Teacher ratings of executive function difficulties in Finnish children with combined and predominantly inattentive symptoms of ADHD

Liisa Klenberg, PhD, Institute of Behavioural Sciences/ Psychology, PB 9, 00014 University of Helsinki, Finland. Email: liisa.klenberg@helsinki.fi, tel. +358505449234 (corresponding author)

Laura Hokkanen, PhD, Institute of Behavioural Sciences/ Psychology, PB 9, 00014 University of Helsinki, Finland. Email: laura.hokkanen@helsinki.fi

Pekka Lahti-Nuuttila, M.A., Institute of Behavioural Sciences/ Psychology, PB 9, 00014 University of Helsinki, Finland. Email: pekka.lahti-nuuttila@helsinki.fi

Vesa Närhi, PhD, School of Educational Sciences and Psychology, PB 111, 80101 Joensuu, University of Eastern Finland, Finland. Email: vesa.narhi@uef.fi

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Abstract

School-age children with difficulties in executive functions (EFs) are at risk for substantial academic impairment and poorer developmental outcome. Although ADHD is generally associated with weaknesses in EFs, relatively little is known about school-related EF difficulties and differences between ADHD subtypes. The present study examined teacher ratings of EF behaviors in 7- to 15-year-old Finnish children with combined symptoms of attention deficit/hyperactivity disorder (ADHD-C; n=189), predominantly inattentive symptoms (ADHD-I; n=25), and no ADHD (n=691). The teacher ratings showed that both ADHD groups had more EF difficulties than controls. Ratings also indicated specific EF profiles for the ADHD subtypes, students with ADHD-I having more wide-ranging EF difficulties in attention as well as initiation, planning, and execution of actions than children with ADHD-C. According to the present findings, the school-related EF difficulties of children with ADHD-I need to be specifically acknowledged. Teacher ratings seem to be sensitive indicators of EF difficulties and distinguish between different kinds of EF profiles. In clinical practice, rating scales with reliable psychometric properties and normative data relevant to the specific cultural environment should be employed.

Keywords: executive function, ADHD, ADHD-C, ADHD-I, assessment, rating scale, school

Introduction

The capacity to stop undesirable actions, to concentrate, and to actively work on assignments are necessary for sustained achievement and adaptive functioning at school. Children with difficulties in executive functions (EFs) may show poorer achievement in mathematics and reading comprehension or educational attainment in general (Best, Miller, & Naglieri, 2011; Biederman et al., 2004; Blair & Razza, 2007; Gathercole, Pickering, Knight, & Stegmann, 2004). Furthermore, EF difficulties in childhood have been shown to predict lower physical and mental well-being in adulthood (Moffitt et al., 2011). Given the strong impact of EFs on learning and developmental outcome, it is important to identify those children who have difficulties in EFs. The present study addresses the assessment of school-related EF difficulties by using teacher ratings of EF behaviors in Finnish children with clinically diagnosed combined or inattentive presentation of attention deficit disorder (ADHD).

EFs refer to mental processes that control and direct behavior and actions. Definitions of EFs vary, but the processes of inhibition, working memory, and shifting are often defined as the core EFs (Miyake et al., 2000; Miyake & Friedman, 2012). Inhibition involves the abilities to stop undesirable actions and prevent the confounding effect of distracting thoughts or stimuli (Friedman & Miyake, 2004). Working memory concerns the ability to hold information in mind while actively processing or working on tasks (Baddeley, 1996), and shifting refers to the ability to flexibly change actions according to situational demands (Miyake et al., 2000). In addition to these core EFs, developmental studies also underline the role of attention regulation in the development of EFs (Garon et al., 2008; Rueda, Posner, & Rothbart, 2005). Hence, controlled focusing and sustaining of attention can be seen as basic functions related to EFs. The core processes all contribute to the execution of more complex EFs such as formulating goals, planning the necessary steps that lead towards them, monitoring decisions in the midst of problem-solving, and evaluating how effectively the goals were met (Barkley, 2006; Diamond, 2013; Miyake & Friedman, 2012). Given the contextual demands we routinely face in everyday life, EFs are particularly important in situations that involve maintaining goal directed behavior as well as working on assignments independently. Difficulties in EFs may show as impulsive reactions, short attention span, and problems in getting started and finishing assignments.

