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Naming Speed and its effect on attentional variables and reading errors depending on the diagnosis

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Título: La velocidad de denominación y su efecto en variables atencionales y errores de lectoescritura en función del diagnóstico.
Resumen: Si bien la velocidad de denominación, generalmente evaluada con pruebas como el RAN/RAS ha demostrado su utilidad en la predicción de ciertos errores lectores y dificultades atencionales, hasta el momento no se ha analizado que variables predicen el rendimiento en la prueba. El objetivo del presente estudio es comprobar el poder explicativo de determinadas variables lectoras y atencionales sobre la velocidad de denominación en función del diagnóstico. Se utilizó una muestra de 132 estudiantes divididos en cuatro grupos (Control, n=34; Dificultades Lectoras, n=22; TDAH, n=41; y TDAH y Dificultades Lectoras, n=35). Los resultados mostraron: 1) en ausencia de dificultades, la velocidad de denominación es explicada por el CI, la edad y el género; 2) ante dificultades lectoras, las variables con mayor poder predictivo son los errores de lectura; 3) ante dificultades atencionales, son ciertas variables atencionales como los índices proporcionados por el TOVA, las que muestran una mayor significatividad.
Palabras Clave: Velocidad denominación; ran/ras; dificultades lectoras; TDAH; problemas atencionales.

Abstract: While naming speed, which is usually assessed with tests such as RAN / RAS, has proven to be useful in predicting certain reading errors and attentional difficulties, the variables that predict performance in the test have not been examined before now. The objective of this study is to test the explanatory power of certain reading and attentional variables over naming speed performance depending on diagnosis. A sample of 132 students, divided into four groups (Control, n=34; Reading difficulties, n= 22; ADHD, n=41; and ADHD+Reading Difficulties, n=35) was used. The results show: 1) without any difficulties, naming speed is explained by IQ, age and gender; 2) in the presence of reading difficulties, reading errors are the variables with more explanatory power; 3) in the presence of attentional difficulties, certain attentional variables such as those provided by the TOVA test were shown to be more significant.
Key words: Naming speed; ran/ras; reading difficulties; ADHD; attentional problems.

Introduction

Much research has looked at a variety of early indicators of Reading Learning Difficulties (RLD) with the aim of timely intervention and long term improvement. It is widely accepted that phonological awareness is able to predict future reading achievement (Aguilar, Navarro, Mechano, Alcale, Marchena, & Ramiro, 2010), and it has been shown that training in phonological skills improves reading and writing acquisition (Defior, 2008).

The ability of phonological awareness to predict RDL, in this case- achievement in naming tasks, has become the object of a variety of studies, as it is an independent factor which contributes to early reading and which is acquired before beginning infant education (Norton & Wolf, 2012). Various research points towards the fact that time taken naming stimuli is closely related to accuracy and fluency in reading words and pseudo-words (Aguilar et al., 2010;), as well as comprehension (Arnell, Joanisse, Klein, Busseri, & Tannock, 2009; Georgiou, Parrila & Kirby, 2009), and reading speed (Norton & Wolf, 2012). For some researchers (Georgiou, Parrila, Cui, & Papadopoulos, 2013), these results are due to both tasks demanding serial processing and oral production of visual stimuli. On the other hand, Loveall, Channell, Phillips and Conners (2013), among others, explain this association by referring to the fact that both reading and visual stimulus naming need access to orthographic representations in long term memory. Other studies suggest that visual stimulus naming activates brain areas related to reading (Liao et al., 2015). In short, they all posit that reading and naming are complex tasks that require processes in common.

The relationship between naming ability and attention has also been the subject of recent research (Pham, Fine, & Semrud-Clikeman, 2011). This relationship has been confirmed, especially in cases of subjects presenting Attention Deficit and Hyperactivity Disorder (ADHD) with a predominantly inattentive profile. That research supposed that difficulties of reading and attention shared certain symptoms such as slow processing speed (Shanahan et al., 2006), or problems of semantic processing (Tannock, Banaschewski, & Gold, 2006), which may influence the results of naming tasks. Most of this research has used the *Rapid Automatized Naming and Rapid Automatized Stimulus* test -RAN/RAS- (Wolf & Denckla, 2005), which is made up of six visual stimulus naming tasks, and scored based on time taken (in seconds) for each task. Some studies indicate that depending on the nature of the stimuli used in the naming tasks, subjects demonstrate reading or attentional difficulties. It has been observed that the alphanumeric RAN (that is, tasks composed of letters or numbers) is more closely associated with reading (Pham et al., 2011), while the non-alphanumeric RAN (tasks composed of colours or objects) is associated with attentional processes (Kieling et al., 2010; Roessner et al., 2008).

In this respect, various researchers state that low scores in the non-alphanumeric RAN in subjects with attentional difficulties are due to the existence of more than one plausible name for a given object or colour, producing a greater demand on attention and the need for more careful, detailed processing than that required for recognising letters or digits (Tannock et al., 2006). Furthermore, letters and numbers

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represent an automised code whereas objects and colours do not, and as such, the latter consumes resources of attention.

In light of previous research and the need to understand how the variables of reading and attentional difficulties influence naming speed, the aim of this current study is to analyse the explanatory power of certain variables related to reading (type of reading error), and attention (commission, omission, and D´ as given by TOVA) when it comes to naming speed, and how this varies in terms of diagnosis (ADHD, RLD, ADHD+RLD, control group).

