SEMANTIC AND PHONOLOGIC VERBAL FLUENCY TESTS FOR ADOLESCENTS WITH ADHD

Neander Abreu, Nayara Argollo, Fernana Oliveira, Anna L. Cardoso, José L.O. Bueno and Gilberto Fernando Xavier

Abstract

Objective: One-minute Semantic Verbal Fluency (SVF) test for the category "animals" and one-minute Phonemic Verbal Fluency (PVF) test for words starting with the letters "F", "A" and "S" (usually called FAS tests), besides DSM-IV criteria, have been used for assessment of Attention Deficit/Hyperactivity Disorder (ADHD). Even though, no criterion validity has been developed for SVF and FAS tests. This study evaluated criterion validity (discriminant), an important step on neuropsychological test validation for SVF and FAS tests, by comparing performance of healthy adolescents (Control Group) and adolescents with ADHD (ADHD Group) in these tests.

Method: Forty-four 12.8 year-old adolescents with ADHD and 6.1 years of formal education, and forty-three 12.11 year-old healthy adolescents and 6.4 years of formal education, were exposed to SVF and FAS tests, to the Weschler Intelligence Scale for Children (WISC-III) and to a test for visual attention (TAVIS-III). For the SVF, letters F, A, S, and sum of F, A and S (ΣFAS), a Receiver Operating Curve (ROC) analysis was used to evaluate discriminant validity in healthy and ADHD groups.

Results: Performance of the subjects with ADHD in the FAS test, particularly for letters starting with "F", was significantly poorer as compared to that seen in the Controls ($P < 0.05$). Whilst the area under ROC curve for both groups was smaller for the SVF test (ROC area = 0.65, $P < 0.015$), it did differ significantly and was greater for FAS scores particularly for letters starting with "F" (ROC = 0.84, $P < 0.001$), "A" (ROC = 0.72, $P < 0.001$), "S" (ROC= 0.70, $P = 0.001$), and the ΣFAS (ROC = 0.81, $P < 0.001$).

Conclusions: These results indicate that one-minute FAS test using the "F" letter is suitable for discriminating healthy and ADHD Brazilian adolescents's verbal fluency.

Key words: semantic verbal fluency, phonemic verbal fluency, ADHD, neuropsychology

Declaration of interest: none

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Introduction

In a typical verbal fluency test the volunteer is required to generate a list of items belonging to a specified category, within a determined period of time. For instance, in semantic verbal fluency (SVF) tests a given category, e.g., "animals", "cloths" or "food", among others, is provided and the volunteer has to generate as many items belonging to that category as he/she can, within a given period of time. Similarly, in phonological verbal fluency (PVF) tests a single letter is provided and the volunteer has to generate as many words starting with the specified letter as he/she can within a specified period of time; the sequence of

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letters “F”, “A” and “S” (FAS) is usually employed (see Strauss et al. 2006). When used to assess children, the number of categories or letters required may be reduced for either one or two (Fonseca et al. 2008, Nunest et al. 2010).

Neuropsychological assessment for Attention Deficit/Hyperactivity Disorder (ADHD) provides quantitative data that supplements clinical impressions and DSM-IV criteria for diagnostic purposes (Seargent et al. 2003, Nigg et al. 2002). ADHD patients' verbal fluency has been evaluated using phonemic (PVF) and semantic (SVF) verbal fluency tests and are useful instruments for screening neuropsychological performance. ADHD patients have neuropsychological impairments on executive functions and PVF low performance seems to produce difficulties on educational setting (López-Campos et al. 2005, Nigg et al. 2002) Walshaw et al. (2010) compared performance of subjects with ADHD and bipolar disorder on neuropsychological tests using PVF and SFV tests. These authors calculated the average effect size (named “weighted ES”) and showed that individuals with ADHD have greater deficits in PVF (weighted ES = 0.68) as compared to SVF (weighted ES = 0.38) tests.

