

## **Cognitive Profile for Children with ADHD by Using WISC-IV: Subtype Differences?**

Javier Fenollar-Cortés\*, Ignasi Navarro-Soria\*\*, Carla González-Gómez\*\*,  
and Julia García-Sevilla\*\*

\*Universidad de Murcia, \*\*Universidad de Alicante

### Abstract

This study explores whether a specific cognitive profile for children with ADHD can be obtained through the Wechsler Intelligence Scale for Children-Fourth Edition (WISC-IV) and whether this profile is capable of differentiating between ADHD clinical subtypes. A control group of 47 children was selected, together with a clinical group of 86 children diagnosed with ADHD and divided into 2 subgroups, according to their clinical characteristics. The clinical group was characterized by a  $GAI > CPI$  with respect to the control group. The clinical subgroups did not score significantly lower in any index, but they did in the difference between the working memory index and the processing speed index. For those diagnosed with inattentive ADHD, this distance was positive; for those diagnosed with ADHD combined group, it was negative. These findings contribute empirical evidence to the hypothesis that there is a characteristic ADHD cognitive profile, with a potential ability of differentiating between ADHD clinical subtypes.

*Keywords:* ADHD, WISC-IV, specific cognitive pattern, working memory, processing speed.

### Resumen

El presente estudio explora si se puede obtener un perfil cognitivo específico para niños/as con TDAH a partir de la Escala de Inteligencia Wechsler para Niños Cuarta Edición (WISC-IV), y si ese perfil es capaz de diferenciar entre los subtipos clínicos de TDAH. Se seleccionó un grupo de control de 47 niños/as y otro grupo clínico de 86 niños/as diagnosticados/as con TDAH, éste último dividido a su vez en dos subgrupos de acuerdo a sus características clínicas. El grupo clínico se caracterizó por una puntuación  $ICG > ICC$  respecto al grupo de control. Los subgrupos clínicos no obtuvieron puntuaciones significativamente diferentes en ninguno de los índices, pero sí lo hicieron respecto a la distancia entre el Índice de Memoria de Trabajo y el Índice de Velocidad de Procesamiento. Para el subgrupo TDAH predominantemente inatento esta distancia fue positiva, mientras que para el subgrupo TDAH-combinado fue negativa. Estos resultados aportan evidencia empírica a la hipótesis de la existencia de un perfil cognitivo específico del TDAH, con potencial para discriminar entre subtipos clínicos de TDAH.

*Palabras clave:* TDAH, WISC-IV, patrón cognitivo específico, memoria de trabajo y velocidad de procesamiento.

Correspondence concerning this article should addressed to Ignasi Navarro Soria, Departamento Psicología Evolutiva y Didáctica, Universidad de Alicante, Dirección. E-mail: ignasi.navarro@ua.es

## Introduction

ADHD has a prevalence rate of around 5% in children and 2.5% in adults, and is one of the most common disorders in infancy and adolescence (Adams, Lucas, & Barnes, 2008). The *Diagnostic and Statistical Manual of Mental Disorders* (5<sup>th</sup> ed.; DSM-5; American Psychiatric Association, 2013) indicates that Attention Deficit Hyperactivity Disorder (ADHD) is characterized by a persistent pattern of inattention and/or hyperactivity/impulsivity that significantly interferes with functioning and development, with symptoms being present before the age of 12. This disorder leads to serious difficulties in both academic context (Barnard-Brak, Sulak, & Fearon, 2011; Frazier, Youngstrom, Glutting, & Watkins, 2007; Massetti, et al. 2008) and family environment (Anastopoulos, Sommer, & Schatz, 2009; Schroeder & Kelley, 2009). For this reason, it is essential to find the most appropriate strategies and tools to reduce the possibility of errors in the diagnostic process (Skounti, Philalithis, & Galanakis, 2007).

The conception and definition of ADHD has gradually changed over time (Stefanatos & Baron, 2007). As stated by Tillman, Eninger, Forssman and Bohlin (2011): "(ADHD) is best viewed within a dimensional and developmental framework in which the symptoms and their neuropsychological bases

lie in the extreme end of a normality continuum and change with developmental level rather than being static" (p. 181). Although the object of analysis in the study of ADHD for a long time has been focused on attention, this interest has widened to include certain other possible deficits in cognitive abilities that have been gathered under the concept of "executive functions" (Gropper & Tannock, 2009). From the pioneering study by Barkley (1997) until today, numerous studies have corroborated the involvement of neuropsychological deficits in the development ADHD, especially in executive functions (e.g., Lambek et al., 2011; Rubia, 2011; Shimoni, Engel, & Tirosh, 2012; Toll, Van der Ven, Kroesbergen, & Van Luit, 2010).

The executive function is involved in those activities that are directly related to the cognitive control of information, working memory, and conscious temporary handling of the information necessary to carry out complex cognitive operations (Miranda, Colomer, Fernández, & Presentación, 2012; Raghobar, Barnes, & Hecht, 2010). Working memory is one of the most studied cognitive skills of executive functions, as it is considered to be the cognitive skill central to executive functions, and is particularly affected in ADHD (Kasper, Alderson, & Hudec, 2012; Soroa, Iraola, Balluerka, & Soroa, 2009). Two important meta-analytical studies confirmed the involvement of working

memory in ADHD (Martinussen, Hayden, Hogg-Johnson, & Tan-nock, 2005; Willcutt, Pennington, Chhabildas, Olson, & Hulslander, 2005). However, other studies have questioned this relation, but according to Kofler, Rapport and Anderson (2011), this could be due to aspects related to the methodology of these studies.

The need to carry out a cognitive study as a complementary tool for the diagnosis of ADHD was already noted by Prifitera and Dersh (1993). Wechsler Intelligence Scales for Children (Wechsler, 1974, 1991, 2003) have been widely used to identify cognitive patterns in different neurological disorders, such as ADHD, autism, and acquired brain damage (e.g. Scheirs & Timmers, 2009; Schwean & McCrimmon, 2008; Thaler et al., 2010). However, the WISC-IV scale has been shown to have greater sensitivity to ADHD symptoms than the WISC-III scale (Mayes & Calhoun, 2006; Styck & Watkins, 2014).

Different studies have found that children evaluated by the WISC-IV test showed a characteristic pattern in their cognitive development (Sattler, 2008). Although they achieve scores that come close to normative ranges in their general intellectual functioning (Devena & Watkins, 2012), children with ADHD tend to perform worse than the control or normative group on the Working Memory Index (WMI) and Processing Speed Index (PSI) with respect to the Verbal Compre-

hension Index (VCI) and the Perceptiv e Reasoning Index (PRI) (Devena & Watkins, 2012; Mayes & Calhoun, 2006; Miguel-Montes, Allen, Puente, & Neblina, 2010). These results have been replicated in adults (Nelson, Canivez, & Watkins, 2013). However, this tendency is not sufficiently strong to be considered a diagnostic tool in itself, and in any case, it is inferior to the classic method of diagnosis by using behavior rating scales (Devena & Watkins, 2012).