Bearing in mind the processes involved in naming visual stimuli, it is expected that naming speeds in the different tasks making up the RAN/RAS (objects, colours, numbers, letters, letters-numbers, letters-numbers-colours) will be differentially related to the various variables involved in reading and writing, and attentional processes, especially in those groups who have some kind of difficulty. More specifically, following on from researchers such as Kieling et al. (2010) and Pham et al. (2011), it is expected that the alphanumeric RAN (tasks made up of numbers or letters) will be more closely related to reading while non-alphanumeric RAN (tasks made up of colours or objects) will be associated with attentional processes.

Method

Participants

This study used a non-probabilistic clinical sample comprising 78 boys (59.4%) and 54 girls (40.6%) aged between 5 and 16 (M = 9.88; SD = 2.87) with a mean IQ of 99.03 (SD = 11.85), who had been referred to a clinic for evaluation.

This sample was divided into four clinical groups (Table 1) according to previous diagnosis: The control group (n = 34; 25.6 %), RLD group (n = 22; 16.5%), ADHD (n = 41; 30.8%), and the group with both ADHD and RLD (n = 35; 26.3 %). IQ was measured using the WISC-IV scale (Wechsler, 2005), subjects scoring below 80 or above 130 were removed from the sample. In addition, in order to confirm the diagnosis of ADHD, the Evaluation of Attention Deficit with Hyperactivity (EDAH) scale was applied (Farre & Narbona, 2001). Following that, a Multivariate Analysis of Covariance was performed to check for statistically significant differences between the four groups, λ = .738, $F(9,277)$ = 3.751, p < .001, controlled for the effect of age, p = .068 and IQ, p = .358. Similarly, given that the scale provides differential scores for each subtype of ADHD, statistically significant differences were looked for in the following variables: Hyperactivity (EDAH-H), $F(1, 122)$ = 5.446, p < .001, ω^2 = .091, Attention-(EDAH-DA), $F(1, 122)$ = 8.790, p < .001, ω^2 = .136, and Hyperactivity+Attention (EDAH-ADHD), $F(1, 122)$ = 12.096, p < .001, ω^2 = .191.

Table 1. Means and Standard Deviations for Intelligence Quotient (IQ), age, and EDAH score for the four groups.

Goups		IQ		Age		EDAH.H		EDAH.DA		EDAH.TDAH	
	n	*M*	*DT*	*M*	*DT*	*M*	*DT*	*M*	*DT*	*M*	*DT*
Control	34	101.85	13.13	10.64	3.23	72.59	23.31	80.53	21.73	81.81	21.00
RLD	22	96.82	8.12	9.36	2.98	62.81	33.13	71.43	22.69	70.95	24.95
ADHD	41	100.66	12.22	10.60	2.67	84.51	17.69	89.46	14.31	92.95	9.25
ADHD+RLD	35	95.77	11.48	8.61	2.16	84.77	20.94	93.23	10.03	95.03	8.70
Total Sample	132	99.03	11.85	9.88	2.87	77.71	24.43	84.94	18.84	86.75	18.44

Note: M = Mean; SD = Standard Deviation; RLD = Reading Learning Difficulties; ADHD = Attention Deficit and Hyperactivity Disorder; ADHD+RLD = Attention Deficit Hyperactivity Disorder and Reading Learning Difficulties. EDAH.H = mean score in hyperactivity scale; EDAH.DA = mean score in attentional deficit scale; EDAH.TDAH = mean score in ADHD scale.

Lastly, with the aim of detecting whether there were significant differences between the four groups in the IQ and age variables, an analysis of variance (ANOVA) was performed. The results showed that, while there was no significant difference between the groups in terms of IQ, p = .130, there were differences in terms of age $F(3,129)$ = 4.483, p = .01, ω^2 = .085.

Instruments

The *Wechsler Intelligence Scale for Children-IV* (WISC-IV) (Wechsler, 2005) was used to evaluate IQ in the sample and to remove those individuals with IQs below 80 or over 130. This is an individually administered test composed of 15 subtests which provide information on cognitively specific areas. It is applicable to children and adolescents aged between 6 and 16. In this study only the Total Intelligence Quotient (TIQ) was considered.

In order to verify previous diagnoses of ADHD, the Evaluation of Attention Deficit with Hyperactivity scale - EDAH- was used (Farré & Narbona, 2001) in the version for families. This is made up of 20 items that evaluate attention deficit, hyperactivity, and impulsivity, which allows the distinction to be made between ADHD that is predominantly hyperactive-impulsive, inattentive, or combined. In this case the following variables were considered: *EDAH.H* (score in hyperactivity items), *EDAH.DA* (score in items which measure attention deficit) and *EDAH.ADHD* (score in items measuring ADHD).

To evaluate reading errors, the TALE Reading and Writing Analysis Test (Toro & Cervera, 1995) was used. This test determines a subject's general reading level and specific reading characteristics at a given moment during their schooling. In this study the following types of reading and writing errors were considered: omission, addition, substitution, inversion, and rotation.

The *Rapid Automatized Naming and Rapid Alternating Stimulus Tests* -RAN/RAS- (Wolf & Denckla, 2005) were used to evaluate naming speed. This is a test of naming speed that reflects the relationship between processing speed and reading speed. The test consists of four naming tests with different single stimulus type (letters, numbers, colours, objects) and two naming tests with alternating stimuli (letters-numbers, letters-numbers-colours). The scores in each task are based solely on the time taken (in seconds) to name each one of the six stimulus matrices.