SVF and PVF tests differ not only in their semantic or phonemic contents, respectively, but seem to engage distinct cognitive processes and brain circuits (Willcutt et al. 2005). That is, PVF seems to be dependent on the left inferior and middle frontal cortices, putamen and thalamus networks, and seems to demand a verbal element in addition to executive functions, these latter involving the unusual generation of strategies based on categorical representations (Perret 1974). In contrast, SVF tests seem to require temporal lobe functions (Gourovitcht et al. 2000) and impose a smaller demand on executive processing because performance would rely on common and established verbal strategies. In despite of that these two tasks seem to require common activation from frontal regions and striatum (Joyce et al. 1996).

Congruent with these views, patients with ADHD seem to reveal greater impairments when performing PVF as compared to SVF tests (López-Campos et al. 2005, Willcutt et al. 2005), not rarely exhibiting lack of significant differences, relative to healthy controls, in SVF, associated with substantial impairments in the PVS (FAS) tests.

These dissociations involving performance of children with ADHD on SVF and PVF tests have been ascribed to distinct requirements for executive functions in each type of task (Brocki et al. 2008, Brocki et al 2010). As a matter of fact, the PVF (FAS) test has been proposed as a reliable test for executive functions, since its performance require cognitive organization, initiation, maintenance of effort, and the ability to conduct a non-routine search for words based on its specific first letter, rather than on its categorical classification (Walsh 1999).

Children with ADHD exhibit a core deficit in executive functions which is still observed in their adolescence and adulthood (Carr et al 2006, Halperin et al 2008). In a longitudinal case-controlled study, Biederman et al. (2012) observed that lower neuropsychological profile is still present sixteen years after diagnosis. On the other hand, executive functions evolve along development. Together, these facts challenge researchers to investigate ADHD by way of adequate tests, since impairments are not seen only in childhood, but extend to adolescence and adult life in association with age-related development in executive functions.

Silveira and colleagues (2009) used SVF and PVF (FAS) tests to compare performance of twenty-two 7-12-year-old Brazilian children with ADHD with that of thirty-four healthy subjects paired for age and years of study. All subjects were screened for ADHD according to DSM-IV clinical criteria. The results were presented in terms of the children's production in time bins of 0-15, 16-30, 30-45 and 46-60 seconds, and also as a global one-minute score. No significant group differences were found; however, there was a significantly higher performance in SVF as compared to PVF (FAS) both for children with ADHD and their matched controls. These results are quite surprising taking into account data of prior studies showing disruption of performance by children with ADHD in PVF tests.

Even though Brazilian studies involving SVF and PVF (FAS) have compared people with ADHD and control subjects, discriminant validity for these tasks was not evaluated. Discriminant validity, is one of the construct validity components directed to evaluate the fact that measures that should *not* be related are in reality *not* related, that is, to which extent performance in these different tasks, supposedly underlied for different functions, correlate among each other.

The present study aims at establishing a criterion validity using discriminant validity analysis for SVF and PVF-FAS tests. Additionally, we compared performance of adolescents with ADHD and healthy adolescents on SVF and PVF-FAS tests. The central hypothesis was that the PVF-FAS test is more accurate than the SVF test for distinguishing performance of adolescents with ADHD from that seen in healthy adolescents. Further, SVF and PVF-FAS results were compared with performance in other tests of intelligence and attention in an attempt to identify additional determinants of the performance looking for its criterion validity.

Methods

Participants

Forty-four 11-14 adolescents with ADHD (11-14 years of age), as diagnosed by either a neurologist or a psychiatrist, and forty-three healthy adolescents matched for age participated in this study. All participants with diagnostic of ADHD had not received medication for ADHD treatment before testing for this study. The volunteers had received five to nine years of formal education (average for ADHD: 6.26; average for Controls: 6.45). Familiar socioeconomic status of the participants was identified using the Brazilian Economical Classification Criteria (Associação Brasileira de Empresas de Pesquisa 2008) and a semi-structured questionnaire to investigate academic achievement as perceived by parents. This questionnaire had four questions about math, writing, reading and language comprehension. Participants were selected using a Brazilian version of the parental scale, SNAP-IV (Mattos et al. 2006), associated with a report by their teachers; participants with ADHD symptons were thus submitted to a neuropsychological assessment. Healthy participants were also exposed to these screening procedures and were assessed using the same neuropsychological instruments.