The relationship between specific cognitive patterns and clinical ADHD subtypes is still unclear. For example, Thaler et al. (2012) found that the cognitive profile characterized by average scores in the VCI, PRI, and WMI, with reduced PSI, was associated with a higher rating of inattention symptoms and a larger proportion of subjects diagnosed with ADHD-inattentive. Solanto et al. (2007) found that the ADHD-combined group had poorer scores on visuospatial working memory than the ADHD-inattentive group, whereas the inattentive subtype scored worse in processing speed measured by the WISC-III. However, Tillman, Eninger, Forssman and Bohlin (2011) concluded that working memory, whether visuospatial or verbal, is only related to inattention symptomatology. Yang et al. (2013) found no differences between two clinical subtypes of ADHD (inattentive and combined) in terms of their scores in the WISC-IV indices.

In general, studies carried out to date have provided empirical evidence that subjects with ADHD-inattentive show a poorer performance on PSI than ADHD-combined (Calhoun & Mayes, 2005; Mayes, Calhoun, Chase, Mink, & Stagg, 2009; Thaler et al., 2012). Chhabildas, Pennington and Willcutt (2001) concluded that a poor performance in the PSI was related to inattention symptomatology, independent of the occurrence of hyperactive/impulsive symptomatology, whereas this poor performance was not found in the ADHD-hyperactive group. Other studies have not found a significant deficit in processing speed, but it needs to be noted that the samples either have been low or have not distinguished between subtypes (Loh, Piek, & Barrett, 2011).

There is a consensus to consider that establishing a cognitive profile in children with ADHD through the WISC-IV may help in the diagnostic process, as well as in indicating the specific strengths and weaknesses of ADHD (Yang et al., 2013), and might become a predictor of the severity of the symptoms and the prognosis (Thaler et al., 2012).

The aim of this study is to explore the relationships between the clinical and cognitive profiles through the main indices in the WISC-IV. We hypothesize that the clinical sample (ADHD) is characterized by a lower Cognitive Processing Index (WMI+PSI) than General Ability Index (VCI+PRI) in

comparison to the control group. We also hypothesize that the ADHD-inattentive group will be characterized by a lower score in the PSI with respect to the WMI, whereas the opposite will be true for the ADHD-combined group.

## Method

### Participants

The clinical group included 86 children with a prior diagnosis of ADHD ranged in age from 6 to 14 years ( $M = 9.66$ ,  $SD = 2.39$ ) and approximately three-quarters (70.9%) were male. Forty-four of them were diagnosed with ADHD-Combined (51.2%) and forty-two were diagnosed with ADHD-Inattentive (48.8%). Fifty-nine (68.6%) were taking medication for ADHD at the time of the study. The control group was made up of 47 subjects collected from schools from the area, aged between 6 and 14 years, ( $M = 9.81$ ,  $SD = 1.29$ ), within which twenty-eight (59.6%) were male (Table 1).

### Measures

The clinical tools used were as follows:

*Strengths and Difficulties Questionnaires for Parents and Teachers* (Goodman, 1997): SDQ is a 25-item screening measure with and emotional symptoms, conduct prob-

Table 1

*Demographic and Clinical Characteristics of ADHD and Control Samples*

		ADHD combined	ADHD inattentive	Clinical sample	Control sample
<i>N</i>		44	42	86	47
Age <i>M</i> ( <i>SD</i> )		8.3 (1.8)	10.7 (2.3)	9.6 (2.4)	9.8 (1.3)
Male <i>n</i> (%)		34 (77.3)	30 (71.4)	61 (70.9)	28 (59.6)
Medicated <i>n</i> (%)		31 (70.5)	28 (66.7)	59 (68.6)	—
SDQ* <i>M</i> ( <i>SD</i> )	Hyp.	8.1 (1.8)	5.78 (2.1)	7 (2.3)	3.2 (2.1)
		8.1 (2.2)	5.1 (2.1)	6.6 (2.7)	1.4 (1.5)
ADHD-RS-IV* <i>M</i> ( <i>SD</i> )	Ina.	20.5 (4.6)	19.3(4.6)	19.4 (4.3)	N/A**
		20.8 (4.6)	17.8 (3.8)	19.2 (4.9)	
	Hyp/ Imp.	18.77 (4.9)	7.35 (4.8)	13.1 (7.3)	
		19.3 (4.9)	4.2 (4.08)	10.6 (8.2)	
Conners 3 (S)* <i>M</i> ( <i>SD</i> )	Ina.	78.5 (9.6)	79.4 (11.6)	78.2 (11.3)	
		71.8 (7.1)	72 (8.6)	71.9 (9.4)	
	Hyp.	79.0 (9.9)	56.3 (11.4)	72.4 (14.6)	
		76.4 (11.4)	50.4 (8.2)	65.8 (16.3)	

*Note.* Hyp. = Hyperactivity; Ina. = Inattention; Hyp/Imp. = Hyperactivity/Impulsivity; SDQ = Strengths and Difficulties Questionnaire; ADHD RS-IV = ADHD Rating Scale IV; Conners 3 (S) = Conners 3 Short Version.

\* Family score is on upper side and teacher score is on lower side.

\*\* Typical controls did not complete neither parent and teacher Conners' questionnaire or ADHD-Rating Scale-IV.

lems, hyperactivity, peers problems, and prosocial scales. Each item was rated on a 3-point frequency of occurrence scale for the past 6-months (0 = "not true"; 1 = "somewhat true"; 2 = "certainly true"). Given the five SDQ subscales demonstrate adequate psychometric properties in earlier studies (Goodman, 2001). Cronbach's alphas for our sample for parents varied from .68 (con-

duct problems) to .75 (emotional symptoms), and was .68 for hyperactivity. The Cronbach's alphas for teachers varied from .67 (emotional symptoms) to .79 (hyperactivity). For the study, we used the "hyperactivity" and "prosocial behavior" subscales within the clinical limits stipulated by the scale, except for those subjects for whom the inattention dimension was predominant, in

which case the limit was established in a score of 4 and above (Ullebo, Posserud, Heiervang, & Gillberg, 2011). Those subjects who did not obtain a clinically significant score either from their family or their education center were excluded from the clinical group.