Finally, the *Test of Variables of Attention*-TOVA- (Greenberg, Kindschi, & Corman, 1996) was used. This is a Continuous Performance Test -CPT- which consists of the presentation of two stimuli on a computer screen over 22.5 minutes. When the first of the stimuli appears on the screen (a square in the upper border), the student must press a button (attention task), and when the second image appears (a square in the bottom part of the screen) the student should not do anything (inhibition task). The TOVA provides information on the following variables: omission, commission, response time, variability, D´(Quality of achievement during the test), and IGCE (Executive Control Index).

Procedure

The sample came from a psycho-educational clinic attended by children diagnosed with RLD and/or ADHD by members of the School Guidance and Educational Psychology Team (*Equipo de Orientación Escolar y Psicopedagógica*: EOEP) in the Principality of Asturias, Spain. Team members use the following protocol. Firstly, once teachers have identified a low achieving student without apparent cause (motivation problems, discipline problems etc.) they request a specialist evaluation from a member of the EOEP team (psychologist, educational specialist, educational psychologist) who visits the school and looks at the case. In order to carry out the evaluation, the specialist administers various psychological tests which provide information about intellectual capability, attentional indices, reading abilities and so on. In that way learning problems due to some kind of disability (visual, hearing, etc) can be discounted. Then, once the evaluation is complete, and when the case requires it, the professional may make appropriate modifications to the child's schooling according to whatever is impeding academic achievement.

For the current study, students who had been diagnosed by members of the EOEP team as having learning difficulties and/or ADHD were invited to the clinic to confirm their diagnosis. To that end, once parental consent had been signed for the child's evaluation, a series of tests was administered to verify the diagnosis of RLD and ADHD. Those with a previous diagnosis of ADHD were given the Diagnostic Interview for Children (DISC-IV: Shaffer, Fisher, Lucas, Dulcanquellin, & Schwab, 2000), along with their parents. To be more specific, this study used the part of the interview which includes the history of progression, observation during play, and the criteria of the DSM-IV-TR (APA, 2000). In addition, the EDAH scale (Farré & de Narbona, 1998) in its aforementioned family version was administered to ensure the correct assignation of subjects to their respective groups.

Similarly, in order to confirm the diagnosis of individuals with learning difficulties the following criteria were used (Jiménez, Rodríguez, & Ramírez, 2009): (a) poor achievement in a reading test, (b) low grades in other academic areas (for example, arithmetic), and (c) a score of more than 80 in an intelligence test, specifically in the WISC-IV (Wechser, 2005). Subjects scoring less than 80 or more than 130 were eliminated. The inconsistency between reading achievement has been questioned (Jiménez et al., 2011) and has not been included in the definition of learning difficulties in this study.

Statistical design and analysis

Once the diagnoses had been verified, a ex post facto design was used to look at the predictive value of the variables. A hierarchical regression analysis was done which included three models, developed in each of the study groups (ADHD; RLD; ADHD+RLD; and the control): model 1 looked at general variables such as IQ, age, and gender; model 2 used the variables from model 1 and added the different types of reading errors identified by the TALE test (inversion, rotation, addition, substitution) from Toro & Cervera (1995); and finally, model 3 used the variables from the previous two models plus the three indicators from the TOVA test (Greenberg, Kindschi, & Corman, 1996): omission, commission, and D´. Only those variables demonstrating a significant correlation with naming speed variables (Table 3) were included in the model. Data analysis was done using SPSS v.19.0 (Arbuckle, 2010). Differences were considered significant a level of $p < .05$.

Results

One important assumption when carrying out this study was that the variables follow a normal distribution according to Kline's (2011) criteria, in which, scores between 3 and 10 are the maximum accepted for asymmetry and kurtosis, in addition to the Kolmogorov-Smirnov test for the various tasks in the RAN/RAS, in each of the four groups. As can be seen in Table 2, all of the variables analysed met these criteria.

Table 2. Means, standard deviations, asymmetry, kurtosis, and Kolmogorov-Smirnov Z for diagnostic groups for each task in the RAN/RAS test.

Diagnosis	RAN Tasks	*M*	*SD*	Asymmetry	Kurtosis	*Z* Kolmogorov-Smirnov	Asymptotic. Sig *(billateral)*
CG (*n*=34)	Objects	42.44	12.47	.506	-.290	.522	.552
	Colours	42.56	12.38	.844	.322	.540	.540
	Numbers	24.41	5.54	.242	-.722	.810	.810
	Letters	25.50	6.81	.545	-.153	.455	.455
	LN	28.62	7.29	-.234	-.933	.687	.687
	LNC	31.59	9.71	.109	-.698	.824	.824
RLD (*n*=22)	Objects	56.95	19.17	.958	.004	.930	.353
	Colours	64.14	37.52	1.960	3.196	1.222	.101
	Numbers	38.09	18.98	1.426	1.685	.862	.448
	Letters	38.86	16.82	.753	-.401	.844	.475
	LN	45.91	21.39	.636	-.881	.777	.582
	LNC	51.18	27.55	1.417	1.510	.889	.408
ADHD (*n*=41)	Objects	44.20	13.84	1.055	.401	1.033	.237
	Colours	44.22	16.35	1.237	1.358	.858	.454
	Numbers	26.02	9.18	2.171	5.846	1.418	.036
	Letters	28.78	13.10	2.509	8.659	1.096	.181
	LN	31.61	14.68	2.384	7.866	1.335	.057
	LNC	34.93	18.68	2.492	7.730	1.193	.116
ADHD+RLD (*n*=35)	Objects	57.40	18.71	2.068	5.861	1.180	.123
	Colours	63.60	20.54	1.606	4.065	.824	.506
	Numbers	40.91	22.55	1.699	1.872	1.597	.012
	Letters	43.49	23.98	2.062	5.339	1.005	.265
	LN	49.89	28.14	1.821	4.230	1.171	.129
	LNC	56.06	29.69	1.565	2.341	.968	.306