The subjects' participation in the study was voluntary and occurred after an informed consent form was signed by parents or guardians. This study was approved by the Ethics Committee in Research of the Institute of Psychology, University of São Paulo (#1406/06).

Procedures

Verbal fluency tests

One SVF and one PVF test were applied to all participants in this order.

Semantic verbal fluency test

The participants were asked to evoke and speak as many animal names as they could, over a time period of 60 seconds. The total number of correct items generated was recorded.

Phonological verbal fluency (PVF) - FAS test

The participants were asked to evoke as many words as they could starting with the letters "F", "A", and "S", over time periods of 60 seconds for each letter separately, in this sequence; proper names and numbers should be avoided. The total number of correct items generated for each letter was recorded. The results in the FAS test were computed for the number of words generated with the initial letter , i.e., F, A , S, and the sum of scores of all three letters F, A, and S (ΣFAS).

Wechsler intelligence scale for children (WISC-III) (Wechsler and Figueiredo 2002)

All participants were assessed using the WISC-III classical neuropsychological instrument. The Intelligence Quotient (IQ), the Freedom from Distractibility Index (FDI) and the Processing Speed Index (PSI) were computed.

Test of visual attention - 3rd version (TAVIS-3).

A computerized test of visual attention, as described by Coutinho et al. (2007), was used. The TAVIS-3 includes 3 tasks.

In the selective attention task, the first one of TAVIS-3, the examinee must selectively respond to a target stimulus regardless of distracters. In an initial blank screen a stimulus is shown with others in sequence (see Coutinho et al. 2007). It consists of a gray stimulus (10mmx10mm) and it appears in an random manner between other stimuli. Each time the target stimulus appears the subject should answer pressing a joystick pushbutton. Reaction time to each stimulus, omission errors and commission errors are registered. Impaired performance may suggest difficulties in focused or selective attention.

In the second task, alternation, the examinee responds to the task shifting between two different rules and this task intends to evaluate shifted attention. A word appear in the center of the computer screen and it defines the rule for the task. Each time two stimulus (geometric forms) appears in the center of the computer screen a joystick pushbutton should be pressed if they follow the rule "form" or "color". Reaction time to each stimulus, omission errors and commission errors are registered. Impaired performance may suggest difficulties in focused or shift attention.

Finally, the third task demands the examinee to sustain attention for a certain amount of time while responding quickly to the appearance of a target stimulus, a coloured circle (10mm) that appears in randomly time in a blank computer screen. Reaction time to each stimulus, omission errors and commission errors are registered. This task is designed to assess sustained attention.

According to Coutinho et al. (2007), the best three scores for identify ADHD were selective attention' reaction time (RMT), shift attention' omission errors (OE) and sustained attention' commission errors (CE). In this study we have decided to use the same measures once they have presented the best properties to discriminate ADHD and non-ADHD subjects as attention measure.

Statistical analysis

The age of the participants, the number of years of formal education, the composition of the groups in terms of gender, the mother's level of formal education (taking into account the number of years of formal education) and the socioeconomic status of both ADHD and control subjects were compared using either a Qui-square test or a Mann-Whitney test. In addition, the Mann-Whitney U test was used to compare ADHD and Controls subjects' scores in the full IQ-WISC 3, TAVIS 3, and VFS and FAS tests.

A Receiver Operating Curve (ROC) curve was used to analyze the discriminant validity of the SVF and the PVF-FAS tests including ADHD and Control subjects' scores. The ROC consists of plotting the true positive rate (Sensitivity) as a function of the false positive rate (1-Specificity) for different cut-off points of a parameter. Sensitivity rate is the probability that a test result will be positive when a disease, as ADHD, is present. False positive rate is the probability that a test will be positive in the absence of the disease. It allows identify the results of this function in different levels of results on a test or parameter. The area under the curve represents how well a parameter can distinguish between two groups (Castanho et al. 2004), for example, one group with a disease and a healthy group. Finally, a Spearman's test was used to search for correlations between WISC-III, TAVIS-3, SVF and FAS scores.