*The ADHD Rating Scale-IV* (DuPaul, Power, Anastopoulos, & Reid, 1998): ADHD-RS-IV is an 18-item scale based on DSM-IV diagnostic criteria for ADHD. Family and teachers rated the occurrence of nine inattentive and hyperactivity/impulsivity symptoms for the past 6-months on a 4-point scale (0 = never or rarely; 1 = sometimes; 2 = often; 3 = very often). ADHD-RS-IV have demonstrated adequate psychometric properties in studies with American and Spanish samples (Servera & Cardo, 2007). Cronbach's alphas for inattention and hyperactivity/impulsivity symptoms for family were .85 and .90, respectively, with the values being .91 and .93 for teachers, respectively.

*Short Version of the Spanish Version of the Conners' Rating Scale 3<sup>rd</sup> Edition for Parents and Teachers* (Conners, 2008): Family and teachers completed the Conners-3 (S), which measures inattention (5 items), hyperactivity/impulsivity (6 items), defiance/aggression (5 items), peer relationship problems (5 items), and learning problems/executive functions (10 items for family form and 6 items for teachers form). Each item was rated on a 4-point frequency of oc-

currence scale for the past month (0 = not true at all; 1 = just a little true; 2 = pretty much true; 3 = very much true). Previous studies provide support for the psychometric properties of the Conners-3 (Conners, 2008). Cronbach's alphas for family varied from .62 (learning problems scale) to .91 (hyperactivity scale), and was .85 for inattention scale, and from .86 (defiance/aggression scale) to .91 (peers relationship problems scale) for teachers. Cronbach's alphas for teacher were .87 and .89 for inattention and hyperactivity/impulsivity, respectively.

*Semistructured Family Interview*: A research team member carried out a semistructured interview with the family to test if the subject fell within the criteria set down by the *Diagnostic and Statistical Manual of Mental Disorders* (4<sup>th</sup> ed., text rev; DSM-IV-TR; American Psychiatric Association [APA], 2000), as well as to review the clinical history to confirm that the subject met the criteria to be included in the sample design. In those cases in which the clinical team deemed it appropriate, an interview was also carried out with the relevant personnel from the education center.

*WISC-IV Wechsler Intelligence Scale for Children. IV Edition* (Wechsler, 2011): The WISC-IV (Wechsler, 2003) is a four-factor cognitive test for children who were between 6 and 16 years of age. The Spanish version of the WISC-IV (Corral, Arribas, Santamaría, Sue-

iro, & Pereña, 2005) was used to assess general intellectual functioning (FSIQ) through 10 mandatory subtest ( $M = 10$ ,  $SD = 3$ ) that form four indices ( $M = 100$ ,  $SD = 15$ ) including Verbal Comprehension Index, Perceptive reasoning index (PRI), Working Memory Index (WMI), and Processing Speed Index (PSI). To the extent possible, General Ability Index (GAI) ( $M = 100$ ,  $SD = 15$ ) and Cognitive Processing Index (CPI) ( $M = 100$ ,  $SD = 15$ ) was calculated. The GAI is a composite score that is based on three verbal and three nonverbal subtest, and does not include the Working Memory or Processing Speed indices). CPI summarizes performance on the Working Memory and Processing Speed indices in a single score. Supplemental subtest were not included in this study. The WISC-IV raw scores of the subtest were converted into age-corrected standard scores.

### Procedure

The clinical sample was initially composed of 138 subjects aged between 6 and 14 years, of both sexes, who were taken from Child and Youth Mental Health Units, Psychology and Education practices, and associations for families with children with ADHD from the regions of Murcia, Alicante, and Valencia, Spain. The following exclusion criteria were established: not having a previous diagnosis of ADHD available, provided

by a specialist in child psychiatry, child neurologist, or child researcher; an  $IQ < 70$  (as measured by the WISC-IV); the occurrence of symptoms of severe mental disorders (psychosis, major depression, etc.); suffering from severe medical conditions (epilepsy, brain damage, etc.); or being diagnosed with a pervasive developmental disorder. The control group met the same exclusion criteria as the clinical group but whose scores on the Strengths and Difficulties Questionnaire were lower, in both informants, than the lowest clinically significant limit in any SDQ subscales. In addition, families and teachers were informed that study participation was voluntary and confidential. All families who met the inclusion criteria agreed to participate and no teachers declined participation.

With the results of the clinical tests as basis two subclinical groups were formed. The subclinical groups were configured as follows:

1. *ADHD combined*: Subjects who had attained a score equal to or higher than 7 on the SDQ scale as scored by both informants (families and teachers), and whose "inattention" and "hyperactivity/impulsivity" scores, both in the ADHD-RS-IV and Conners 3, as scored by both informants, were clinically significant. Finally, the researcher confirmed the ADHD-combined diagnosis in a clinical interview.

2. *ADHD inattentive*: Subjects who obtained a score on the SDQ scale equal to or higher than 4, and who obtained clinically significant scores only in the inattentive dimension both in the ADHD-RS-IV and Connors 3 scales as scored by both informants. Finally, the researcher confirmed the ADHD-inattentive diagnosis in a clinical interview.

### Data analysis

First, differences were explored between the means of the main indices (VCI, PRI, WMI, and PSI) and the FSIQ by gender (in both the control and clinical groups) and by medication taken (in the clinical group only). Second, any possible significant differences between the means of the main indices were explored, as well as in the means of, and the mean distance between, the CPI and GAI indices and the means of the subclinical groups. Furthermore, any potential significant differences between the means of the differences between the VCI and the PRI, as well as the WMI and the PRI. By setting the mean of the difference between these four indices, not only does the gross value of the scores lose weight on the indices but also if patterns of relation can be identified between the different indices. ANOVAs statistical tools were used for this purpose (a method for finding out the least significant differences [LSDs]), as well as t-test scores to discover the

significance (at 95% and at 99%). Cohen's  $d$  were calculated for effect size, interpreted as 0.2, 0.5, and 0.8 reflecting small, medium, and large effect sizes, respectively (Cohen, 1969). The normality and homoscedasticity of the distribution of the variables studied were also tested. Finally, discriminant analysis was used to identify the cognitive variables best able to classify in which clinical group would each participant be assigned.

### Results

No significant differences were found by gender in the main indices and the WISC-IV general indices. Similarly, no significant differences were found between those who were taking medication and those who were not, suggesting that, at least in our sample, neither medication nor gender affected to cognitive performance.

