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Reading Performance of Young Adults With ADHD Diagnosed in Childhood: Relations With Executive Functioning

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Abstract

Objective: To study reading performance of young adults with ADHD and its relation with executive functioning. **Method:** Thirty young adults with a childhood diagnosis of ADHD and 30 with normal development (ND) were compared on reading accuracy, fluency, and comprehension. Furthermore, ADHD with reading disabilities (ADHD+RD) and ADHD without reading disabilities (ADHD-RD) subgroups were compared using self-report and informant-report versions of the Behavior Rating Inventory of Executive Function–Adult version (BRIEF-A). **Results:** Adults with ADHD obtained significantly worse results than the ND adults on reading speed, responses to literal questions, and a cloze test. Although the comparison of the ADHD+RD and ADHD-RD groups did not show significant differences on the BRIEF-A subscales, the ADHD+RD group surpassed the critical percentile (85) on more subscales, with working memory and metacognition especially affected. **Conclusion:** The findings point out that reading should be assessed in individuals with ADHD as part of their evaluation to design effective early interventions. *(J. of Att. Dis. XXXX; XX(X) XX-XX).*

Keywords

adult ADHD, executive function, learning disabilities, BRIEF-A

ADHD is characterized by a persistent pattern of behaviors of inattention, hyperactivity, and impulsivity. The symptoms are developmentally inappropriate and have negative effects on individuals' cognitive, personal, and social development, interfering with their learning and general adaptation *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.; *DSM-IV-TR*; American Psychiatric Association [APA], 2000). Furthermore, ADHD is a chronic neurobiological disorder, and it is the second most common psychological problem in adults, after depression (Goldstein & Teeter-Ellison, 2002). According to a meta-analysis of follow-up studies, around 15% of the cases diagnosed in childhood continue to meet the diagnostic criteria for ADHD at the age of 25, and another 50% suffer a significant impairment due to the residual symptomatology of the disorder (Faraone, Biederman, & Mick, 2006).

An explanatory model of ADHD that is widely accepted by the scientific community suggests that the symptoms stem from a deficit in the development of the executive functions (EF), a set of superior cortical functions that coordinate thoughts, emotions, and goal-directed actions (Barkley, 1997; Brown, 2013). EF deficits produce difficulties in inhibition, initiation, flexibility, planning, organization, emotional control, or working memory skills, which are all essential for the individual's adaptation to the environment. Although they cannot be considered sufficient cause or necessary, EF deficits are an essential element of the complex neuropsychology of ADHD, and this has been supported by a large body of studies conducted with samples of children and adolescents (see meta-analytic review by Willcutt, Doyle, Nigg, Faraone, & Pennington, 2005). A growing line of research has also shown the differences between adults with ADHD and adults with normal development (ND) on EF measures such as persistence, inhibition, interference, planning, set shifting, or working memory (see reviews by Boonstra, Oosterlaan, Sergeant, & Buitelaar, 2005; Hervey, Epstein, & Curry, 2004; Seidman, 2006). In general, the findings are *consistent* and can be detected regardless of the evaluation procedure used, that is, neuropsychological tests (Boonstra, Kooij, Oosterlaan, Sergeant, & Buitelaar, 2010; Halleland, Haavik, & Lundervold, 2012; Stavro, Ettenhofer, & Nigg, 2007; Surman et al., 2013) or estimation scales (Barkley, Murphy, & Fischer, 2008; Biederman et al., 2006).

The executive dysfunction in children with ADHD is associated with a broad spectrum of negative academic and

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behavioral results—oppositionism, defiance, poorer adaptive behavior (Clark, Prior, & Kinsella, 2002; Wåhlstedt, Thorell, & Bohlin, 2008), learning disabilities, attending support classes, low school grades, and repeating grades (Barry, Lyman, & Klinger, 2002; Biederman et al., 2004; Miranda, Meliá, & Marco, 2009; Seidman, Biederman, Monuteaux, Doyle, & Faraone, 2001)—and it has a considerable predictive value in school expulsions/suspensions (Miller, Nevado-Montenegro, & Hinshaw, 2012). Along the same lines, deficiencies in executive processes increase the risk of low academic and job performance in adults with ADHD, compared with other adults with ADHD but without executive deficits (Barkley & Fischer, 2011; Biederman et al., 2006). Generally speaking, executive dysfunction worsens the already compromised socioeconomic status and adaptive functioning of the adult with ADHD in job performance.