Results

Table 1 shows the groups' general characteristics including age, gender, number of years of formal education, mother's education level and socioeconomic level. As can be seen, statistics revealed significant Groups differences for (1) gender, with the ADHD group exhibiting more boys as compared to the Control group, (2) number of years of formal education, with slightly smaller scores for the ADHD subjects, and (3) socioeconomic level, with the ADHD subjects exhibiting poorer indexes (see **table 1** for relevant statistics).

Figure 1 shows performance of the ADHD and Control subjects in the FAS and SVF tests, and relevant statistics comparing the Groups scores. As can be seen, ADHD subjects exhibited poorer scores as compared to Control subjects in all verbal fluency tests, thus indicating a poorer capacity of generating words on both the FAS and the SVF tests. A detailed Mann Whitney analysis of these scores is also presented in **table 2**.

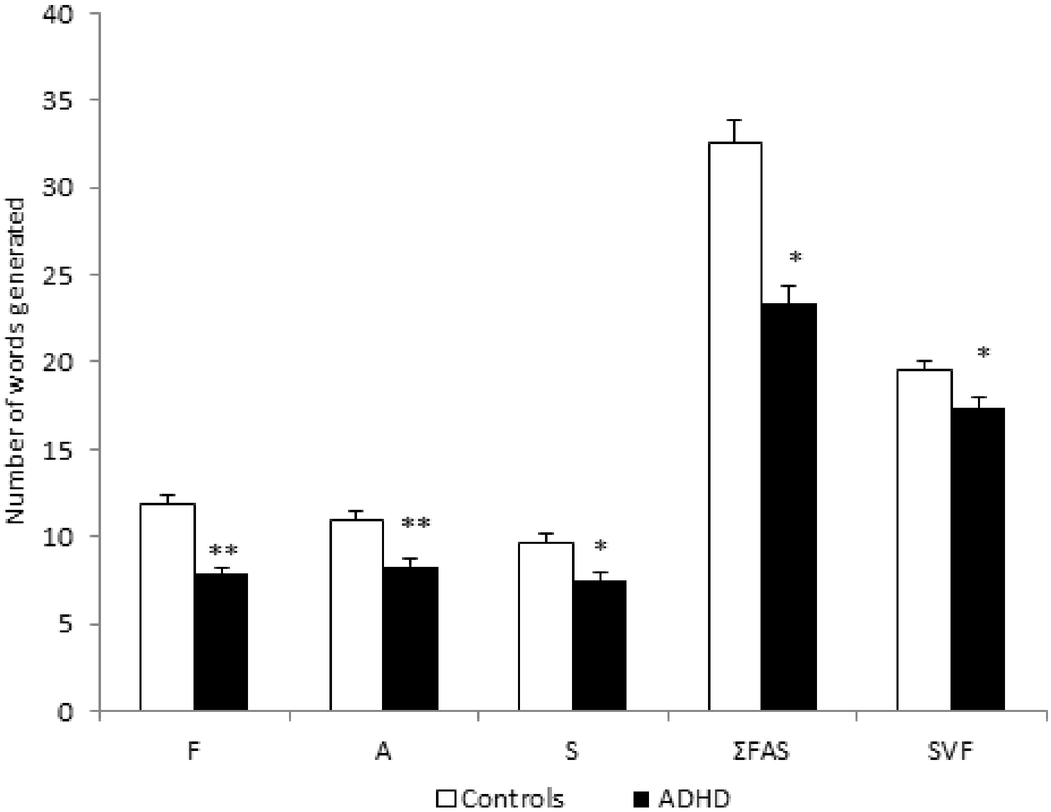
Figure 2 shows the scores achieved by ADHD and Control subjects in the WISC-III test, in terms of IQ, FDI and PSI (**Figure 2a**) and in the TAVIS-3 test in terms of MRT, OE and CE (**Figure 2b**). In addition, **table 2** shows a detailed Mann Whitney analysis of