With respect to the differences between the control and clinical groups, significant differences were found in WMI [ $F(1, 131) = 9.51$ ;  $p = .002$ ;  $d = 0.67$ ], the PSI [ $F(1, 131) = 7.88$ ;  $p = .006$ ;  $d = 0.51$ ], and the CPI [ $F(1, 131) = 11.99$ ;  $p = .001$ ;  $d = 0.68$ ] (Table 1). No further significant differences were found at any indices. With respect to the mean differences between the GAI and the CPI, significant differences were found between them [ $F(1, 131) = 14.90$ ;  $p = .000$ ;  $d = 0.67$ ] with the difference in the



Table 2

*WISC-IV Scores Comparison between Control vs ADHD vs Subclinical Groups*

	ADHD combined N = 44	ADHD Inattentive N = 42	Clinical N = 86	Control N = 47	ANOVA			
					Clinical vs Control		ADHD-C vs ADHD-I	
					F(1, 131)	d	F(1, 84)	d
VCI	106.2 (13.9)	106.1 (15.7)	106.4 (14.9)	105.3 (12)	0.13		0.00	
PRI	105.7 (15.7)	104.1 (12.1)	104.4 (15.5)	105.7 (13.2)	0.1		0.28	
WMI	91.8 (13.2)	102.4 (16)	96.9 (15.5)	105 (12.3)	9.51**	0.67	11.15***	0.75
PSI	104.9 (17.2)	90.4 (12.4)	98.1 (16.3)	105.5 (11.6)	7.88**	0.51	19.95***	0.95
FSIQ	103 (16.7)	101.1 (13.5)	101.9 (15.5)	106.3 (11.3)	2.86		0.36	
GAI	107.3 (15.1)	106.5 (13.1)	106.6 (14.4)	106.3 (11.5)	0.74		0.06	
CPI	98.3 (16.8)	95.5 (14.5)	97.0 (15.5)	106.4 (11.5)	11.99***	0.68	0.70	
GAI-CPI	8.95 (13)	11.1 (15.1)	9.98 (14)	0.29 (13.5)	14.90***	0.67	0.48	
VCI-PRI	0.52 (13.1)	2.10 (15.4)	1.29 (14.2)	-0.38 (13.8)	0.43		0.26	
WMI-PSI	-13.1 (13.1)	11.9 (12.1)	-0.86 (17.8)	-0.51 (15.1)	0.01		84.67***	1.99

Note. VCI = Verbal Comprehension Index; PRI = Perceptual Reasoning Index; WMI = Working Memory Index; PSI = Processing Speed Index; FSIQ = Full Scale Intelligence Quotient; GAI = General Ability Index; CPI = Cognitive Proficiency Index. ADHD-C = ADHD combined; ADHD-I = ADHD inattentive; d = Cohen's d.

\* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .

clinical group being larger than that in the control group (Figure 1). Linear Discriminant Analysis (LDA) was applied to the data, but the null hypothesis about poblational covariance matrix was rejected (Box's  $M > .05$ ).

In the cognitive performance in the main indices between ADHD-combined and ADHD-inattentive groups, significant differences were found both for WMI [ $F(1, 84) = 11.15$ ;  $p < .001$ ;  $d = 0.75$ ] (Figure 2) and PSI [ $F(1, 84) = 19.95$ ;  $p < .000$ ;  $d = 0.95$ ] (Figure 3). The rest of the comparisons between the means of the main indices and the general ones of the WISC-IV were not significant. Lin-

ear Discriminant Analysis (LDA) was applied to the data but in all cases was lower than 75%.

Significant differences were found [ $F(1, 84) = 84.67$ ;  $p < .000$ ;  $d = 1.99$ ] in the mean of the difference between the WMI and PSI for ADHD-combined ( $M = -13.1$ ,  $SD = 13.88$ ) and for ADHD-inattentive ( $M = 12$ ,  $SD = 12.1$ ) groups (Figure 4). A positive result in this variable indicates a higher score in the WMI than in the PSI, whereas a negative result indicates the opposite. No significant differences were found in this variable between the clinical sample and the control sample.

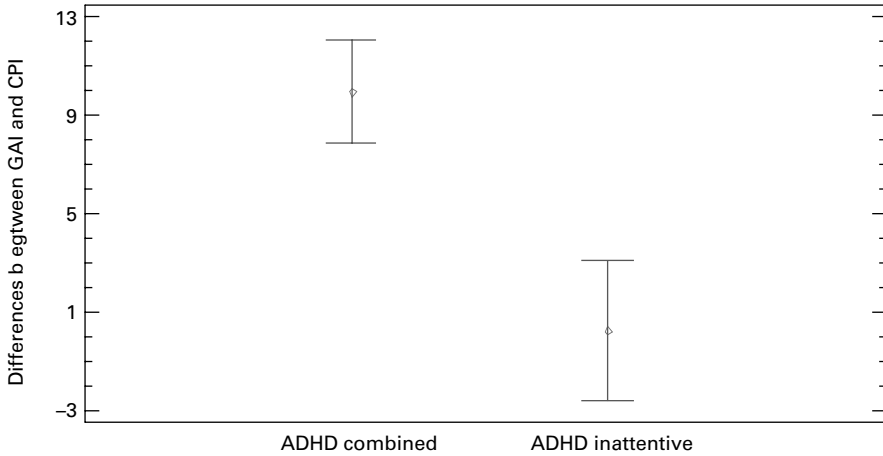


Figure 1. Differences between GAI and CPI by sample. LSD intervals with a confident level of 95%.

Note. GAI = General Ability Index; CPI = Cognitive Proficiency Index.

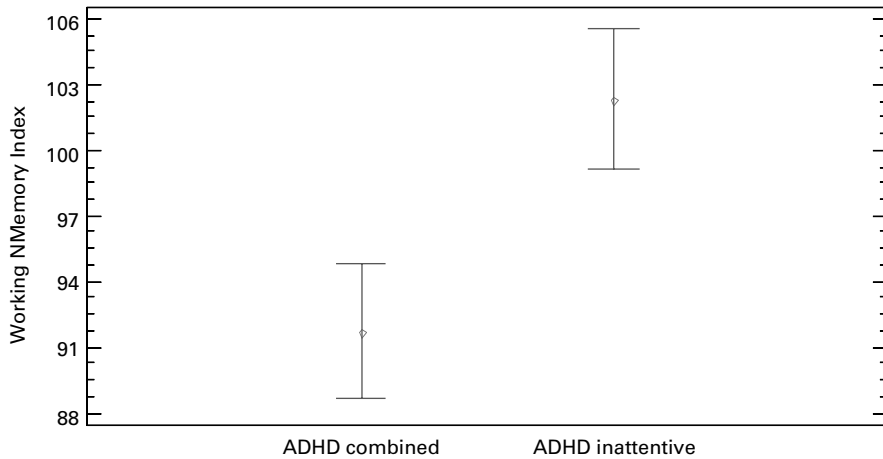


Figure 2. Working Memory Index between ADHD subgroups. LSD intervals with a 95% confident level.