Note: *M* = Mean; *SD* = Standard Deviation; RLD = Reading Learning Difficulties; ADHD = Attention Deficit and Hyperactivity Disorder; ADHD+RLD= Attention Deficit Hyperactivity Disorder and Reading Learning Difficulties; LN = naming task with letters and numbers; LNC = naming task with letters, numbers, and colours.

Following that, a MANCOVA test was performed, with covariables IQ (p = .290) and age, F(6,124) = 16.099, p < .001 checking for statistically significant differences in the four groups in terms of the results of the RAN/RAS tests, λ = .738, F(18,357) = 4.108, p = .028. Given the significance of these results, inter-subject effects were examined which demonstrated significant differences for each of the naming tasks: Objects, F(3,129) = 4.829, p = .003, ω^2= .043; Colours, F(3,129) = 3.884, p = .011, ω^2= .039; Numbers, F(3,129) = 7.120, p < .001, ω^2= .085; Letters, F(3,129) = 5.666, p = .001, ω^2 = .062; Letters and Numbers, F(3,129) = 6.529, p < .001, ω^2 = .013; Letters, Numbers and Colours F(3,129) = 4.372, p = .006, ω^2 = .045.

Similarly, as shown in Table 3, on analysing the correlations between variables related to reading and attentional processes and achievement in RAN/RAS tasks, it can be seen that time taken to name visual stimuli correlates significantly with most of the errors in reading and writing (errors of inversion, errors of addition, errors of rotation, and errors of substitution) as well as with certain variables from the TOVA test, namely: omission, commission, and D´.

Table 3. Bivariate correlations (Pearson) between naming tasks and variables from the TALE and TOVA tests.

	Naming Tasks						
	Objects	Colours	Letters	Numbers	LN	LNC	
TALE	omission	.166	.167	.132	.137	.149	.166
	inversion	.334***	.282***	.418***	.430***	.424***	.367***
	addition	.212*	.138	.242*	.187	.246**	.225*
	rotation	.371***	.450***	.470***	.355***	.482***	.512***
	substitution	.389***	.397***	.319***	.321***	.363***	.390***
TOVA	omission	-.357***	-.272**	-.286**	-.245**	-.275**	-.245*
	commission	-.215*	-.182	-.246**	-.173	-.261**	-.198*
	RT	.049	.041	.069	-.009	.073	.051
	Variability	-.017	-.067	-.029	-.091	.005	-.040
	D prime	-.403***	-.318**	-.336**	-.290**	-.320***	-.286***
	GECI	-.100	-.085	-.095	-.098	-.072	-.080

Note: RT = Response time; GECI = General index of executive control; LN = Letters and numbers; LNC = Letters, numbers and colours.
**p* < .05; ***p* < .01; ****p* < .001.

The variables from the TALE and TOVA tests which demonstrated significant correlation with naming tasks in the RAN were taken as independent variables in a hierarchical regression analysis for each of the four diagnostic groups. The hierarchical regression analysis for the control group (Table 4) demonstrated that model 1 (with IQ, gender, and age variables) explains the majority of the variance explained as the introduction of other variable types related to reading and attention (models 2 and 3) leads to increases in variance explained which are not significant.

Table 4. Hierarchical regression analysis models with dependent variables for the Control Group.