Table 1. *ADHD and control groups socio-demographic and cognitive variables*

Characteristics	ADHD (n=44)	*Range*	Controls (n=43)	*Range*	*p-value*
Age	12.75(1.15)	11.1-15.1	13.2 (1.1)	11.0-15.0	0.10[a]
Gender ($_X2$)					
Male	34		12		<0.001[b]
Female	10		31		
Years of formal Education	6.26 (1.19)	5-8	6.45(1.08)	4-9	0.04[a]
Mother's Education Level (Years of formal Education)	4.64 (0.57)	3-5	4.83 (0.37)	4-5	0.09[a]
Socioeconomic Level	2.59 (1.19)	1-5	3.42 (0.66)	2-4	<0.001[a,c]

ADHD: Attention Deficit/Hyperactivity Disorder; Mean (SD, Variance). a) Mann-Whitney; b) Qui-Square; c) ABEP,2003; d) IQ, FDI, PSI: cut point <80; FDI: Freedom of distractibility index; PSI: Process speed index. p<0,05.

Figure 1. *Number of words (mean + S.E.M.) generated by the ADHD and control subjects for each single letter, including F, A and S, and the sum of them (ΣFas), during performance of the FAS test, and for the SVF test involving the category "animals". * p< 0.01, ** p < 0.001*



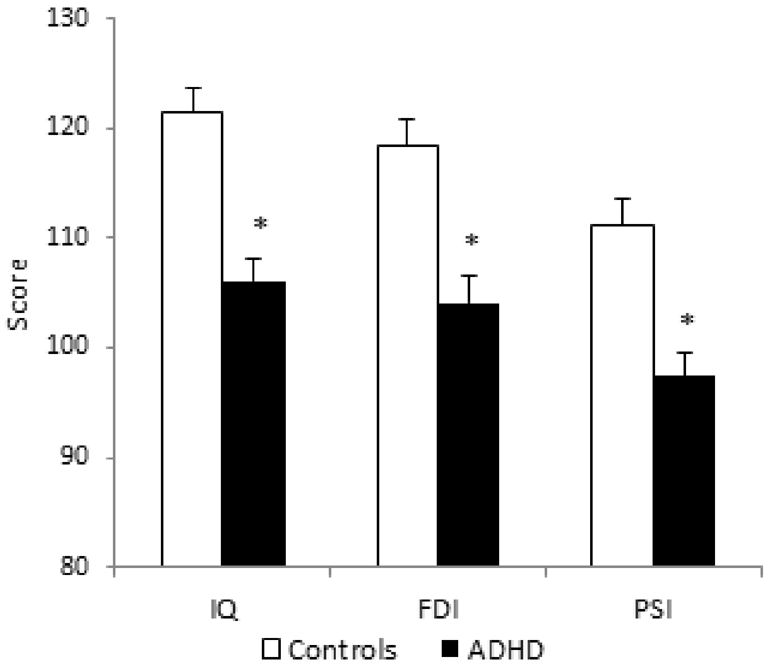
these scores. As can be seen, performance of the ADHD subjects in the WISC-III test was much poorer as compared to that of the Control subjects (**Figure 2a** and **table 2**). In addition, ADHD subjects exhibited a greater number of commission errors (CE) in the TAVIS-3 as compared to Control subjects (**Figure 2b** and **table 2**). It was included a Cliff' delta for each measure. Scores on F, ΣFAS, total IQ, freedom from distractibility index (FDI) and processing speed index (PSI) were much higher for control group than ADHD group. Commission errors index(CE) were moderately lower for control group than for ADHD group. Discriminant validity

Table 2. *ADHD and control groups performance on verbal fluency, intelligence and attention tests*

