to the importance of gathering information from more than one informant to obtain a complete picture of the functioning of children with ADHD. It is clear that teacher, parent, and direct observation about child performance is clinically useful. In other words, a close collaboration between professionals working in different settings is critical for optimal diagnosis and intervention for children with ADHD.

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