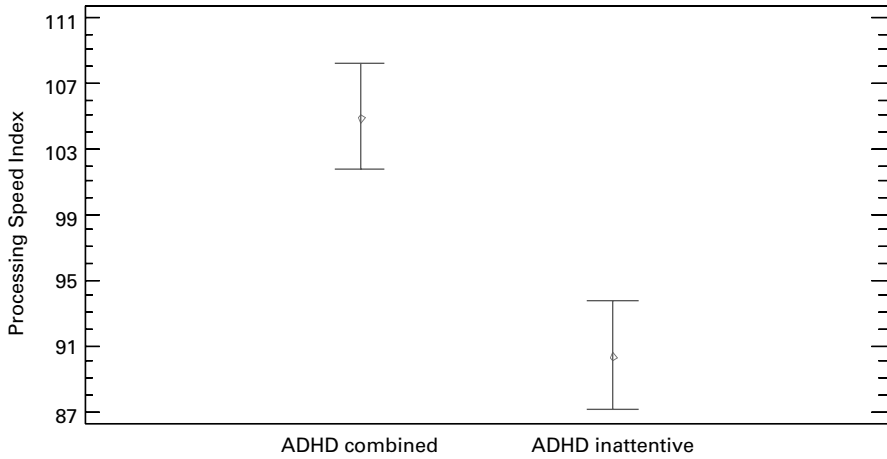


Figure 3. Processing Speed Index between ADHD subgroups. LSD intervals with a 95% confident level.

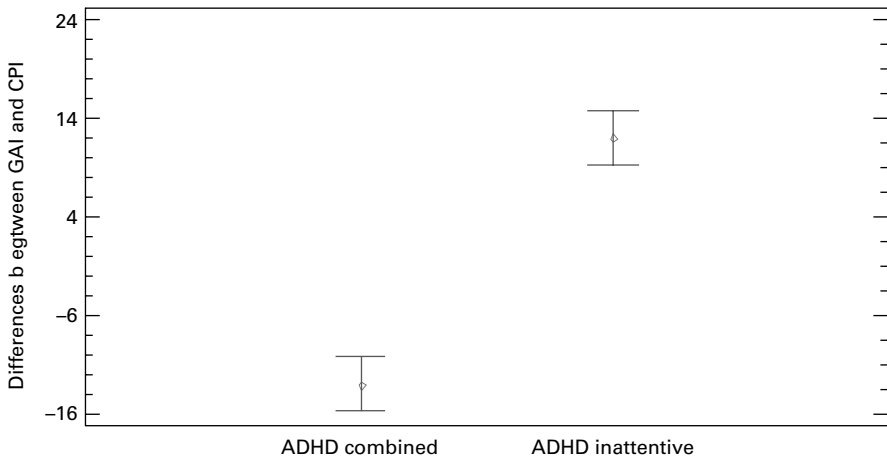


Figure 4. Differences between WMI and PSI. LSD intervals with a 95% confident level.

## Discussion

The aim of this study was to explore the relationships between the clinical profile of ADHD and the cognitive profile of each of the subjects, as obtained using the WISC-IV. For this, scrupulous sample design, which consisted of a graded 3-scale protocol, was administered to two independent informants, concerning subjects who had previously been diagnosed with ADHD.

With respect to the first hypothesis, our results suggest that there are significant differences between the clinical and control groups on the Cognitive Proficiency Index. The General Ability Index is practically identical in both groups, which would confirm that Verbal Comprehension and Perceptual Reasoning indices, was not affected in ADHD group (Devena & Watkins, 2012; Mayes & Clahoun, 2006). However, a significant difference was obtained on the Cognitive Proficiency Index between control and clinical groups. There were significant differences in the results obtained in the difference between the General Ability Index/Cognitive Proficiency Index, something which is consistent with the literature and answers our first hypothesis. These results initially show that at least one of the indices that comprise the Cognitive Proficiency Index must score clearly lower than the rest of the indices.

With respect to the second hypothesis, our results clearly suggest

that the ADHD-inattentive profile was characterized by a significantly lower score on the Processing Speed Index with respect to the Working Memory Index, which is consistent with Thaler, Bello and Etkoff (2012). These authors found that the cluster characterized by average scores on the Verbal Comprehension, Perceptual Reasoning, and Working Memory indices, with low scores on Processing Speed Index, was related to a high level of inattention symptoms and a greater proportion of ADHD predominantly inattentive. In effect, the variable representing the difference between the Working Memory Index and the Processing Speed Index obtained a mean of 12 points, which indicates that the difference is positive, that is, that higher scores were obtained on the Working Memory Index than on the Processing Speed Index. Mayes et al. (2009) suggested that the Processing Speed is affected in children with ADHD-inattentive but not in ADHD-combined. Therefore, given that there is considerable empirical support for the hypothesis that working memory is affected in ADHD (González, Rodríguez, Cueli, Cabeza, & Álvarez, 2014; Passolunghi & Cornoldi, 2008; Willcutt et al., 2005), the relation should be negative, that is, lower scores should be obtained on the Working Memory Index than on the Processing Speed Index, without affecting the Verbal Comprehension and Perceptual Reasoning indices. From our data, we found

that the ADHD-combined group obtained negative scores in the difference between the Working Memory Index/Processing Speed Index, that is, higher scores on the Processing Speed Index. In the study by Thaler et al. (2012), a cluster was not found in which the Verbal Comprehension, Perceptual Reasoning, and Processing Speed scores were normal and the Working Memory Index was affected; however, it could be seen in their clinical and demographic data that the Working Memory Index was lower than the scores for the Verbal Comprehension and Perceptual Reasoning indices. We consider that the reason for not finding this cluster could be the involvement of the two Verbal Comprehension and Perceptual Reasoning indices.

If we compare the control and ADHD groups in the variable determined by the difference between Working Memory Index and Processing Speed Index, no significant differences were found between the groups, as the trends of both clinical subtypes were offset.

In general terms, it is clear that the Verbal Comprehension and Perceptual Reasoning indices do not provide any information that may be discriminating; instead, it is the interaction between the Working Memory and Processing Speed indices that characterizes clinical subtypes.

This study has numerous limitations. First, we are aware that a cluster analysis would have been a

more robust tool in establishing relations between cognitive and clinical profiles and would have enabled us to establish the relation between certain cognitive patterns and the symptoms of ADHD on a continuum. When creating clinical groups, despite the robustness of the protocol for establishing inclusion into the various groups, the possibility of exploring the degree of clinical impact in one dimension with respect to the scores in the clinical profile would be reduced. However, we consider that establishing clear diagnostic groups and exploring their cognitive characteristics as measured by the WISC-IV was a natural step, following on from important studies such as that by Thaler et al. (2012) or that by Devena and Watkins (2012).