		Raw.Obj	Raw.Col	Raw.N	Raw.L	Raw.LN	Raw.LNC
MODEL 1	Gender	-.404 (-3.252**)	-.377 (-2.260*)	-.397 (-1.862)	-.603 (-3.191**)	-.130 (-.689)	-.398 (-2.146*)
	IQ	-.441 (-3.480**)	-.029 (-.167)	.046 (.210)	-.196 (-1.015)	-.231 (-1.196)	-.101 (-.535)
	Age	-.839 (7.170***)	-.701 (-4.456***)	-.511 (-2.545)	-.515 (-2.891*)	-.793 (-4.447***)	-.667 (-3.812**)
	R^2	.834	.700	.511	.527	.614	.629
	$F(3,31)$	10.096***	4.534*	6.951**	6.905**	7.360**	5.789**
MODEL 2	Gender	-.469 (-3.643**)	-.297* (-1.363)	-.438 (-1.862)	-.591 (-2.889*)	-.345 (-1.505)	-.361 (-1.388)
	IQ	-.478 (-3.697**)	.123 (.563)	.310 (1.312)	-.059 (-.288)	-.214 (-.933)	-.095 (-.364)
	AGE	-.963 (-7.524***)	-.662 (-3.056*)	-.584 (-2.496)	-.713 (-3.506**)	-.869 (-3.816**)	-.598 (-2.314*)
	TALE. inversion	-.068 (-.457)	.157 (.626)	-.043 (-.158)	.084 (.358)	-.345 (-1.309)	.039 (.130)
	TALE. addition	-.286 (-2.521*)	.070 (.365)	-.043 (-.208)	-.376 (-2.087)	-.112 (-.556)	.150 (.654)
	TALE. rotation	.164 (1.155)	-.334 (-1.391)	-.523 (-2.016)	-.165 (-.734)	.010 (.040)	-.060 (-.209)
	TALE. substitution	-.183 (-1.535)	.117 (.583)	.183 (.843)	-.231 (-1.224)	.137 (.647)	.086 (.357)
	R^2	.914	.755	.714	.784	.729	.651
	ΔR^2	.080	.055	.203	.168	.115	.021
	$F(7,27)$	3.963*	3.212*	4.674*	3.461*	2.396	3.485*
MODELO 3	Gender	-.522 (-1.535*)	-.219 (-.761)	-.436 (-1.222)	-.667 (-2.328)	-.517 (-1.774)	-.506 (-1.314)
	IQ	-.558 (-3.727*)	-.028 (-.110)	.249 (.804)	-.129 (-.518)	-.355 (-1.403)	-.085 (-.255)
	Age	-.860 (-5.036**)	-.518 (-1.820)	-.470 (-1.333)	-.523 (-1.845)	-.731 (-2.536*)	-.687 (-1.805)
	TALE. inversion	-.156 (-.743)	.231 (.659)	-.059 (-.136)	-.047 (-.135)	-.599 (-1.684)	-.138 (-.294)
	TALE. addition	-.240 (-1.898)	.097 (.461)	-.010 (-.037)	-.302 (-1.436)	-.023 (-.109)	.162 (.576)
	TALE. rotation	.261 (1.571)	-.236 (-.854)	-.462 (-1.348)	-.052 (-.191)	.204 (.729)	-.021 (-.058)
	TALE. substitution	-.128 (-.634)	-.044 (-.130)	.210 (.504)	-.045 (-.135)	.288 (.848)	.186 (.413)
	TOVA. omission	-.292 (-1.350)	-.517 (-1.433)	-.209 (-.467)	-.248 (-.689)	-.528 (-1.442)	-.001 (-.002)
	TOVA commission	-.120 (-.699)	-.130 (-1.433)	.011 (.030)	.034 (.119)	-.355 (-1.229)	-.260 (-.680)
	TOVA. D prime	.178 (638)	.598 (1.289)	.100 (.175)	-.083 (-.179)	.317 (.676)	-.008 (-.013)
	R^2	.936	.823	.728	.825	.818	.683
	ΔR^2	.022	.068	.015	.040	.089	.033
	$F(10,24)$	2.792	1.607	2.819	2.701	1.295	2.367*

Note: Values in the table are the β regression coefficient, those in brackets are the *Student t*. R^2 = variance explained; ΔR2=change in variance explained. Raw.Obj = score obtained for naming Objects; Raw.Col = score obtained for naming Colours; Raw.N = score obtained for naming Numbers; Raw.L= score obtained for naming Letters; Raw.LN = score obtained for naming Letters and Numbers; Raw.LNC = score obtained for naming Letters, Numbers and Colours. $*p < .05$; $**p < .01$; $***p < .001$.

It is clear from the regression analysis for the RLD group (Table 5), that model 2 has statistically significant predictors. Within model 2 it can be seen that for colour naming tasks the statistically significant predictor is the number of substitution errors in the TALE test. For naming tasks with numbers, or letters and numbers, the statistically significant predictor is the number of errors of inversion in the TALE test. When the naming task is only letters, there were two significant predictors: the number of inversion and rotation errors. Lastly, in naming tasks with alternating letters, numbers and colours, the significant predictor is the number of errors of rotation.

Table 5. Hierarchical regression analysis models with dependent variables for the RLD Group.