In the course of ADHD, there is a decisive influence of high rates of comorbid disorders, especially anxiety disorders, major depression, oppositional defiant disorder (ODD), conduct disorder, antisocial personality, addictive behaviors, and learning disabilities (Barkley et al., 2008; De Zwaan et al., 2012; Goldstein, 2002; Klein et al., 2012; Michielsen et al., 2012; Miranda, Baixauli, & Colomer, 2013; Sobanski, 2006; Spencer, 2006; Spencer, Biederman, & Mick, 2007). Specifically, reading disabilities (RD) are frequently linked to ADHD, presenting an index of co-occurrence that ranges between 10% and 40% (Carroll, Maughan, Goodman, & Meltzer, 2005; Del'Homme, Kim, Loo, Yang, & Smalley, 2007; Maughan & Carroll, 2006). A recent review based on 17 studies provides quite similar numbers, with the data showing an overlap of the two conditions of between 11% and 52%, percentages that are much higher than what would be expected by chance (DuPaul, Gormley, & Laracy, 2013). However, in addition to being frequent, the coexistence of ADHD and RD entails a high risk of academic failure, low job status, and unsatisfactory psychosocial and emotional adaptation (Faraone, Biederman, Monuteaux, & Seidman, 2001; Sexton, Gelhorn, Bell, & Classi, 2012).

The literature provides evidence about the low performance of children with ADHD on tasks of lexical processing, rapid naming (Semrud-Clikeman, Guy, Griffin, & Hynd, 2000; Willcutt, Pennington, Olson, Chhabildas, & Hulslander, 2005), and orthographic and phonological decision-making tasks (De Jong, Licht, Sergeant, & Oosterlaan, 2012). Likewise, the analysis of text comprehension processes suggests that children with ADHD have less competence than children with ND in identifying main ideas and topics (Brock & Knapp, 1996), making inferences, logically ordering sentences in a paragraph (Miranda, García, & Soriano, 2005), detecting incoherencies in a text (Berthiaume, Lorch, & Milich, 2009) or constructing a coherent mental representation of the text (Miller et al., 2013).

Although scarce, the research devoted to examining the ADHD and RD association beyond childhood provides interesting information. A study carried out with adolescents reported that they had adequate reading skills, although they showed subtle difficulties in word and text reading speed and a low comprehension level on silent reading (Ghelani, Sidhu, Jain, & Tannock, 2004). The findings for adults with ADHD reveal a similar tendency, suggesting that they show no significant impairments in phonological awareness, phonological memory, or rapid naming (Laasonen, Lehtinen, Leppämäki, Tani, & Hokkanen, 2010), or in the decoding skills involved in reading (Samuelsson, Lundberg, & Herkner, 2004; Seidman, Biederman, Weber, Hacht, & Faraone, 1998). To our knowledge, only one study found mild difficulties in reading achievement in adults with ADHD, but they disappeared when the effect of IQ was statistically controlled by introducing it as a covariate (Laasonen et al., 2010). Finally, studies carried out in the adult stage have identified significant reading comprehension difficulties in ADHD samples (Gregg et al., 2002), and these are maintained, even when age, socioeconomic status, and the educational level reached are introduced as covariables (Samuelsson et al., 2004).

In the frequent ADHD with RD (ADHD+RD) association, EF impairments are involved. A large number of studies highlight that children with ADHD+RD experience more problems than children with ADHD-RD (ADHD without RD) on inhibitory control, slower naming, processing speed, shifting, and working memory (see reviews by De Jong, Oosterlaan, & Sergeant, 2006; Germanó, Gagliano, & Curatolo, 2010; Miranda, Presentación, Siegenthaler, Colomer, & Pinto, 2011). In the area of reading comprehension, the findings from one study conducted with adolescents with ADHD emphasize the influence of verbal working memory and attentional control. Moreover, the relationship between working memory, attention, and comprehension is maintained, even after controlling reading speed and vocabulary knowledge (Miranda, Fernández, Robledo, & García, 2010). The possible involvement of EF deficits in comorbid ADHD+RD in adults has hardly been explored, but a recent study carried out with a sample of older adolescents and adults found that the ADHD plus reading disorder association entails more difficulties in processing speed and working memory measures than ADHD without a comorbid reading disorder (Katz, Brown, Roth, & Beers, 2011). A crucial research question is to analyze whether the presence of comorbid RD is associated with a more severe profile of executive functioning deficits.

Within this framework, the goals of this study were twofold. The first objective was to compare the performance of adults with an ADHD childhood diagnosis and adults with ND on reading tasks. The measures applied evaluated different reading areas, that is, accuracy, speed, and comprehension. We hypothesized that adults with ADHD may present a significantly inferior performance in reading fluency and comprehension due to the involvement of sustained attention, working memory, planning/organization, and processing speed, processes that are affected in adults with this disorder (Alderson, Hudec, Patros, & Kasper, 2013; Brown, Reichel, & Quinlan, 2009; Katz et al., 2011; Marchetta, Hurks, Krabbendam, & Jolles, 2008; McLean et al., 2004). However, the level of performance of the two groups, ADHD and ND, would be expected to be fairly similar in reading accuracy, which involves cognitive phonological skills, as ADHD is not related to significant impairments in phonological processing (Laasonen et al., 2010).