Batteries	Tests	Mean (S.E.M.)		*d*	U	Z	p
		Controls	ADHD				
Verbal Fluency	1. F	11.86 (0.54)	7.83 (0.38)	.70	289.50	-5.60	<0.001
	2. A	11.00 (0.51)	8.30 (0.42)	.45	517.50	-.3.65	<0.001
	3. S	9.67 (0.54)	7.37 (0.47)	.36	555.50	-3.19	0.01
	4. ΣFAS	32.54 (1.30)	23.51 (0.99)	.58	346.00	-4.99	.001
	5. SVP	19.51 (0.56)	17.37 (0.62)	.32	643.00	-2.58	0.01
WISC-3	6. IQ	121.56(2.12)	106.06 (2.04)	.66	315.00	-5.35	<0.001
	7. FDI	118.51(2.32)	104.09(2.50)	.55	419.00	-4.37	<0.001
	8. PSI	111.16(2.47)	97.41(2.22)	.49	476.00	-4.00	<0.001
TAVIS-3	9. MRT	0.43 (0.00)	0.45 (0.01)	-.10	726.50	-0.83	0.407
	10. OE	2.70(0.31)	3.13(0.33)	-.16	677.50	-1.32	0.186
	11. CE	0.51(0.14)	2.27 (0.38)	-.42	381.50	-4.33	0.001

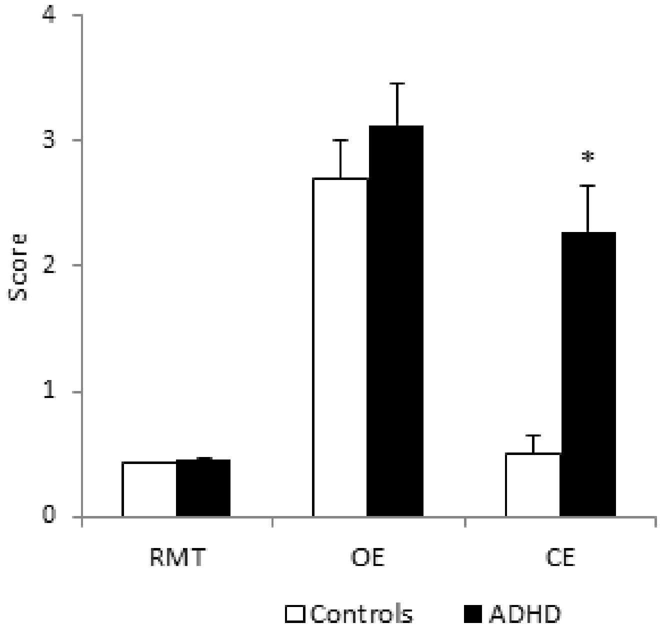
Scores achieved (mean and S.E.M.) by the ADHD and Control subjects for (1) each single letter, including F, A and S, and the sum of them (ΣFAS), during performance of the FAS test, (2) the SVF test involving the category "animals", (3) the intelligence quotient (IQ), freedom from distractibility index (FDI) and Process Speed Index (PSI) of the WISC-III test, and (4) the mean reaction time (MRT), omission errors (OE) and commission errors (CE) in the TAVIS-3 Test, and respective Mann Whitney U Test comparing Groups scores in each of these test. *d* is Cliff'delta for non-parametric data. All comparisons conidering p<0.05

Figure 2a. *Score (mean + S.E.M.) generated by the ADHD and control subjects for IQ: intelligence quocient; FDI: Freedom from distractibility index ; PSI: Processing speed index, during performance of the WISC-3 * p<0,001*



for performance of ADHD and Control subjects in the verbal fluency tests was analysed using ROC curves (**Figure 3**). As can be seen, the best discriminants are achieved, successively, for scores related to generation of words starting with the "F" letter in the FAS test (ROC area = 0.84, P < 0.001), ΣFAS (ROC area = 0.81, P < 0.001), "A" letter (ROC area = 0.72, P < 0.001) and "S" letter (ROC area = 0.69, P < 0.001). Interestingly,