EF difficulties are common in children with various developmental conditions such as learning disorders (Booth, Boyle, & Kelly, 2010; Toll, Van der Ven, Kroesbergen, & Van Luit, 2011), oppositional defiant disorder and conduct disorder (Sergeant, Geurts, & Oosterlaan, 2002), autism spectrum disorders (Hill, 2004), and, especially, ADHD (Barkley, 1997; Doyle et al., 2005; Nigg, 2001). Although ADHD is clearly associated with EF difficulties, not all children with ADHD have weaknesses in EFs. Of the ADHD subtypes, or presentations, (DSM-IV; American Psychiatric Association, 1994; DSM-5; American Psychiatric Association, 2013), children with combined symptoms of inattention and hyperactivity-impulsivity (ADHD-C) and children with predominantly inattentive symptoms (ADHD-I) have shown significant impairment in EFs, while the predominantly hyperactive-impulsive subtype (ADHD-H) has not been associated with EF impairment (Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005). Apart from the effect of subtype, the heterogeneity within ADHD groups may come from co-occurring difficulties. Many children with ADHD have co-occurring learning disorders (DuPaul, Gormley, & Laracy, 2013), conduct and oppositional defiant disorders (Connor, Steeber, & McBurnett, 2010; Rommelse et al., 2009), or depression and anxiety disorders (Steinhausen et al., 2006). Previous findings indicate that co-occurring learning disorders, especially, may have an additive effect on EF difficulties (Mattison & Mayes, 2012; Rucklidge & Tannock, 2002). The ADHD diagnosis in itself, therefore, does not give sufficient information of the child’s EF difficulties. Rather, clinicians and educators need an explicit account of where the difficulties lie, how they impact response to intervention, and what specifically can be done to support these students. EFs are typically assessed through structured clinical measures. They include (but are not limited to) stop signal tasks, continuous performance testing, and Stroop-like procedures. These performance measures assess the cognitive components of EFs. However, they are often constructed in fairly restrictive ways and given within a standardized context that does not correspond with the broader or fluctuating demands the child is facing. Furthermore, the examiner may offer guidance in a way that doesn't reflect what generally happens in real life situations. With this in mind, it isn't surprising that clinical measures do not necessarily reveal ineffective EFs that influence decision-making within the commerce of daily life. (Burgess, Alderman, Evans, Emslie, & Wilson, 1998; Gioia, Isquith, Kenworthy, & Barton, 2002; Jurado & Rosselli, 2007). In line with clinical observations, the correlations between EF tasks and everyday EFs have repeatedly been shown to be low or moderate at best (Bennett, Ong, & Ponsford, 2005; Biederman et al., 2008; Gross, Deling, Wozniak, & Boys, 2015; McAuley, Chen, Goos, Schachar, & Crosbie, 2010). A child who performs adequately on EF tasks may still have substantial difficulties in unguided and rapidly changing real-life situations.

A more ecologically valid account of everyday EF difficulties can be obtained via behavioral rating scales (e.g., Isquith, Roth, & Gioia, 2013). Recently, several rating scales assessing EF difficulties in children have been developed and are available for clinical use. These include the Behavior Rating Inventory of Executive Function (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000), the Dysexecutive Questionnaire for Children (DEX-C; Emslie, Wilson, Burden, Ninno-Smith, & Wilson, 2003), the Childhood Executive Function Inventory (CHEXI; Thorell & Nyberg, 2008), the Attention and Executive Functions Rating Inventory (ATTEX; Klenberg, Jämsä, Häyrinen, Lahti-Nuuttila, & Korkman, 2010), the Barkley Deficits in Executive Function Scale - Children and Adolescents (BDEFS-CA, Barkley, 2012), the Delis Rating of Executive Functions (D-REF; Delis, 2012), and the Comprehensive

Executive Function Inventory (CEFI, Naglieri & Goldstein, 2013). Rating scales typically contain several scales representing different components of EFs although the selection of items and number of scales may vary. EF rating scales have been shown to differentiate children with developmental disorders from controls (Gioia et al., 2002; Klenberg et. al, 2010; Thorell & Nyberg, 2008) and they have been associated with impaired academic performance (Clark, Pritchard, & Woodward, 2010; McAuley et al., 2010; Thorell, Veleiro, Siu, & Mohammadi, 2013).