The second objective of this study was to examine the possible additive EF deficits in adults with ADHD+RD and determine in which specific types differences occur, comparing the behavioral estimations of the EF in adults with ADHD+RD, adults with ADHD-RD, and adults with ND. Although the research discussed above suggests that children with both ADHD and RD have greater difficulties in measures of EF than individuals with either disorder alone, the limited research carried out with adults has used a reduced number of EF (Katz et al., 2011). Nevertheless, based on studies that support the contribution of the EF to reading problems in children (Locascio, Mahone, Eason, & Cutting, 2010; Miranda et al., 2010), we hypothesize that adults with ADHD+RD will show a similar profile to that of the children who present both conditions; that is, they will show a greater EF impairment than those without RD.

Method

Participants

There were 60 participants in the study, all of them males from 18 to 24 years old, divided into two equal groups: one group who had received a clinical diagnosis of ADHD in childhood and a control group without ADHD. The two groups were matched on age, $t(58) = -1.14$, $p = .260$, and sex (all the participants were men). The adults with ADHD had slightly lower scores than the adults without ADHD on IQ estimated by the vocabulary and cubes tests on the Wechsler Adult Intelligence Scale–III (WAIS-III; Wechsler, 1999). However, the difference in IQ between the two groups was not significant, $t(58) = -0.64$, $p = .525$.

ADHD group. This group was composed of 30 participants with a childhood clinical diagnosis of ADHD-combined subtype, a mean age of 19.07 ($SD = 1.66$), and a mean IQ of 101.87 ($SD = 14.88$). All of them form part of a follow-up study of the sample recruited in Spain between 2003 and 2007 for the IMAGE project (International Multicentre ADHD Genetics), in which seven European countries and Israel participated (Kuntsi, Neale, Chen, Faraone, & Asherson, 2006). Prior to their entrance in the IMAGE study, all the participants underwent clinical evaluations performed by a neuropediatrician and a clinical child psychologist from La Fe university hospital in Valencia to determine the diagnosis of ADHD-combined subtype, according to the criteria of the *DSM-IV-TR* (APA, 2000).

In the present evaluation, carried out in 2012, 70% of the young men (21/30), according to the self-report version, and 53.33% (16/30) according to the informant-report version, obtained a score of $T > 65$ on total ADHD symptoms on the Conners' Adult ADHD Rating Scales (CAARS; Conners, Erhardt, & Sparrow, 1999). As expected, the adults who were evaluated in this follow-up phase met the criteria for the following comorbid conditions: 16.7% met the criteria for ODD, 20% for a conduct disorder, 6.7% for anxiety disorder, and 10% for an affective disorder. In addition, 76.7% of the participants had received pharmacological treatment for ADHD at some point in their lives, although only 36.7% continued taking medication at the 2012 evaluation.

Comparison group. This group was composed of 30 adults with ND. They had a mean age of 19.80 ($SD = 1.95$) and a mean IQ of 104.07 ($SD = 11.57$), and they were selected taking into account the educational level of the Spanish population between 18 and 24 years old, according to the Spanish National Statistical Institute. A diagnosis of ADHD and/or a diagnosis of RD were exclusion criteria for the control group. The participants of this group were recruited during the first quarter of 2012 through information on this research project distributed in high schools, vocational schools, and universities. Furthermore, three characteristics were taken into account in the selection process to increase the similarity with the ADHD group: age, gender, and IQ. At the end of the selection process, the two groups, ADHD and comparison, were equivalent on these three variables. Finally, 3.7% of the adults with ND met the criteria for ODD, and 7.4% met the criteria for an anxiety disorder.

As observed in follow-up studies with adults (Barkley et al., 2008; Kuriyan et al., 2013), the educational results of the comparison group were higher than those of the ADHD group; specifically, the groups differed on their educational level, $\chi^2(4, N = 60) = 20.76$, $p < .001$. Only 6.7% of the participants with ADHD had completed university or vocational education studies, compared with 20% of the participants in the comparison group, $\chi^2(1, N = 60) = 2.31$, $p = .129$. Moreover, the percentage of students who had completed high school studies in the ADHD group was 6.7%, compared with 40% of the participants in the control group, with the difference being significant in this case, $\chi^2(1, N = 60) = 9,32$, $p = .002$. At the lower educational levels, this tendency was inverted, with the percentages being clearly higher in the participants with ADHD.

To explore the second objective, the group with an ADHD diagnosis was divided into two subgroups: participants with ADHD and participants who also showed disabilities in reading performance (ADHD+RD). RD were determined based on the parameters of reading speed and comprehension, given their importance in the functional use of reading in adult life, and based on the need to differentiate the manifestations of reading difficulties presented by participants with ADHD in the different developmental stages (Samuelsson et al., 2004).

Thus, the ADHD without RD group (ADHD-RD) was composed of 11 participants with a score above the 25th percentile on the parameters of reading speed and reading comprehension on the corresponding subtests of the Battery of Evaluation of Reading Processes in Secondary Education (Ramos & Cuetos, 1999). The ADHD+RD group included 13 participants whose scores on reading speed and comprehension were under the 25th percentile on the aforementioned reading test. This is a commonly adopted criterion in the literature to subtype adults with RD (Swanson, 2012).