Equally, we are aware that in creating a new variable, such as the difference between the Working Memory the Processing Speed indices, caution must be applied in its use, and for it to be considered a useful tool, a detailed theoretical justification would need to be provided to ensure that the psychometric qualities of the scale are maintained. Once it was seen that there were significant differences between the ADHD-inattentive and ADHD-combined groups in relation to the Working Memory and Processing Speed indices, we do not know what the specific magnitude of this difference should be to have a potential discriminating value. In the same way, it would be interest-

ing to assess if the Sluggish Cognitive Tempo has an effect on the cognitive profiles, particularly on the Processing Speed Index.

The results of this study provide empirical evidence to the hypothesis that a relation exists between ADHD clinical profiles and the cognitive profiles obtained by WISC-IV. This relation is sufficiently robust to characterize the ADHD-inattentive group with a cognitive pattern in which the Processing Speed Index are lower than Working Memory Index, and to characterize the ADHD-combined by lower scores on the Working Memory Index than on the Processing Speed Index. The Verbal Comprehension and Perceptual Reasoning indices we're not affected in the ADHD group. However, from our study, the relevant data in the main indices of the WISC-IV in their relation with the clinical profile were not the gross scores but rather the

correlations of the scores between the Working Memory and Processing Speed indices. Therefore, what is relevant is not the low scores on the Working Memory Index, for example, but rather, a lower score with respect to the other indices related to the subject, irrespective of whether that low score is, despite everything, above the normative average.

With respect to the characterization of the clinical group through the "cognitive stage" created by the difference between the General Ability Index and Cognitive Proficiency Index, despite the fact that our study found significant differences between the control group and the clinical group, we consider that these differences are subject to the characteristics of specific cognitive profiles of the clinical subtypes and, therefore, to the magnitude of the main index affected in each case.

## References

- Adams, P. F., Lucas, J. W., & Barnes, P. M. (2008). Summary health statistics for U.S. children: National Health Interview Survey 2006. *Vital Health Statistics, 10*, 1-104.
- Alexander, D. M., Hermens, D. F., Keage, H. A., Richard-Clark, C., Williams, L. M., Kohn, M. R., ... Gordon, E. (2008). Event-related wave activity in the EEG provides new marker of ADHD. *Clinical Neurophysiology, 119*(1), 163-179. doi: 10.1016/j.clinph.2007.09.119
- Anastopoulos, A. D., Sommer, J. L., & Schatz, N. K. (2009). ADHD and family functioning. *Current Attention Disorders Reports, 1*(4), 167-170.

- American Psychiatric Association (2000). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.
- American Psychiatric Association (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Publishing.
- Barkley, R. (1997). Behavioral inhibition, sustained attention and executive functions: Constructing a unifying theory of ADHD. *Psychological Bulletin*, *121*(1), 65-94.
- Barnard-Brak, L., Sulak, T. N., & Fearon, D. D. (2011). Coexisting disorders and academic achievement among children with ADHD. *Journal of Attention Disorders*, *15*(6), 506-515. doi: 10.1177/1087054710369667
- Brookes, K. X. (2006). The analysis of 51 genes in DSM-IV combined type attention deficit hyperactivity disorder: Association signals in DRD4, DAT1 and 16 other genes. *Molecular Psychiatry*, *11*(10), 934-953. doi: 10.1038/sj.mp.4001869
- Bruchmüller, K., Margraf, J., & Schneider, S. (2012). Is ADHD diagnosed in accord with diagnostic criteria? Overdiagnosis and influence of client gender on diagnosis. *Journal of Consulting and Clinical Psychology*, *80*(1), 128-138. doi: 10.1037/a0026582
- Chhabildas, N., Pennington, B., & Willcutt, E. (2001). A comparison of the neuropsychological profiles of the DSM-IV subtypes of ADHD. *Journal of Abnormal Child Psychology*, *29*(6), 529-540.
- Cohen, J. (1969). *Statistical power analysis for the behavioral sciences*. New York, NY: Academic Press.
- Corral, S., Arribas, D., Santamaría, P., Sueiro, M. J., & Pereña, J. (2005). *Wechsler Intelligence Scale for Children-Four Edition (WISC-IV) (Spanish Version)*. Madrid, Spain: TEA ediciones.
- Devena, S., & Watkins, M. (2012). Diagnostic utility of WISC-IV general abilities index and cognitive proficiency index difference scores among children with ADHD. *Journal of Applied School Psychology*, *28*(2), 133-154. doi: 10.1080/15377903.2012.669743
- Devito, E. E., Blackwell, A. D., Clark, L., Kent, L., Dezser, A. M., Turner, D. C., & Sahakian, B. J. (2009). Methylphenidate improves response inhibition but not reflection-impulsivity in children with attention deficit hyperactivity disorder (ADHD). *Psychopharmacology*, *202*(1-3), 531-539. doi: 10.1007/s00213-008-1337-y
- DuPaul, G., Power, T., Anastopoulos, A., & Reid, R. (1998). *ADHD rating scale-IV: checklists, norms, and clinical interpretation*. New York: Guilford.
- Fair, D. A., Bathula, D., Nikolas, M. A., & Nigg, J. T. (2012). Distinct neuropsychological subgroups in typically developing youth inform heterogeneity in children with ADHD. *Proceedings of the National Academy of Sciences*, *109*(17), 6768-6774.
- Frazier, T. W., Youngstrom, E. A., Glutting, J. J., & Watkins, M. W. (2007). ADHD and achievement: Meta-analysis of the child, adolescent, and adult literatures and a concomitant study with college students. *Journal of Learning Disabilities*, *40*(1), 49-65.
- González-Castro, P., Rodríguez, C., Cueli, M., Cabeza, L., & Álvarez, L. (2014). Competencias matemáticas