Figure 2b. *Score (mean + S.E.M.) generated by the ADHD and control subjects for RMT: Mean reaction time; OE: Omission errors; CE: Comission errors during performance of the TAVIS-3 test* p < 0.001*



the weaker discriminant was achieved for the scores related to generation of word in the SVF test (ROC area = 0.65, P < 0.015). **Table 3** shows Spearman correlation analyses including scores of both ADHD and Control subjects in the FAS (F, A, S letters and ΣFAS were included), WISC-III (IQ, FDI and PSI were included) and TAVIS-3 (MRT, OE and CE were included) tests. As can be seen, several significant positive and negative correlations were found, indicating that these tasks are tagging corresponding functions. For instance, all the verbal fluency tests had significant and direct correlation with between then. Significant and direct correlation (p<0.001) was found between verbal fluency tests and IQ (F=.49, A= .46, S=. 35, ΣFAS= .51 and SVF= .27) and FDI (F=.31, A= .42, S=. 32, ΣFAS= .40 and SVF= .23). A significant and inverse correlation was showed for letters and commission errors on sustained attention (F=-.36, S= -.25). An inverse correlation was presented for ΣFAS and commission errors either (-0,33). No other significant associations were shown for SVP with factors analyzed. As expected, the stronger correlation of verbal fluency measures was found for F and ΣFAS (0,84, p<0,001). We added an analysis of covariance (ANCOVA), controlling years of education, IQ and gender. Education had influenced only results on reaction time (MRT), with no other influence on all measures. When we considered IQ, the results were significant for all measures, excepting SVF and F and

Figure 3. *Areas under the ROC curves for verbal fluency tests: phonological tests: letters F, A, S, ΣFAS and SVP: Semantic verbal fluency*

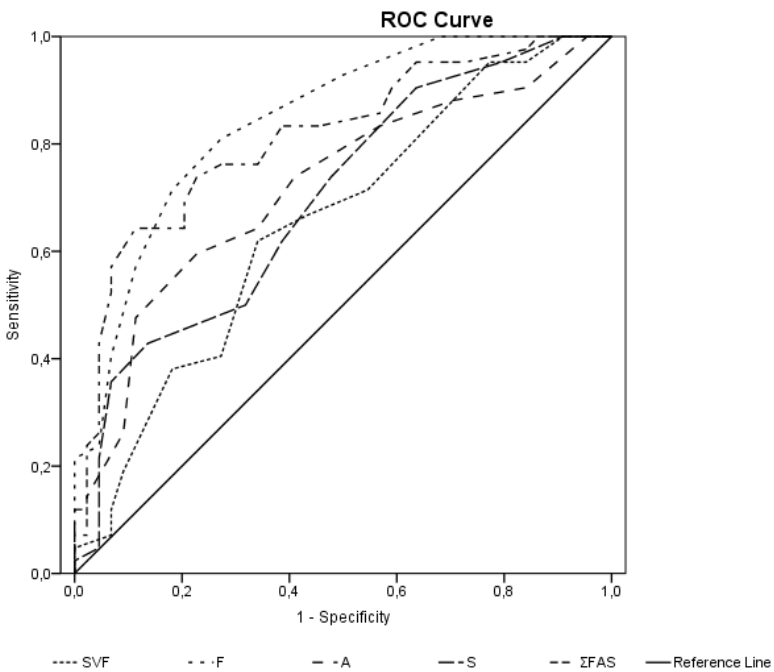


Table 3. *Correlations between verbal fluency tests, IQ and attention scores*

			1	2	3	4	5	6	7	8	9	10	11	ANCOVA Education	ANCOVA IQ	ANCOVA Gender
Verbal Fluency	1.	ΣFAS	—	.84**	.83**	.78**	.45**	.51**	.40**	.17	-.09	-.04	-,33**	.50	.003*	.87
	2.	F		—	.61**	.47**	.38**	.49**	.31**	.13	-.13	-.02	-,36**	.61	.09	.95
	3.	A			—	.46**	.40**	.46**	.42**	.21	.01	-.07	-,17	.69	**	.54
	4.	S				—	.30**	.35**	.32**	.05	-.15	.04	-,25*	.15	.06	.87
	5.	SVF					—	.27*	.23*	.15	-.06	.02	-,06	.08	.45	.97
WISC-3	6.	IQ						—	.64**	.53**	.16	-.37**	-,40**	.31	—	.89
	7.	FDI							—	.38**	.03	-.35**	-,22*	.36	.12	.78
	8.	PSI								—	.17	-.28*	-,27*	.20	.06	**
TAVIS-3	9.	MRT									—	-.44**	-,02	**	.03*	.91
	10.	OE										—	,18	.63	**	.18
	11.	CE											—	.06	**	.73