Rating scales provide structured information of the child's EF behaviors from multiple environments, e.g., home and school, and from multiple respondents, e.g., parents and teachers. Although ratings are intended to reflect actual behavior of the child (trait effects), they are also affected by factors related to the rater or situation (source effects), and/or other, unknown confounding factors (error effects) (DuPaul, 2003). For example, parent and teacher ratings often yield differing results (McCandless & O'Laughlin, 2007¸ Mares, McLuckie, Schwartz, & Saini, 2007) indicating large source effects that may arise from differences in the child behavior across settings or from factors related to the rater, e.g., the history of interaction with the child or former experience of children with problem behaviors. In examining these effects, Gomez, Burns, Walsh, & Moura (2003) found little measurement error effect but large source effects in ratings. The source effects, however, seemed to be more strongly associated with situation specificity of behavior than with biased perceptions of the raters (Gomez, 2007). Behavioral ratings may thus be especially useful when gathering information about what is customary versus atypical for a specific environment.

Parent ratings of EF difficulties have consistently shown that children with ADHD have considerable problems in almost all EF behaviors (Jarratt, Riccio & Siekierski, 2005; Mahone et al, 2002, Sullivan & Riccio, 2007; Thorell, Eninger, Brocki, & Bohlin, 2010; Toplak, Bucciarelli, Jain, and Tannock, 2009). Although both subtypes have shown wide-ranging difficulties as compared with non-ADHD children, comparisons between subtypes indicate that children with ADHD-C have more difficulties in behavioral inhibition than children with ADHD-I (Gioia et al., 2002; McCandless & O'Laughlin, 2007; Riccio, Homack, Jarratt, & Wolfe, 2006; Semrud-Clikeman, Walkowiak, Wilkinson, & Butcher, 2010).

Fewer studies have reported teacher ratings of EF difficulties in ADHD and findings from these studies are less clear. In a study including adolescents, Toplak et al. (2009) used four BRIEF scales (inhibition, shifting, working memory, and planning) and reported elevated scores for adolescents with ADHD, compared to a control group, on all of these scales. Similarly, Thorell et al. (2010) reported elevated scores for children with ADHD in the two factors of the CHEXI rating scale. Jarrat et al. (2005), however, used the entire BRIEF and found significant differences only in two out of eight scales, and Sullivan and Riccio (2007) reported no significant differences between children with ADHD and controls. Only one study, conducted by McCandless and O'Laughlin (2007), has compared teacher ratings of EF difficulties in the ADHD subtypes. They found no differences between children in the ADHD-C and ADHD-I groups on the two indexes and the two scales (inhibition and working memory) of the BRIEF included in the study. Findings from studies using teacher ratings thus indicate that the EF problems of children with ADHD do appear in school environments, but they have not shown how wide ranging these difficulties are and whether there are specific EF profiles typical for children with ADHD-C and ADHD-I.

In summary, EF difficulties are common in many school-age children and especially in children with ADHD. These students have an increased risk for impairment in school settings, and teacher ratings of EF behaviors are necessary for screening and planning interventions for them. There are relatively few studies on school-related EF difficulties and only one that has differentiated the effects of ADHD subtype. The present study examines teacher ratings of EF difficulties using Finnish normative samples of the ATTEX rating scale (Klenberg et al., 2010). According to previous findings, the ATTEX total score differentiates children with ADHD from controls and a summary score differentiates between the subtypes ADHD-C and ADHD-I. The present study compares the profiles of behavioral EF difficulties of children with ADHD-C, ADHD-I, and controls by employing the ten scales from the ATTEX.

Method

Participants and procedures

The participants in the ATTEX standardization study (Klenberg et al., 2010) were 7- to 15-year-old children and adolescents who followed the normal curricula in general education classes. Ethics approval for the study was granted from the Helsinki University Central Hospital Ethical Committee for Pediatrics, Adolescent Medicine, and Psychiatry and written informed consent and background information from caregivers were obtained prior to teacher ratings.