		Raw.Obj	Raw.Col	Raw.N	Raw.L	Raw.LN	Raw.LNC
MODEL 1	Gender	.163	.384	.106	.144	.227	.354
		(.906)	(2.005)	(.523)	(.808)	(1.481)	(2.057)
	IQ	-.166	.214	.350	.170	.174	.149
		(-.920)	(1.115)	(1.727)	(.955)	(1.131)	(.864)
	Age	-.708	-.474	-.493	-.677	-.719	-.604**
		(-3.899**)	(-2.450*)	(-2.413*)	(-3.774**)	(-4.640***)	(-3.476)
	R^2	.554	.494	.437	.565	.675	.592
	$F(3,19)$	5.789**	4.560*	3.618*	6.055**	9.714***	6.780**
MODEL 2	Gender	.085	.180	.137	.044	.167	.180
		(.440)	(1.452)	(1.089)	(.320)	(1.430)	(1.302)
	IQ	-.435	-.051	.025	-.197	-.085	-.142
		(-2.032)	(-.371)	(.177)	(-1.298)	(-.658)	(-.933)
	Age	-.695	.002	-.028	-.369	-.312	-.232
		(-2.688*)	(.010)	(-.167)	(-2.021)	(-2.014)	(-1.259)
	TALE. Inversion	.511	.121	.663	.643	.389	.287
		(1.947)	(.720)	(3.900**)	(3.468**)	(2.474*)	(1.540)
	TALE. addition	-.360	-.037	.144	-.018	.136	-.068
		(-1.513)	(-.242)	(.931)	(-.106)	(.954)	(-.401)
	TALE. rotation	.194	.336	.130	.480	.280	.390
		(.735)	(1.998)	(.760)	(2.578*)	(1.776)	(2.085*)
	TALE. substitution	-.067	.594	.218	-.102	.197	.313
		(-.234)	(3.252**)	(1.180)	(-.507)	(1.153)	(1.542)
	R^2	.709	.798	.878	.855	.895	.853
	ΔR^2	.156	.387**	.441**	.290*	.220*	.260*
	$F(7,15)$	3.485*	10.581***	10.225***	8.394**	12.238***	8.274**
MODEL 3	Gender	-.028	.252	.176	-.011	.101	.254
		(-.120)	(1.938)	(1.383)	(-.063)	(.966)	(1.747)
	IQ	-.349	-.002	.126	-.122	.018	-.070
		(-1.406)	(-.015)	(.926)	(-.673)	(.159)	(-.447)
	Age	-.602	.017	.139	-.274	-.208	-.163
		(-1.820)	(.093)	(.766)	(-1.142)	(-1.394)	(-.785)
	TALE. inversion	.437	.161	.677**	.605	.342	.326
		(1.526)	(1.004)	(4.323)	(2.911)	(2.652*)	(1.820)
	TALE. addition	-.478	.111	.210	-.067	.098	.077
		(-1.585)	(.655)	(1.272)	(-.306)	(.721)	(.407)
	TALE. rotation	.360	.353	.093	.566*	.422	.386
		(1.168)	(2.043)	(.550)	(2.527)	(3.034*)	(1.997)
	TALE. substitution	-.249	.678	.310	-.183	.084	.418
		(-.731)	(3.547**)	(1.659)	(-.739)	(.548)	(1.954)
	TOVA. omission	-.482	.081	.163	-.234	-.358	.136
		(-1.274)	(.381)	(.786)	(-.851)	(-2.096)	(.571)
	TOVA commission	.154	.308	.321	.171	.278	.356
		(.536)	(1.915)	(2.046)	(.823)	(2.149*)	(1.982)
	TOVA. Dprime	.007	-.064	-.420	-.102	-.068	-.200
		(.018)	(-.274)	(-1.841)	(-.338)	(-.361)	(-.766)
	R^2	.772	.826	.932	.880	.954	.910
	ΔR^2	.062	.047	.054	.025	.058	.058
	$F(10, 12)$	2.367	9.073**	9.543**	5.117*	14.365***	7.103**

Note: Values in the table are the β regression coefficient, those in brackets are the *Student t*. R^2 = variance explained; ΔR2 = change in variance explained. Raw.Obj = score obtained for naming Objects; Raw.Col = score obtained for naming Colours; Raw.N = score obtained for naming Numbers; Raw.L = score obtained for naming Letters; Raw.LN= score obtained for naming Letters and Numbers; Raw.LNC= score obtained for naming Letters, Numbers and Colours.

$^*p < .05$; $^{**}p < .01$; $^{***}p < .001$.

With the ADHD group, it was found that although model 2 is significant when subjects are naming matrixes made up of objects, letters and numbers, or letters, numbers and colours; model 3 has greater explanatory power when naming matrixes made up of letters or colours (Table 6)

Table 6. Hierarchical regression analysis models with dependent variables for the ADHD group

		Raw.Obj	Raw.Col	Raw.N	Raw.L	Raw.LN	Raw.LNC
MODEL 1	Gender	.066 (.358)	-.126 (-.603)	-.031 (-.155)	.050 (.295)	.083 (.384)	-.163 (-.836)
	IQ	.151 (.881)	.276 (1.438)	-.023 (-.126)	-.077 (-.489)	.023 (.117)	-.274 (-1.527)
	Age	-.659 (-3.552**)	-.569* (-2.725)	-.673 (-3.398**)	-.742 (-4.361***)	-.538 (-2.494*)	-.675 (-3.465**)
	R^2	.505	.373	.437	.584	.332	.455
	F(3,38)	5.777**	3.373*	4.392*	7.940**	2.820	4.738*
MODEL 2	Gender	.153 (.921)	.106 (.555)	.106 (.575)	.047 (.281)	.099 (.469)	-.111 (-.537)
	IQ	.110 (.647)	.157 (.804)	-.141 (-.739)	-.112 (-.650)	-.025 (-.117)	-.298 (-1.393)
	Age	-.640 (-3.499**)	-.682 (-3.250**)	-.747 (-3.663**)	-.712 (-3.877**)	-.506 (-2.167*)	-.653 (-2.852*)
	TALE. inversion	1.285 (2.013)	2.105 (2.873*)	1.453 (2.041)	.334 (.521)	.656 (.805)	.748 (.936)
	TALE. addition	-.222 (-1.322)	-.295 (-1.528)	-.364 (-1.944)	-.125 (-.741)	-.217 (-1.010)	-.046 (-.221)
	TALE. rotation	-.770 (-1.234)	-1.774 (-2.478*)	-1.013 (-1.456)	.131 (.208)	-.082 (-.102)	-.312 (-.400)
	TALE. substitution	-.226 (-1.138)	-.474 (-2.081*)	-.313 (-1.411)	-.137 (-.685)	-.162 (-.639)	-.251 (-1.010)
	R2	.751	.672	.691	.749	.549	.610
	ΔR2	.246	.299*	.254	.165	.262*	.155
	F(7,34)	5.610**	3.810*	4.174*	5.538**	2.719*	2.908*
MODEL 3	Gender	.433 (1.833)	.374 (1.417)	.220 (.726)	.268 (1.253)	.118 (.388)	.083 (.273)
	IQ	.299 (1.421)	.320 (1.358)	-.054 (-.199)	.030 (.158)	-.034 (-.126)	-.216 (-.794)
	Age	-.503 (-2.375*)	-.570 (-2.412*)	-.707 (-2.602*)	-.644 (-3.353**)	-.585 (-2.153)	-.572 (-2.097)
	TALE. inversion	1.370 (1.903)	2.070 (2.572*)	1.607 (1.739)	.424 (.649)	.677 (.733)	.423 (.456)
	TALE. addition	-.242 (-1.487)	-.306 (-1.686)	-.371 (-1.777)	-.130 (-.885)	-.195 (-.936)	-.049 (-.232)
	TALE. rotation	-1.207 (-1.640)	-2.159 (-2.624*)	-1.340 (-1.418)	-.361 (-.541)	-.402 (-.425)	-.344 (-.362)
	TALE. substitution	-.447 (-1.923)	-.743 (-2.863)	-.391 (-1.311)	-.359 (-1.703)	-.290 (-.974)	-.526 (-1.759)
	TOVA. omission	.031 (.111)	-.114 (-.361)	-.054 (-.150)	-.212 (-.828)	-.526 (-1.452)	-.151 (-.416)
	TOVA commission	-.851 (-2.016)	-.969 (-2.053*)	-.430 (-.794)	-.942 (-2.457*)	-.651 (-1.200)	-.757 (-1.390)
	TOVA. Dprime	.329 (.896)	.438 (1.069)	.290 (.615)	.584 (1.755)	.724 (1.538)	.238 (.503)
	R^2	.825	.781	.711	.856	.711	.417
	ΔR^2	.073	.109	.021	.107	.117	.098
	F(10,31)	4.698**	3.563*	2.459	5.922**	2.457	2.430