- ticas y control ejecutivo en estudiantes con trastorno por déficit de atención con hiperactividad y dificultades de aprendizaje de las matemáticas. *Revista de Psicodidáctica*, 19(1), 125-143. doi: 10.1387/RevPsi-codidac.7510
- Goodman, R. (1997). The Strengths and Difficulties Questionnaire: A research note. *Journal of Child Psychology and Psychiatry*, 38, 581-586.
- Gropper, R. J., & Tannock, R. (2009). A pilot study of working memory and academic achievement in college students with ADHD. *Journal of Attention Disorders*, 12(6), 574-581. doi: 10.1177/1087054708320390
- Hellwig-Brida, S., Daseking, M., Keller, F., Petermann, F., & Goldbeck, L. (2011). Effects of methylphenidate on intelligence and attention components in boys with Attention-Deficit/Hyperactivity Disorder. *Journal of Child and Adolescent Psychopharmacology*, 21(3), 245-253. doi: 10.1089/cap.2010.0041
- Hyman, S. (2010). The diagnosis of mental disorders: The problem of reification. *Annual Review of Clinical Psychology*, 6, 155-179. doi: 10.1146/annurev.clinpsy.3.022806.091532
- Jarrett, M., & Ollendick, T. H. (2008). A conceptual review of the comorbidity of Attention-Deficit/Hyperactivity Disorder and anxiety: Implications for future research and practice. *Clinical Psychology Review*, 28(7), 1266-1280. doi: 10.1016/j.cpr.2008.05.004
- Kasper, L., Alderson, R., & Hudec, K. (2012). Moderators of working memory deficits in children with Attention-Deficit/Hyperactivity Disorder (ADHD): A meta-analytic review. *Clinical Psychology Review*, 32, 605-617. doi: 10.1016/j.cpr.2012.07.001
- Kofler, M., Rapport, M., Bolden, J., Sarver, D., & Raiker, J. (2011). ADHD and working memory: The impact of central executive deficits and exceeding storage/rehearsal capacity on observed inattentive behavior. *Journal of Abnormal Child Psychology*, 38, 149-161. doi: 10.1007/s10802-009-9357-6
- Lambek, R., Tannock, R., Dalsgaard, S., Trillingsgaard, A., Damm, D., & Thomsen, P. (2011). Executive dysfunction in school-age children with ADHD. *Journal of Attention Disorders*, 15(8), 646-655. doi: 10.1177/1087054710370935
- Loh, P. R., Piek, J. P., & Barrett, N. C. (2011). Comorbid ADHD and DCD: Examining cognitive functions using the WISC-IV. *Research in Developmental Disabilities*, 32, 1260-1269. doi: 10.1016/j.ridd.2011.02.008
- Martinussen, R., Hayden, J., Hogg-Johnson, S., & Tannock, R. (2005). A meta-analysis of working memory impairments in children with Attention-Deficit/Hyperactivity Disorder. *Journal of the American Academy of Child & Adolescent Psychiatry*, 44, 377-384. doi: 10.1097/01.chi.0000153228.72591.73
- Masseti, G., Lahey, B., Pelham, W., Loney, J., Ehrhardt, A., & Lee, S. K. (2008). Academic achievement over 8 years among children who met modified criteria for Attention-Deficit/Hyperactivity Disorder at 4-6 years of age. *Journal of Abnormal Child Psychology*, 36(3), 399-410.
- Mayes, S., & Calhoun, S. (2006). WISC-IV and WISC-III profiles in children with ADHD. *Journal of Attention Disorders*, 9, 486-493. doi: 10.1177/1087054705283616
- Mayes, S., Calhoun, S., Chase, G., Mink, D., & Stagg, R. (2009). ADHD sub-



- types and co-occurring anxiety, depression, and oppositional-defiant disorder: Differences in Gordon diagnostic system and Wechsler working memory and processing speed index scores. *Journal of Attention Disorders*, 12(6), 540-50. doi: 10.1177/1087054708320402
- Miguel-Montes, L.E., Allen, D., Puente, A., & Neblina, C. (2010). Validity of the WISC-IV Spanish for a clinically referred sample of Hispanic children. *Psychological Assessment*, 22(2), 465-469. doi: 10.1037/a0018895
- Miller, G. (2010). Psychiatry. Beyond DSM: Seeking a brain-based classification of mental illness. *Science*, 327, 1537. doi: 10.1126/science.327.5972.1437
- Miranda, A., Colomer, C., Fernández, I., & Presentación, M. J. (2012). Executive functioning and motivation of children with Attention Deficit Hyperactivity Disorder (ADHD) in problem solving and calculation tasks. *Revista de Psicodidáctica*, 17(1), 51-72.
- Nelson, J. M., Canivez, G. L., & Watkins, M. W. (2013). Structural and incremental validity of the Wechsler Adult Intelligence Scale-Fourth Edition (WAIS-IV) with a clinical sample. *Psychological Assessment*, 25, 618-630. doi: 10.1037/a0032086
- Pazvantoglu, O., Alptekin-Aker, A., Karabekiroglu, K., Akbas, S., Sarisoy, G., Baykal, S., & Rifat-Sahin, A. (2012). Neuropsychological weakness in adult ADHD; cognitive functions as core deficit and roles of them in persistence to adulthood. *Journal of the International Neuropsychological Society*, 18, 819-826. doi: 10.1017/S1355617712000574
- Prifitera, A., & Dersh, J. (1993). Base rates of WISC-III diagnostic subtest patterns among normal, learning-disabled, and ADHD sample. In B. Bracken, & R. McCallum (Eds.), *Journal of psychoeducational assessment monograph series, advances in psychoeducational assessment: Wechsler Intelligence Scale for Children-Third Edition* (pp. 43-55). Germantown, TN: Psychoeducational Corporation.
- Quintana, H., Snyder, S. M., Purnell, W., Aponte, C., & Sita, J. (2007). Comparison of a standard psychiatric evaluation to rating scales and EEG in the differential diagnosis of Attention-Deficit/Hyperactivity Disorder. *Psychiatry Research*, 152(2-3), 211-222.
- Raghubar, K. P., Barnes, M. A., & Hecht, S. A. (2010). Working memory and mathematics: A review of developmental, individual differences and cognitive approaches. *Learning and Individual Differences*, 20, 110-122. doi: 10.1016/j.lindif.2009.10.005.
- Rubia, K. (2011). "Cool" inferior frontostriatal dysfunction in Attention-Deficit/Hyperactivity Disorder versus "hot" ventromedial orbitofrontal- limbic dysfunction in conduct disorder: A review. *Biological Psychiatry*, 69(12), e69-e87. doi: 10.1016/j.biopsych.2010.09.023
- Sattler, J. (2008). *Assessment of children: Cognitive foundations (5th ed.)*. Diego, CA: Jerome M. Sattler.
- Scheirs, J., & Timmers, E. (2009). Differentiating among children with PDD-NOS, ADHD, and those with a combined diagnosis on the basis of WISC-III profiles. *Journal of Autism and Developmental Disorders*, 39(4), 549-556. doi: 10.1007/s10803-008-0657-4
- Schroeder, V. M., & Kelley, M. L. (2009). Associations between fam-