The ADHD-C and ADHD-I groups were recruited from the Outpatient Clinic of Pediatric Neurology of the Helsinki University Hospital, Finland, between May 2005 and May 2007. The diagnoses were set according to the DSM-IV criteria for ADHD-C or ADHD-I by child neurologists or clinically experienced resident doctors. The diagnostic evaluation of symptoms of ADHD and co-occurring disorders included a diagnostic semi-structured interview of the child and parents (developmental history, symptoms related to developmental disorders), parent ratings of the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997;) and the ADHD Rating Scale-IV (ADHD RS-IV; DuPaul, Power, Anastopoulos, & Reid, 1998), and written reports from teachers (learning history, working habits, and behavior of the child during school days). Children who had a diagnosis of severe neurological (e.g., cerebral palsy) or psychiatric condition (e.g., autistic disorders) or who followed individualized curriculum at school due to general learning disabilities were excluded from the study. Children with co-occurring developmental or learning disorders were, however, included. The co-occurring disorders of ADHD groups included specific learning disorders in reading, writing, or mathematics, developmental cognitive disorders in language or motor skills, disorders of social interaction, and conduct disorders. The ATTEX ratings from teachers were collected after the diagnostic procedure.

The normative group included two samples. The first sample (n=510) was collected during years 2005–2006 from 45 schools in Finland. School psychologists selected every fifth from an alphabetical student list of each class, and after receiving the signed consent, teachers completed the ATTEX. If consent was not received, the next student from the alphabetical list was recruited instead. The attrition rate of this sample is not known, but the teachers' estimation was that there were very few refusals. The second normative sample (n=194) was from the Finnish NEPSY-II standardization study, recruited from the population register during years 2006–2007 (Korkman, Kirk, & Kemp, 2008). All participants within the appropriate age range (n=482) received a request to participate in the ATTEX study, and 194 rating scales (40.3% of the targeted sample) were returned. No differences between respondents and non-respondents were found according to the child's age, gender, teacher reported learning difficulties, or parent education level. Children with a parent reported diagnosis of ADHD-C or ADHD-I were excluded from the normative samples.

Of the participants 5.2% had missing values in the ATTEX items. These were replaced with the participant's mean value of the respective scale items, and seven cases, with more than two missing items, were omitted. Additionally, participants who had missing observations in parent education level (ten in the normative and one in ADHD-C group) were omitted. Thus, the sample in the present study included 905 children and adolescents, 691 in the normative group, 189 in the ADHD-C group, and 25 in the ADHD-I group (Table 1).

Instrument

The Attention and Executive Function Rating Inventory ATTEX is a teacher-completed rating scale developed for assessment of EF behaviors in school settings (Klenberg, et al., 2010). The 55 ATTEX items that cover school-related EF behaviors are grouped into ten clinical scales: Distractibility, Impulsivity, Motor hyperactivity, Directing attention, Sustaining attention, Shifting attention, Initiative, Planning, Execution of action, and Evaluation. The English version of the rating scale is available as an Appendix in Klenberg et al. (2010).

The ATTEX items are based on an integration of theories and developmental studies on EFs and attention (Barkley, 1997; Lezak, 1995; Luria, 1973; Mirsky, Anthony, Duncan, Ahearn, & Kellam, 1991; Stuss & Benson, 1986) and on pilot studies including teacher feedback of relevant items. For clinical purposes, e.g., intervention planning, a list describing strengths of the child and questions related to the situational variability of behavior are also included in the questionnaire. The EF scales have demonstrated appropriate psychometric properties including internal consistency (ranging from .73 to .92 in the normative sample and from .67 to .90 in the ADHD sample) and evidence of construct validity with the ADHD RS-IV School Version (correlations ranging from .58 to .95) (Klenberg et al., 2010). The total score of ATTEX also showed good discriminant validity for ADHD, and a summary score of four scales acceptably differentiated the ADHD subtypes. The ATTEX items are scored on a scale of 0 (not a problem), 1 (sometimes a problem), or 2 (often a problem). In the present study, the individual EF scale scores (maximum scores ranging from 6 to 18) and the EF total score (maximum score 110) were employed.

Data analyses

Differences between the EF profiles of ADHD-C, ADHD-I, and normative groups were examined with analysis of covariance (ANCOVA) for the total score and multivariate analysis of covariance (MANCOVA) for the scale scores, followed-up with separate ANCOVAs and contrasts for group comparison. The effects of gender, parent education level and age were controlled in the analyses. Significance level $p < .05$ was applied in the main ANCOVAs and MANCOVAs, and the Bonferroni corrected significance level $p < .0167$ was applied in group contrasts. In all analyses, the effect size was measured with partial eta squared (η_p^2), values, < .06 indicating small, .06 - .13 medium, and ≥ .14 large effects (Cohen, 1988).