Note: Values in the table are the β regression coefficient, those in brackets are the *Student t*. R^2 = variance explained; ΔR2 = change in variance explained. Raw.Obj = score obtained for naming Objects; Raw.Col = score obtained for naming Colours; Raw.N = score obtained for naming Numbers; Raw.L = score obtained for naming Letters; Raw.LN = score obtained for naming Letters and Numbers; Raw.LNC = score obtained for naming Letters, Numbers and Colours.
**p* < .05; ***p* < .01; ****p* < .001

In the co-morbid group (Table 7), model 2 is significant for all of the RAN tasks, with significantly increased explained variance when the tasks are made up of only letters or letters and numbers alternately.

Table 7. Hierarchical regression analysis models with dependent variables for the ADHD+RLD group.

		Raw.Fig	Raw.Col	Raw.N	Raw.L	Raw.LN	Raw.LNC
MODEL 1	Gender	-.262 (-1.726)	-.309 (-2.068)	-.189 (-1.189)	-.296 (-1.979)	-.382* (-2.400)	-.180 (-1.242)
	IQ	.311 (-1.726*)	.270 (1.912)	.288 (1.918)	.201 (1.423)	-.012 (-.079)	.374 (2.732*)
	Age	-.515 (-3.394**)	-.554 (-3.706***)	-.474 (-2.977**)	-.596*** (-3.984)	-.544** (-3.418)	-.536 (-3.703**)
	R^2	.367	.386	.304	.385	.304	.424
	$F(3,32)$	5.984**	6.508**	4.517**	6.479**	4.511**	7.606***
MODEL 2	Gender	-.311 (-1.983)	-.385 (-2.578*)	-.198 (-1.190)	-.358 (-2.480*)	-.442 (-2.887**)	-.210 (-1.461)
	IQ	.279 (1.865)	.183 (1.289)	.230 (1.447)	.115 (.833)	-.110 (-.754)	.317 (2.319*)
	Age	-.500 (-3.133**)	-.595 (-3.916***)	-.446* (-2.630)	-.596 (-4.054***)	-.544 (-3.490**)	-.503 (-3.446**)
	TALE. inversion	-.304 (-1.076)	-.417 (-1.550)	-.012 (-.041)	-.244 (-.935)	-.239 (-.866)	-.203 (-.785)
	TALE. addition	.181 (.802)	.188 (.876)	-.128 (-.533)	.096 (.462)	.052 (.234)	-.007 (-.034)
	TALE. rotation	.426 (1.893)	.506 (2.365*)	.327 (1.365)	.534 (2.575*)	.569 (2.590**)	.492 (2.389*)
	TALE. substitution	-.042 (-.206)	-.200 (-1.039)	-.086 (-.398)	-.217 (-1.162)	-.227 (-1.146)	-.045 (-.241)
	R^2	.458	.509	.387	.540	.483	.547
	ΔR^2	.091	.123	.083	.155*	.179*	.123
	$F(7,28)$	3.256**	4.000**	2.437*	4.532*	3.608**	4.652**
MODEL 3	Gender	-.370 (-2.366*)	-.393 (-2.535*)	-.213 (-1.173)	-.361 (-2.292*)	-.426 (-2.560*)	-.221 (-1.444)
	IQ	.376 (2.283*)	.303 (1.860)	.243 (1.270)	.118 (.710)	-.131 (-.752)	.355 (2.199*)
	Age	-.410 (-2.494*)	-.510 (-3.133**)	-.432 (-2.266)	-.593 (-3.588***)	-.565 (-3.241**)	-.473 (-2.939**)
	TALE. inversion	-.222 (-.773)	-.441 (-1.548)	-.002 (-.006)	-.257 (-.888)	-.257 (-.843)	-.257 (-.912)
	TALE. addition	.170 (.748)	.238 (1.055)	-.126 (-.478)	.107 (.467)	.052 (.217)	.044 (.198)
	TALE. rotation	.445 (2.038*)	.516 (2.383*)	.330 (1.303)	.534 (2.429*)	.564 (2.433*)	.494 (2.308*)
	TALE. substitution	-.001 (-.005)	-.163 (-.808)	-.071 (-.298)	-.204 (-.994)	-.241 (-1.112)	.009 (.047)
	TOVA. Omisiones	.002 (.007)	-.198 (-.909)	-.009 (-.035)	-.036 (-.161)	.004 (.017)	-.174 (-.804)
	TOVA commission	.338 (1.688)	.049 (.248)	.076 (.329)	.008 (.039)	-.092 (-.433)	.040 (.203)
	TOVA. Dprime	-.389 (-1.572)	-.096 (-.390)	-.048 (-.169)	.038 (.151)	.085 (.325)	.115 (.472)
	R^2	.547	.556	.391	.541	.489	.565
	ΔR^2	.090	.046	.046	.001	.006	.019
	$F(10,25)$	2.902*	3.000*	1.539	2.833*	2.296*	3.120**