The participants received a payment of 30 euros as compensation for transportation costs and the time dedicated to completing the evaluation.

Measures

Information was gathered on the participants' performance in different reading domains. Accuracy and fluency were assessed by the Word Reading subtest and the Text Reading Speed subtest of the Battery of Evaluation of Reading Processes in Secondary Education (*Bateria de Evaluación de los Procesos Lectores en Secundaria—PROLEC-SE*; Ramos & Cuetos, 1999). The Word Reading Subtest consists of a list of 40 words that vary in length, frequency of use, and the complexity of their syllabic structure. The words read correctly and the time spent reading the complete list of 40 words are recorded. On the Text Reading Speed Subtest, the task consists of reading a text containing 294 words ("Maldito apéndice" [Damn appendix]). The reading of the text is timed, and the number of words per minute is extracted.

To evaluate reading comprehension, three types of tests were used: open questions (Reading Comprehension Subtest) about the text structure from the PROLEC-SE battery and a cloze test (CLT; Suarez & Meara, 1992). The Reading Comprehension Subtest (PROLEC-SE; Ramos & Cuetos, 1999) is composed of two expository texts—one about the Eskimos ("Los esquimales" [The Eskimos]) containing 341 words, and the other about the Australian Papua ("Los papúes australianos" [The Australian Papuans]) containing 377 words. After each text is read silently, the text is removed, and the participant has to answer 10 questions. Of them, 5 are literal and can be answered with the aid of the memory, and 5 are inferential questions that can only be responded to if the participant has understood the text and can make the pertinent inferences. Each correct answer receives one point. On the Text Structure Subtest (PROLEC-SE; Ramos & Cuetos, 1999), after silently reading an expository text called planet Aurea ("El planeta Áurea" [Aurea Planet]), the participant has to fill in 22 gaps in an outline of the text he or she has just read. This task measures comprehension through three different procedures: capacity to recall the text, capacity to make inferences, and capacity to make outlines of the text to obtain more complete information. One point is awarded for each correct answer. In addition, participants took the CLT (Suarez & Meara, 1992). The text presented mixes description, narration, and dialogue. It is broken up following the Cloze procedure, omitting 1 word in every 7. The participant has to fill in the gaps in each text. The basic idea is that the reader can only complete the text correctly if he or she uses all the clues it provides, taking into account the syntactic and semantic conditionings, the author's stylistic choices, and so on. One point is awarded for each gap completed correctly.

The specific measurement instrument chosen to obtain EF estimations from family observers and the participants themselves was the Behavior Rating Inventory of Executive Function–Adult version (BRIEF-A; Roth, Isquith, & Gioia, 2005). This subscale evaluates multiple components of executive functioning (cognitive, behavioral, and emotional) in everyday situations in adults from 18 to 90 years old. Items are rated on a 3-point scale (never, sometimes, often), with higher scores indicating greater EF impairment in daily life. It includes the following nine factorial subscales: inhibit, shift, emotional control, self-monitor, initiate, working memory, plan/organize, task monitor, and organization of materials. The nine subscales form two separate indexes, the behavioral regulation index (BRI) and the metacognition index (MI). The BRI includes the factors of inhibit, shift, emotional control, self-monitor, and initiate, while the MI includes the factors of working memory, plan/organize, task monitor, and organization of materials. *T*-scores greater than 65 on the different scales are considered clinically impairing.

The BRIEF-A is an instrument with adequate psychometric properties in terms of test–retest reliability (correlations ranging from .82 to .94) and internal consistency (α coefficients ranging from .85 to .98); in addition, support for the convergent and discriminant validity of the BRIEF-A has been reported (Roth et al., 2005). In this study, the two versions were applied, the self-report and the informant-report, and both have received positive evaluations in the research (e.g., Pizzitola, 2002). The informant-report form was filled out by the parents of the participants, as all of them were still living at home.

The evaluation of the participants was performed in an office that met all the necessary conditions in the Faculty of

Table 1. Means, Standard Deviations, and *F* Values of the Groups With and Without ADHD on the Reading Variables (Percentiles).

	Comparison (n = 30)		ADHD (n = 30)				
	M	*SD*	*M*	*SD*	$F(1, 57)$	p	η_p^2
A. words	68.50	34.09	46.00	37.14	2.59	.113	.043
S. words	49.67	31.64	33.73	25.59	3.34	.073	.055
S. text reading	68.80	19.33	36.47	25.83	9.44	.003**	.142
Text structure	52.80	36.44	32.57	33.25	2.39	.128	.040
Literal Q.[a]	7.83	1.46	6.03	2.45	4.07	.049*	.067
Inferential Q.[a]	6.90	1.82	5.87	2.09	0.11	.746	.002
Cloze test	53.70	11.01	42.13	10.30	7.68	.008**	.119

Note. A = accuracy; S = speed; Q = questions.
[a]Raw scores.
*p < .05. **p < .01.