Results

Group characteristics

Comparisons between groups showed that the proportion of boys was larger in the ADHD-C, $X^2(1) = 88.60$, $p < .001$, and ADHD-I groups, $X^2(1) = 12.58$, $p < .001$, than in the normative group. Mother's education level, categorized as lower (comprehensive school with lower further education), medium (comprehensive or upper secondary school with medium further education), and higher level (upper secondary with higher further or university education), was lower in the ADHD-C group than in the normative group, $X^2(2) = 31.90$, $p < .001$ and the ADHD-I group, $X^2(2) = 9.91$, $p < .007$.

Of the co-occurring disorders, learning disorders were significantly more frequent in the ADHD-I group than in the ADHD-C group, $X^2(1) = 16.27$, $p < .001$. The effect of co-occurring learning disorders on the ATTEX total score was significant, $F(1, 208) = 4.44$, $p = .036$, $\eta_p^2 = .02$, children with ADHD plus learning disorders having higher total scores (*M* = 64.4, *SD* = 19.7) than other children with ADHD (*M* = 57.6, *SD* = 24.0). Based on a non-significant interaction between learning disabilities and subtype the effect was similar for both ADHD subtypes. Co-occurring cognitive, social interaction, or conduct disorders were not significantly associated with the ATTEX total score.

For ethical reasons, medication was not discontinued during the assessment and the 69 children with medication for ADHD (all in the ADHD-C group) were included in the study. Within the ADHD-C group, the medication status was not significantly related to the ATTEX total score, $F(1, 209) = 1.22$, $p = .270$, $\eta_p^2 = .01$, or scale scores, Wilks's lambda = .94, $F(10, 200) = 1.97$, $p = .300$, $\eta_p^2 = .06$.

EF difficulties

The ATTEX total score was significantly higher, $F(2, 898) = 378.38$, $p < .001$, $\eta_p^2 = .46$, in the ADHD-C (*M* = 59.35; *SD* = 23.32) and ADHD-I (*M* = 61.44; *SD* = 20.32) groups than in the normative group (*M* = 12.78; *SD* = 17.71). Accordingly, the groups differed significantly in the scale scores, Wilks's lambda = .43, $F(20, 1778) = 46.70$, $p < .001$, $\eta_p^2 = .34$., both ADHD groups having higher scores than the normative group on all scales. However, comparisons between the ADHD groups showed that the ADHD-I group had higher scores on six scales: Directing attention, Sustaining attention, Shifting attention, Initiative, Planning, and Execution of action. The ADHD-C group had significantly higher scores than the ADHD-I group on two scales, Impulsivity and Motor Hyperactivity (Table 2).

Discussion

EF difficulties in school situations were assessed with a teacher-completed rating scale. The teacher ratings showed that children with ADHD-C and ADHD-I both had difficulties in all domains of EF behaviors as compared to children without ADHD. Children with different subtypes of ADHD did not differ in the total amount of difficulties, but their profiles of EF difficulties were different.

Comparisons between subtypes showed that children with ADHD-I had more wide-ranging EF difficulties than children with ADHD-C in school situations. This is somewhat unexpected as previous findings using parent ratings have indicated that children with ADHD-C have more difficulties in EFs (Gioia et al., 2002; McCandless & O'Laughlin, 2007; Riccio et al., 2006; Semrud-Clikeman et al., 2010). In the present study, the teacher ratings indicated that children with ADHD-I show more difficulties in regulating attention (e.g., focusing attention to instructions, working for extended time periods, or returning to a task after interruption) than children with ADHD-C. Moreover, they also showed difficulties in initiating (e.g., getting books and other equipment ready for work), planning (e.g., paying attention to the order in which tasks should be done), and following through actions (e.g., getting tasks completed without extra supervision). Previous studies on cognitive difficulties related to ADHD-I suggest that the school-related EF difficulties may follow from slowness in the speed of processing. In studies using EF tasks, slow cognitive tempo and "sluggish" motor output have been characteristic of children with ADHD-I (Carlson & Mann, 2002; Nigg, Blaskey, Huang-Pollock, and Rappley, 2002). Accordingly, inattentive symptoms, more than hyperactivity-impulsivity symptoms, have been associated with difficulties in tasks of sustained attention and processing speed (Chhabildas, Pennington, & Willcutt, 2001; Martel, Nikolas & Nigg, 2007).