Note: Values in the table are the β regression coefficient, those in brackets are the *Student t*. R^2 = variance explained; ΔR2=change in variance explained. Raw.Obj = score obtained for naming Objects; Raw.Col = score obtained for naming Colours; Raw.N = score obtained for naming Numbers; Raw.L = score obtained for naming Letters; Raw.LN = score obtained for naming Letters and Numbers; Raw.LNC = score obtained for naming Letters, Numbers and Colours.
$*p < .05$; $**p < .01$; $***p < .001$.

Discussion and Conclusions

This comparative study aimed to analyse the explanatory power of certain variables related to reading and attention over naming speed and to examine variation in explanatory power in terms of diagnosis (ADHD, RLD, ADHD+RLD, control group). The results confirm that although the RAN/RAS test is influenced by variables of distinct natures (chronological age, reading and writing errors, attentional variables…), said variables have varying weight, and differential effect, depending on the diagnostic group being analysed.

As previous research has stated, RAN/RAS naming tasks are closely related to variables involved in reading and writing processes (Arnell et al., 2009; Georgiu et al., 2009; Gasperini, Brizzolara, Cristofani, Casalini, & Chilosi, 2014) and attentional processes (Roessner et al., 2008; Stringer, Toplak, & Stanovich, 2004). This may be because naming tasks activate a series of interrelated processes which need a specified time between them. Because of that, when one of these processes is affected as a consequence of some kind of difficulty (reading or attentional), the naming speeds slow significantly compared to the control group (Norton & Wolf, 2012).

Although most research cited has examined variables which influence execution of the RAN/RAS tests generally (without looking at the type of difficulty that the subjects present) (Schatschneider, Carlson, Francis, Foorman, & Fletcher, 2002), this study has found differential functioning of the models depending on which diagnostic group is being analysed. In other words, the percentage of variance explained by each of the variables in the three models changes depending on the subjects' diagnoses.

Naming speed in the control group is fundamentally explained by model 1 which includes variables such as age, IQ and gender. This may be due to the fact that naming speed depends on the level of automatisation of various processes, and this automatisation is positively related to IQ and age (Norton & Wolf, 2012). The explanatory power of the gender variable is underpinned by the neurological differences between men and women in early years (Tian, Wang, Yan & He, 2011).

Unlike the control group, the naming speeds from the RLD group cannot be explained solely by model 1, as members of this group have problems with the lexical and/or phonological route, in addition to alterations in saccadic movement (Rodríguez, González-Castro, Álvarez, Álvarez & Cueli, 2012). This symptomatology means that model 2 best explains achievement of students with RLD, considering the frequency of the various types of reading errors.

In the ADHD group, it could be seen how the attentional variable "commission" had a close relationship with naming colours and letters. While the existing relationship between naming colours and ADHD is in line with previous research (Roessner et al., 2008), the same cannot be said of the relationship between the alphanumeric RAN and ADHD, as the majority of studies state that deficits in the alphanumeric RAN are related specifically to the presence of reading difficulties (Pham, Fine, & Semrud-Clikeman, 2011). This may be because those studies have been carried out in opaque languages like English, rather than transparent languages such as Spanish. The relationship may indicate the underlying importance of attention in reading processes (Lora & Díaz, 2011).

Finally, the comorbid group (ADHD+RLD) produced similar results to the RLD group, as model 2 contained significant predictors of RAN/RAS test results and the highest percentage of variance explained. This would indicate that the comorbidity of these two difficulties presents a complex symptomatology which cannot be reduced to a simple sum of the characteristic symptoms of ADHD and RLD (García et al., 2013).

This study has demonstrated how a range of different variables have greater or lesser influence depending on the presence or absence of reading and/or attentional difficulties. In other words, the weight of each of the variables changes depending on the diagnosis being examined.

The principal practical implication of these results will be found when it comes to interpreting scores in naming speed tests. As seen in this study, a low score in naming certain visual stimuli may be due to the presence of reading or attentional difficulties. This means that, when faced with a low RAN/RAS score, an educational professional should try to ascertain the cause through tests related to reading and attention.

There are limitations to this research which should be borne in mind in future work, such as increasing the sample size of each of the diagnostic groups with the aim of looking more deeply into the influence of these variables on the speed of naming visual stimuli.

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