Psychology at the University of Valencia. The tests were applied by experienced professionals who were familiar with the application norms and scoring. They were filled out during two sessions lasting approximately 50 min each. The participants were given the instructions just as they appear in the respective manuals.

The participants with ADHD who were taking medication as part of their diagnosis stopped taking it 48 hr before the evaluation, as well as during the 2 days it lasted. All participants were given verbal and written information, and they signed written consent to participate in the study before beginning the first evaluation session.

Results

Data were analyzed using the SPSS™, version 19.0 (SPSS Inc., Chicago, IL, USA). To address our first research question, MANCOVA, with educational level as the covariate, was used to examine group differences in reading accuracy, speed, and comprehension. The significance level was set at .05, and the value of η_p^2 was calculated to test the strength of the association.

The main effect of group was significant, Wilks's Lambda (Λ) = .743, $F(7, 51) = 2.52$, $p = .027$, $\eta_p^2 = .257$. Specifically, the results for the reading achievement variables were as follows: accuracy in word reading, $F(1, 57) = 2.59$, $p = .113$, $\eta_p^2 = .043$; word reading speed, $F(1, 57) = 3.34$, $p = .073$, $\eta_p^2 = .055$; text reading speed, $F(1, 57) = 9.44$, $p = .003$, $\eta_p^2 = .142$; correct answers on literal questions, $F(1, 57) = 4.07$, $p = .049$, $\eta_p^2 = .067$; correct answers on inferential questions, $F(1, 57) = 0.11$, $p = .746$, $\eta_p^2 = .002$; text structure, $F(1, 57) = 2.39$, $p = .128$, $\eta_p^2 = .040$; and the CLT, $F(1, 57) = 7.68$, $p = .008$, $\eta_p^2 = .119$. On the variables that showed statistically significant differences, the ADHD group performed worse than the ND group (see Table 1).

To determine the differences in EF between the ADHD-RD, ADHD+RD, and ND groups, MANCOVAs were performed with the variables of the self-report version and the informant-report version of the BRIEF-A scale, introducing the educational level reached as the covariate. Wilks's Lambda was used as the overall test of significance, and if the overall omnibus F was significant ($p < .05$), the subsequent univariate analyses were interpreted. When the variable *group* was introduced as a between-groups factor, the main effect of group was significant on both the self-report version, Wilks's $\Lambda = .44$, $F(22, 80) = 1.83$, $p = .028$, $\eta_p^2 = .334$, and the informant-report version, Wilks's $\Lambda = .37$, $F(22, 80) = 2.43$, $p = .004$, $\eta_p^2 = .389$.

Specifically, the analysis of the variables related to the self-report version revealed the following results (see Table 2): inhibit, $F(2, 50) = 5.46$, $p = .007$, $\eta_p^2 = .179$; shift, $F(2, 50) = 2.40$, $p = .100$, $\eta_p^2 = .088$; emotional control, $F(2, 50) = 6.42$, $p = .003$, $\eta_p^2 = .204$; self-monitor, $F(2, 50) = 6.38$, $p = .003$, $\eta_p^2 = .203$; initiate, $F(2, 50) = 10.36$, $p < .001$, $\eta_p^2 = .293$; working memory, $F(2, 50) = 11.01$, $p < .001$, $\eta_p^2 = .306$; plan, $F(2, 50) = 10.45$, $p < .001$, $\eta_p^2 = .295$; task monitor, $F(2, 50) = 8.44$, $p = .001$, $\eta_p^2 = .252$; organization of materials, $F(2, 50) = 1.33$, $p = .274$, $\eta_p^2 = .050$; BRI, $F(2, 50) = 9.23$, $p < .001$, $\eta_p^2 = .270$; and MI, $F(2, 50) = 9.50$, $p < .001$, $\eta_p^2 = .275$.

Post hoc tests were conducted using Bonferroni corrected t tests, with p values corrected for the number of multiple comparisons. The ADHD+RD group and the ND group presented statistically significant differences in the variables of emotional control (p = .002), self-monitor (p = .005), initiate (p < .001), working memory (p = .001), task monitor (p =.005), the BRI (p < .001), and the MI (p = .001). The ADHD-RD group and the ND group presented statistically significant differences in the variables of initiate (p = .005), working memory (p = .001), task monitor (p = .003), plan (p = .013), and MI (p = .004). All the differences indicate lower executive functioning skills of the clinical groups compared with the control group. No statistically significant differences were found between the clinical groups on any of the BRIEF-A subscales (see Table 2).

Table 2. T-Scores' Means and Standard Deviations of the ADHD-RD, ADHD+RD, and Comparison Groups on the Self-Report Version of the BRIEF-A Scales.