The wide-ranging EF difficulties of children with ADHD-I can be especially impairing in school environments. In the study comparing parent and teacher ratings of EF difficulties, McCandless and O'Laughlin (2007) found no significant differences between ADHD subtypes in either parent or teacher ratings. However, they discovered that parents and teachers rated the subtypes differently. For children with ADHD-C, parents rated difficulties in behavior regulation and inhibition as well as in metacognitive skills and working memory while teachers reported problems only in working memory. For children with ADHD-I, parents reported no significant difficulties while teachers reported problems in working memory. Thus, it seemed that difficulties of children with ADHD-I were less apparent in home situations than in the school environment. Further, the teacher ratings indicated that problems in working memory were especially noticeable in school situations. At school, the learning situations may set specific demands for working memory as well as for the ability to sustain attention. Accordingly, as children need to work in groups without individual guidance, they need to initiate activity, plan ahead, monitor their actions, and evaluate their behavior independently. Inattention and difficulties in taking initiative and executing actions can result in substantial underachievement and accumulating difficulties in functioning at school.

For children with ADHD-C, the teacher ratings indicated that difficulties related to regulation of motor activity, e.g., difficulties in staying seated or excessive talking, and impulsive behavior, e.g., responding without permission and working too hastily, are specifically noticeable in school situations. Previous research using parent EF ratings have shown similar results emphasizing the inhibitory problems of children with ADHD-C (Gioia et al., 2002; McCandless & O'Laughlin, 2007; Semrud-Clikeman et al., 2010). In the EF profiles of children with ADHD-C, thus, impulsivity and motor hyperactivity seem to stand out as pervasive, and probably most impairing, EF difficulties in both school and home environments. However, clinicians should keep in mind that difficulties in certain EFs, e.g., sustaining of attention or getting started with assignments, may be partly masked by impulsive and hyperactive behavior, and children with ADHD-C may actually need support for these behaviors as well.

The results of the present study indicate that children with ADHD-C and ADHD-I show distinctive difficulties in EF behaviors in school situations. However, these findings need to be replicated with other samples, preferably including larger ADHD-I groups. In the present study, the ADHD-I group was considerably smaller than the ADHD-C group and also smaller than would be expected according to prevalence studies (Froehlich et al., 2007; Skounti, Philalithis, & Galanakis, 2007). However, clinical samples typically include a much higher proportion of children with ADHD-C than ADHD-I (e.g., Willcutt, 2010). Children with ADHD-C are thus more likely to receive clinical services, possibly because their symptoms are often clearly visible and disturbing. Of children with inattentive symptoms, only those with severe difficulties may actually get a referral to clinical assessment. Thus, the present findings indicating wide-ranging difficulties in EF behaviors may be typical only for the most severe cases of ADHD-I. On the other hand, the small size of the ADHD-I group may result in underestimation of the EF deficits in the ADHD-I group versus the other two groups. Also, it should be kept in mind that data on ratings always reflect factors related to the rater and possible error effects.

A large proportion of children in the ADHD-I group also had co-occurring learning disorders. In the present ADHD samples, as well as in several previous studies (Mattison & Mayes, 2012; Rucklidge & Tannock, 2002), co-occurring learning difficulties had an additive effect on EF difficulties. This effect, however, was similar for both ADHD subtypes.

Clinical implications

The present findings indicate that teacher ratings give detailed information of children's EF behaviors in school environments. These ratings are fairly easy to obtain and can be used in both screening for EF difficulties and planning for support (Isquith, Roth, Kenworthy, & Gioia, 2014). Assessment of EF behaviors should rely on psychometrically well studied teacher-completed rating scales. The present study utilized the ATTEX which provides norms for Finnish school-age children. In practice, when assessing EF difficulties in schools or clinical settings, rating scales with normative data relevant to the specific cultural environment should be used. Recently, several EF rating scales have been standardized and published in different countries and reliable and valid assessment tools are increasingly available across cultural settings (e.g., Gioia et al., 2000; Huizinga & Smidts, 2011; Naglieri & Goldstein, 2013; Thorell et al., 2013).