- ility environment, parenting practices, and executive functioning of children with and without ADHD. *Journal of Child and Family Studies*, 18, 227-235. doi: 10.1007/s10826-008-9223-0
- Schwean, V. L., & McCrimmon, A. (2008). Attention-Deficit/Hyperactivity Disorder: Using the WISC-IV to inform intervention planning. In A. Priftera, D. Saklofske, & L. Weiss (Eds.), *WISC-IV clinical assessment and intervention* (pp. 193-215). San Diego, CA: Academic Press.
- Sciutto, M. J., & Eisenberg, M. (2007). Evaluating the evidence for and a General Ability Index on the overdiagnosis of ADHD. *Journal of Attention Disorders*, 11(2), 106-113. doi: 10.1177/1087054707300094
- Seidman, L. J., Doyle, A., Fried, R., Valera, E., Crum, K., & Matthews, L. (2004). Neuropsychological function in adults with Attention-Deficit/Hyperactivity Disorder. *Psychiatric Clinics of North America*, 27, 261-282.
- Servera, M., & Cardo, E. (2007). ADHD Rating Scale-IV in a sample of Spanish schoolchildren: normality data and internal consistency for teachers and parents. *Revista de Neurología*, 45(7), 393-399.
- Shiels, K., Hawk, L. W., Reynolds, B., Mazzullo, R. J., Rhodes, J. D., Pelham, W. E.,... Gangloff, B. P. (2009). Effects of methylphenidate on discounting of delayed rewards in attention deficit/hyperactivity disorder. *Experimental and Clinical Psychopharmacology*, 17(5), 291-301. doi: 10.1037/a0017259
- Shimoni, M., Engel, B., & Tirosh, E. (2012). Executive dysfunctions among boys with Attention Deficit Hyperactivity Disorder (ADHD): Performance-based test and parents report. *Research in Developmental Disabilities*, 33, 858-865. doi: 10.1016/j.ridd.2011.12.014
- Skounti, M., Philatithis, A., & Galanakis, E. (2007). Variations in prevalence of Attention Deficit hyperactivity disorder world wide. *European Journal Pediatric*, 166, 117-123.
- Solanto, M., Gilbert, S., Raj, A., Zhu, J., Pope-Boyd, S., Stepak, B.,... Newcorn, J. (2007). Neurocognitive functioning in AD/HD, predominantly inattentive and combined subtypes. *Journal of Abnormal Child Psychology*, 35(5), 729-744.
- Soroa, M., Iraola, J. A., Balluerka, N., & Soroa, G. (2009). Evaluación de la atención sostenida de niños con trastorno por déficit de atención con hiperactividad. *Revista de Psicodidáctica*, 14(1), 13-27.
- Spencer, S. V., Hawk, L. W., Richards, J. B., Shiels, K., Pelham, W. E., & Waxmonsky, J. G. (2009). Stimulant treatment reduces lapses in attention among children with ADHD: The effects of methylphenidate on intra-individual response time distributions. *Journal of Abnormal Child Psychology*, 37(6), 805-816. doi: 10.1007/s10802-009-9316-2
- Stefanatos, G., & Baron, I. (2007). Attention-Deficit/Hyperactivity Disorder: A neuropsychological perspective towards DMS-V. *Neuropsychological Review*, 17, 35-38.
- Styck, K. M., & Watkins, M. W. (2014). Structural validity of the WISC-IV students with ADHD. *Journal of Attention Disorders*, 1-8. doi: 10.1177/1087054714553052
- Thaler, N. S. (2013). WISC-IV profiles are associated with differences in

- symptomatology and outcome in children with Attention Deficit hyperactivity disorder. *Journal of Attention Disorders*, 17(4), 291-301. doi: 10.1177/1087054711428806
- Thaler, N. S., Barchard, K. A., Parke, E., Jones, W. P., Etcoff, L. M., & Allen, D. N. (2012). Factor structure of the Wechsler Intelligence Scale for Children: Fourth Edition in children with ADHD. *Journal of Attention Disorders*, XX(X), 1-9. doi: 10.1177/1087054712459952
- Tillman, C., Eninger, L., Forssman, L., & Bohlin, G. (2011). The relation between working memory components and ADHD symptoms from a developmental perspective. *Developmental Neuropsychology*, 36, 181-198. doi: 10.1080/87565641.2010.549981
- Toll, S. W. M., Van der Ven, S. H. J., Kroesbergen, E. H., & Van Luit, J. E. H. (2010). Executive functions as predictors of math learning disabilities. *Journal of Learning Disabilities*, 44(6), 521-532. doi: 10.1177/0022219410387302
- Ullebø, A., Posserud, M., Heiervang, E., Gillberg, C., & Obel, C. (2011). Screening for the attention deficit hyperactivity disorder phenotype using the strength and difficulties questionnaire. *European Child & Adolescent Psychiatry*, 20, 451-458. doi: 10.1007/s00787-011-0198-9
- Wechsler, D. (2003). *Wechsler Intelligence Scale for Children-Four Edition*. San Antonio, TS: Psychological Corporation.
- Willcutt, E., Pennington, B., Chhabildas, N., Olson, R., & Hulslander, J. (2005). Neuropsychological analyses of comorbidity between RD and ADHD: In search of the common deficit. *Developmental Neuropsychology*, 27, 35-78.
- Yildiz, O., Sismanlar, S. G., Memik, N. C., Karakaya, I., & Agaoglu, B. (2011). Atomoxetine and methylphenidate treatment in children with ADHD: The efficacy, tolerability and effects on executive functions. *Child Psychiatry and Human Development*, 42(3), 257-69. doi: 10.1007/s10578-010-0212-3.

Dr. Javier Fenollar Cortés, Doctor in Psychology from the University of Murcia. Specialized in Attention Deficit Hyperactivity Disorder (ADHD) neurocognitive performance, he has authored several publications regarding ADHD evaluation and treatment. Currently he develops his work activity at the University of Murcia for the Applied Psychology Service Attention and Memory Unit.

D. Ignasi Navarro Soria, Associate Professor at the University of Alicante in the Evolutionary and Educational Psychology area from the 2008-2009 academic year. School psychologist between 2002-2003 and 2009-2010 academic years. Psychologist at several underage protection services in the Province of Alicante. He specializes in early detection of learning difficulties at school environments.

Dr. Carla González Gómez, Tenured lecturer at the University of Alicante in the Evolutionary and Educational Psychology area. PhD in psychology from the Autonomy University of Barcelona. She specializes in psychoeducational identification and intervention with gifted students in their early educational stages, a field in which she has authored many publications.

Dr. Julia Garcia Sevilla, Doctor in Psychology from the University of Murcia. Tenured lecturer at Basic Psychology and Methodology Department, University of Murcia Faculty of Psychology. She is author of many publications related to attention processes and cognitive rehabilitation.

Received date: 25-07-2014

Review date: 18-10-2014

Accepted date: 20-11-2014