	ADHD-RD (n = 11)		ADHD + RD (n = 13)		Comparison (n = 30)							
	M	SD	M	SD	M	SD	$F(2, 50)$	p	η_p^2	ADHD+RD vs. comparison	PosthocADHD-RD vs. comparison	ADHD+RD vs. ADHD-RD
Inhibit	69.82	34.41	84.85	19.10	55.57	27.18	5.46	.007**	.179	.006	.253	.310
Shift	67.82	26.28	74.62	24.57	51.53	26.22	2.40	.100	.088	—	—	—
Emotional control	52.64	29.96	76.85	28.18	39.33	21.84	6.42	.003**	.204	.002†	.458	.092
Self-monitor	68.82	28.12	78.46	22.64	46.20	26.41	6.38	.003**	.203	.005†	.044	.886
Initiate	75.55	23.27	84.08	12.54	48.83	27.66	10.36	.000**	.293	.000‡	.005†	.721
Working memory	85.55	16.83	89.00	11.76	57.60	23.59	11.01	.000**	.306	.001†	.001†	1.00
Plan/organize	76.36	29.98	90.92	13.21	51.27	27.25	10.45	.000**	.295	.000‡	.013	.304
Task monitor	90.55	11.67	91.08	13.91	64.73	24.76	8.44	.001**	.252	.005†	.003†	1.00
Organization materials	78.36	24.84	75.46	15.60	59.00	29.97	1.33	.274	.050	—	—	—
Behavior/regulation index	62.55	31.66	82.85	18.63	42.00	24.95	9.23	.000**	.270	.000‡	.063	.135
Metacognition index	82.36	20.74	90.23	11.12	54.00	25.89	9.50	.000**	.275	.001†	.004†	1.00

Note. Reported post hoc tests were conducted with Bonferroni. ADHD-RD = ADHD without reading disabilities; ADHD+RD = ADHD with reading disabilities; BRIEF-A = Behavior Rating Inventory of Executive Function–Adult version.
*p < .05. **p < .01 (Bonferroni correction for posthoc comparisons: †p < .006. ‡p < .001).

Table 3. T-Scores' Means and Standard Deviations of the ADHD-RD, ADHD+RD, and Comparison Groups on the Informant-Report Version of the BRIEF-A Scales.

	ADHD-RD (n = 11)		ADHD+RD (n = 13)		Comparison (n = 30)							
	M	SD	M	SD	M	SD	$F(2, 50)$	p	η_p^2	ADHD + RD vs. comparison	PosthocADHD-RD vs. comparison	ADHD + RD vs. ADHD-RD
Inhibit	76.73	19.17	81.15	13.99	51.40	20.57	11.19	.000**	.402	.000‡	.000‡	.743
Shift	69.45	18.12	78.38	21.17	52.87	23.06	4.57	.007**	.215	.019	.125	.992
Emotional control	59.64	23.59	81.00	22.49	41.70	21.10	9.96	.000**	.374	.000‡	.060	.054
Self-monitor	64.09	28.56	89.23	9.59	46.17	25.56	10.49	.000**	.386	.000‡	.072	.025
Initiate	79.45	22.12	85.69	17.84	47.60	21.61	13.27	.000**	.443	.000‡	.000‡	.883
Working memory	75.73	20.47	88.46	18.42	56.07	20.05	8.70	.000**	.343	.001†	.026	.388
Plan/organize	74.27	26.52	84.31	22.83	54.00	21.95	6.47	.001**	.280	.001†	.024	.475
Task monitor	87.64	17.52	90.69	15.77	58.50	21.73	10.88	.000**	.395	.000‡	.000‡	1.00
Organization materials	83.18	23.55	77.69	29.33	49.23	24.63	6.59	.001**	.283	.078	.004†	1.00
Behavior/regulation index	67.18	20.10	84.00	16.69	43.83	22.55	12.53	.000**	.429	.000‡	.004†	.091
Metacognition index	81.27	22.58	87.62	19.88	48.93	20.01	13.60	.000**	.449	.000‡	.000‡	1.00

Note. Reported post hoc tests were conducted with Bonferroni. ADHD-RD = ADHD without reading disabilities; ADHD+RD = ADHD with reading disabilities; BRIEF-A = Behavior Rating Inventory of Executive Function–Adult version.
*p < .05. **p < .01 (Bonferroni correction for posthoc comparisons: †p < .006. ‡p < .001).

However, the analysis performed with the variables from the BRIEF-A informant-report version provided the following results (see Table 3): inhibit, $F(2, 50) = 11.19$, $p < .001$, $\eta_p^2 = .402$; shift, $F(2, 50) = 4.57$, $p = .007$, $\eta_p^2 = .215$; emotional control, $F(2, 50) = 9.96$, $p < .001$, $\eta_p^2 = .374$; self-monitor, $F(2, 50) = 10.49$, $p < .001$, $\eta_p^2 = .386$; initiate, $F(2, 50) = 13.27$, $p < .001$, $\eta_p^2 = .443$; working memory, $F(2, 50) = 8.70$, $p < .001$, $\eta_p^2 = .343$; plan, $F(2, 50) = 6.47$, $p = .001$, $\eta_p^2 = .280$; task monitoring, $F(2, 50) = 10.88$, $p < .001$, $\eta_p^2 = .395$; organization of materials, $F(2, 50) = 6.59$, $p = .001$, $\eta_p^2 = .283$; BRI, $F(2, 50) = 12.53$, $p < .001$, $\eta_p^2 = .429$; and MI, $F(2, 50) = 13.60$, $p < .001$, $\eta_p^2 = .449$.