EF ratings are especially helpful when planning school-based interventions in collaboration with teachers. In collaborative consultation, psychologists and teachers jointly define the behavioral and academic problems, discuss applicable interventions, choose an intervention plan, and evaluate and revise the plan when necessary (DuPaul, Weyandt, &

Janusis, 2011). A teacher-completed rating scale involves the teacher as an active participant in the processes of assessment. Further, in defining the targeted problem behaviors, the detailed and structured information of classroom teacher's observations helps to select the behaviors that appear as the most problematic in school situations (Isquith et al., 2014).

Empirically supported school-based intervention strategies for children with ADHD include behavioral classroom management and also some training interventions (Evans, Owens, & Bunford, 2014; Pelham and Fabiano, 2008). For children with disinhibitory problems, behavioral interventions that include modifications of both antecedents and consequences of behavior can be applied. The antecedent-based interventions typically include strategic use of clear behavioral expectations, and the consequence-based interventions involve use of contingent positive reinforcement of following the rules (DuPaul et al., 2011). Children with problems in attention may also benefit from behavioral strategies. For example, manipulation of antecedents may involve structuring of tasks in a list, listing the steps needed for starting the assignment, or modifying the length of assignments. For children with difficulties in initiating, planning, and following through actions, training of organization skills (e.g., learning routines to record assignments and due dates, organizing school papers into binders, and using checklists for materials needed) may be effective (Abikoff et al., 2013; Evans et al., 2014; Langberg, Epstein, Becker, Girio-Herrera, & Vaughn, 2012).

The present study highlighted the variability of EF difficulties of students with ADHD. Specifically, the present findings indicated that, in school environments, children with ADHD-I have problems related to both attention regulation and complex EFs. As children with predominantly inattentive symptoms are not always referred to clinical services, there probably exist many undiagnosed children with inattentive symptoms and impairing EF difficulties. Identifying these children is important so that the accumulation of academic and other functional difficulties can be prevented.

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Table 1. Description of groups.

	ADHD-C (C)	ADHD-I (I)	normative (N)	Contrasts
Sample size *n*	189	25	691	
Age in years *M (SD)*	10.8 (2.4)	9.9 (2.5)	11.1 (2.5)	*ns*
Male	86.2%	84.0%	47.9%	N < C, I[a]
Parent education				C < I, N[a]
Lower	40.2%	8.0%	23.0%	
Medium	45.0%	68.0%	45.0%	
Higher	14.8%	24.0%	32.0%	
Co-occurring disorders				
Learning	24.9%	64.0%	na	C < I
Developmental cognitive	21.2%	16.0%	na	*ns*
Social interaction	7.9%	4.0%	na	*ns*
Conduct	5.8%	4.0%	na	*ns*

[a] Bonferroni corrected significance level $p < .0167$

Table 2. EF scale score means, standard deviations, and ANCOVA results by group.

	ADHD-C (C)		ADHD-I (I)		normative (N)					
EF scale	*M*	*SD*	*M*	*SD*	*M*	*SD*	$F(2, 898)$	p	η_p^2	Contrasts [a]
Distractibility	5.13	2.03	4.80	2.31	1.14	1.57	337.27	<.001	.43	N < C, I
Impulsivity	11.27	5.05	6.72	4.34	2.14	3.55	302.80	<.001	.40	N < I < C
Motor hyperactivity	6.70	4.05	3.40	3.40	1.05	2.12	251.74	<.001	.36	N < I < C
Directing attention	5.23	2.69	7.76	2.40	1.62	2.23	182.32	<.001	.29	N < C < I
Sustaining attention	5.83	2.91	6.92	3.23	1.29	2.09	255.87	<.001	.36	N < C < I
Shifting attention	4.52	2.39	5.80	2.16	0.79	1.52	320.86	<.001	.42	N < C < I
Initiative	5.02	2.73	7.04	2.62	1.25	1.96	221.94	<.001	.33	N < C < I
Planning	4.00	2.37	4.88	2.33	0.79	1.51	227.52	<.001	.34	N < C < I
Execution of action	7.66	3.93	9.40	2.97	1.90	2.74	246.62	<.001	.36	N < C < I
Evaluation	2.81	1.71	3.16	1.91	0.58	1.09	188.67	<.001	.30	N < C, I

[a] Bonferroni corrected significance level $p < .0167$