In relation to the BRIEF-A informant-report version, post hoc Bonferroni corrected t tests showed the existence of statistically significant differences between the ADHD+RD and the ND group on the variables of inhibit ($p < .001$), emotional control ($p < .001$), self-monitor ($p < .001$), initiate ($p < .001$), working memory ($p = .001$), plan ($p = .001$), task monitor ($p < .001$), the BRI ($p < .001$), and the MI ($p < .001$). The ADHD-RD group and the ND group presented statistically significant differences in the variables of inhibit ($p < .001$), initiate ($p < .001$), task monitor ($p < .001$), organization of materials ($p = .004$), the BRI ($p = .004$), and the MI ($p < .001$). All the differences indicate lower executive functioning skills of the clinical groups compared with the control group. No statistically significant differences were found in the shift variable in a posteriori comparisons in any of the cases. No statistically significant differences were found between the clinical groups on any of the BRIEF-A subscales (see Table 3).

Discussion and Conclusion

Adequate reading skills are necessary in academic settings and for successful adaptation to day-to-day life. Proficient reading facilitates productivity and independence, both key markers of successfully transitioning to adulthood.

In spite of its transcendence, there is a lack of studies that analyze reading achievement in adults with ADHD and how the presence of RD may impact their executive functioning. The purpose of the present study was to pursue two fundamental objectives. The first was to identify the possible existing differences between adults with a childhood diagnosis of ADHD and adults with ND in their performance in different reading tasks, valuing parameters of accuracy, speed, and comprehension, and controlling the effect of the educational level. The comparison of word recognition accuracy in the two groups did not reach the established level of statistical significance. This result diverges from the general trend found in studies with children (Semrud-Clikeman et al., 2000; Willcutt, Pennington, et al., 2005; Willcutt et al., 2010), but there are consistencies with findings from one of the few studies on reading in adults, in which the difficulties of the ADHD group disappeared when the intelligence quotient was controlled (Laasonen et al., 2010). However, the two groups, ADHD and ND, showed a significantly different performance level on text reading speed. Various intertwined reasons could justify the slow reading of the ADHD group. It must also be kept in mind that some basic deficits in processing speed and phonological and visuospatial working memory are frequently associated with the disorder (Alderson et al., 2013; Rohlf et al., 2012; Willcutt et al., 2010). In fact, processing speed and working memory are significant predictors of oral reading fluency in children with ADHD (Jacobson et al., 2011). Another factor in our findings about slow reading could be little reading practice. Fast reading requires the use of the superficial route or direct lexical access route, whose development is based on repeated practice.

The results partially support an inferior performance in reading comprehension tasks in adults with ADHD. As in other studies (Gregg et al., 2002; Samuelsson et al., 2004), their scores on responses that require literal comprehension skills and gap filling were lower. By contrast, the performances of the ADHD group and the ND group were not significantly different in responses to inferential questions or the text structure task. It is quite possible that this relative lack of coherence in the results corresponds to the different processing demands of the tests used to evaluate comprehension. Thus, the format of the CLT requires the working memory to integrate information across sentences to identify the missing word (Greene, 2001). As the reading flow is interrupted, it is also necessary to use flexible reading strategies to solve the problem, and flexibility is a cognitive skill that is less developed in adults with ADHD (Halleland et al., 2012). Moreover, difficulties in monitoring comprehension processes, a critically important aspect of ADHD, may have provoked incorrect completions that did not correspond to a coherent semantic representation of the text (Miranda et al., 2010).

The difficulties in responding to literal questions can largely be justified by failures in attention and memory, short-term deficits experienced by adults with ADHD (Quinlan & Brown, 2003). It should be pointed out that the questions on the test were directly based on the text, referring, above all, to specific data (geographical location, dates, demographic figures, etc.) and the specific characteristics of the characters. Therefore, the temporary storage of information was being evaluated, especially taking into account the fact that the participants could not consult the text to respond to the questions. The requirements for producing correct answers to the questions that required making inferences were somewhat different, and the prior knowledge of the participants with ADHD about the contents of the texts may have been a factor that helped them to find the correct answer from long-term memory. In fact, the texts presented dealt with relatively simple and familiar topics, that is, the characteristics of the lives of the Eskimos and the Australian Papua. Likewise, the text structure task was relatively easy to do, as the participants did not have to autonomously construct a complete representation of the text; instead, they were presented with a partial outline with some information missing that they had to include. We consider that the performance of the participants in the ADHD group may have been facilitated by the inclusion of clues to resolve the task.

The second objective of this study was to broaden the understanding of the executive basis of the reading difficulties of adults with ADHD, by exploring whether the group with comorbidity has a different profile from that of the group of adults with ADHD but without RD. The covariance analyses, controlling educational level, showed poorer EF in the two ADHD groups (with and without RD) compared with the ND group, on both self-report and informant-report measures. The results, which complement those from previous studies using neuropsychological tests (Boonstra et al., 2010; Halleland et al., 2012; Stavro et al., 2007; Surman et al., 2013) or estimation scales (Barkley et al., 2008; Biederman et al., 2006), show that adults with ADHD have various executive deficits that affect processes of inhibition, interference, planning, set shifting, or working memory.

The comparison of the two ADHD groups, ADHD+RD and ADHD-RD, across executive domains assessed by the BRIEF-A on both the self-report and the family informant report, reflected a pattern that was not as different as expected. The comparison of the two ADHD groups did not yield significant differences in the estimations supplied by the informant or the self-report. However, the panorama offered by the comparison of the ADHD groups and the ND group is more revealing. Specifically, on the self-report, the participants with ADHD+RD showed lower skills than the ND group on emotional control, self-monitoring, plan/organize, and the BRI. Along the same lines, according to the family informant report, the adults with ADHD+RD showed lower skills than the ND group on emotional control, working memory, plan/organize, and self-monitoring, while the adults with ADHD-RD have lower skills than the ND participants on organization of the material.

These results, also supported by the analysis of the mean scores in percentiles, suggest a broader executive dysfunction in the ADHD+RD group. On five subscales, according to the informant (self-monitor, initiate, working memory, task monitor, and the MI), and four, according to the self-report (working memory, plan, task monitor, and the MI), the ADHD+RD group surpassed the clinical range, that is, the critical percentile of 85, compared with only one and two scales, respectively, in the case of the ADHD-RD group. Furthermore, it is important to highlight the noteworthy concordance between the self-report and the informant-report on rating behaviors related to working memory and metacognition, which are essential processes in fluency and text comprehension in adults and adolescents with ADHD (Katz et al., 2011; Miller et al., 2012; Miranda et al., 2010). Reading longer text passages requires more effortful cognitive processing; deficits in working memory could make it difficult to retain or access the information read in the mind, and low task monitoring while reading makes it difficult to identify comprehension errors and use appropriate comprehension strategies to resolve them. Neuroimaging suggests that greater difficulties with processing speed and working memory may be associated with neuroanatomical abnormalities in both ADHD and RD. In this case, the findings may further support a common underlying atypical brain development. This is an interesting question open to the field of neuroscience (Katz et al., 2011).

Limitations and Clinical Applications

The results of the present study add to the knowledge about difficulties in reading of adults with ADHD and the extension of the executive deficits in the ADHD and RD association. However, several limitations are worth noting.

First, all of the individuals with ADHD were clinically referred and, therefore, did not come from the community. Moreover, as it was a sample in clinical remission, it was made up entirely of men, so that the findings cannot be generalized to the broader population of adults with ADHD. An additional limitation was the sample size, as only 30 young adults with ADHD participated in this study. A greater number of participants could have more clearly shown differences in EF between the ADHD-RD and ADHD+RD groups, helping to establish a possible neuropsychological profile of the ADHD+RD condition in adult life. Furthermore, including a group of individuals with RD alone would offer greater possibilities of identifying convergences and divergences between the EF of individuals with comorbidity (ADHD+RD) and the EF of one of the pure conditions (ADHD and RD). Other limitations are related to the evaluation materials. The comprehension difficulties would be detected better on texts with an expository structure that is more similar to the reading material required in high school. It would also be necessary to explore the contribution of oral comprehension, the semantic background, or language difficulties, selecting the tasks according to the different processing demands. Another recommendation would be to use the performance in neuropsychological tests to evaluate the executive functioning to compare the results with the information provided by the behavioral estimations.

Finally, it should be pointed out that the occurrence of the two disorders, ADHD and RD, may lead to the exacerbation of one by the other and, thereby, increase the risk of academic failure and social and job maladjustment (Sexton et al., 2012). It would be necessary to design treatments in schools that would incorporate procedures directed toward the development of self-regulation and working memory, in addition to teaching specific strategies for optimizing the reading skills of students with ADHD. Empirical studies (Johnson, Reid, & Mason, 2012; Rogevich & Perin, 2008) verify the improvements made in reading comprehension in adolescents with ADHD using self-management techniques and multicomponent strategies. For example, the TWA (Think Before Reading, Think While Reading, Think After Reading) strategy encompasses a series of skills: "Think Before Reading," which includes questioning the author's purpose, what is already known, and what one wants to learn; "Think While Reading," which includes improving reading speed, connecting knowledge, and rereading; and "Think After Reading," which includes identifying the main idea, summarizing information, and identifying what has been learned. Likewise, although few in number, there are excellent manuals containing practical guidelines for the evaluation and treatment of late adolescents and adults struggling with ADHD and learning disabilities (e.g., Goldstein, Naglieri, & DeVries, 2011; Gregg, 2009), and manuals focused on cognitive-behavioral intervention with memory, attention and organization, and time management modules (Young & Bramham, 2012).

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