ΣFAS: F+A+S; F: F letter verbal fluency; A: A letter verbal fluency; S: S letter verbal fluency; SVP: semantic verbal fluency (animals); IQ: intelligence quotient; FDI: freedom from distractibility index; PSI: Process Speed Index; RMT: reaction mean time selective attention; OE: omission errors on shifted attention; CE: commission errors on sustained attention; Spearman correlation, Analysis of Covariance, * p< 0,05. ** p< 0,001.

S letters fluency. Finally, once we have more boys than girls with ADHD and more girls than boys in the control group, the ANCOVA was performed. No influence was found for all the measures, excepting speed processing index.

Discussion

The present study shows criterion validity using discriminant validity analysis for semantic and phonemic verbal fluency tests, comparing the results of Attention Deficit/Hyperacitivity Disorder and healthy adolescents. As predicted, we have found that F letter verbal fluency test and ΣFAS showed a larger area under the curve ROC than SVF test. These results confirm that FAS is a good test to neuropsychological assessment of adolescents with ADHD, allowing comparisons with typical development adolescents.

This is the first study of criterion validity for verbal semantic and phonological fluency tests using an ADHD teenager sample in Brazil. It is very important to have it, considering that letters used on phonemic tests may imply differences on final scores depending on language and education effects (Barry et al. 2008, Mungas et al. 2011). We did not find education effects on FAS and SVF tests results. Cross-cultural differences have not been demonstrated on semantic verbal fluency scores (Mok et al. 2007, Ostrosky-Solisket al. 2007).

Our results showed that ADHD adolescents with normal cognitive functioning measured by IQ produce fewer words on 1 minute SVP and 1 minute FAS tests. Our results are in contrast with Silveira et al. (2009) study that did not found differences on SVP and FAS tests for 7-12 years old children. Age and level of education have direct and strong association with performance on verbal fluency tests as shown in a Brazilian normative study (Brucki et al. 1997) and in the elegant meta-analytic study of FAS and its variant Benton COWA either (Barry et al. 2008). Some discussion has been proposed about equivalence of FAS and COWA phonemic tests. A study of Lacy et al. (1996) with 287 patients with neuropsychological complaint showed a high correlation between the two phonemic tests scores showing that FAS and COWA are useful for verbal fluency assessment. But on these studies the differences on level of education were in terms of levels of educations. The difference we found in the present study was really lower with only few months of difference. Thus, we think, considering all the other results of ADHD group on IQ and attention tests that verbal fluency discriminant differences only on phonological results were not a result of the low difference on years of education, but as showed through the ANCOVA analyses, results on FAS were dependent of IQ. Both groups, ADHD and control had IQ level over one hundred. IQ level influenced FAS results, but not SVF performance. In despite of this difference, our study showed that FAS was satisfactory to assess ADHD and normal adolescents' verbal fluency.

Few studies about normative data for one-minute SVF and FAS tests have been reported for children and adolescents. In contrast, more studies for adults have been published for norms (Passos et al. 2011) or clinical profiles, for example, analyzing Alzheimer's and Parkinson's patient performance (Araujo et al. 2011). Norms for Brazilian adults on SVF (Brucki et al. 1997, Brucki and Rocha 2004) are well established. Norms on Canada (Troyer 2000) were proposed for adults. Harrison, Buxton , Husain and Wise (2000) have proposed normal performance scores, validity and test-retest validity of SVP, PVF complete test and a single letter "B" for use in United Kingdom. IQ, age, years of education and sex were considered and compared in correlations. No sex effect was found and a small correlation between age and verbal fluency tests was found for SVP, but not PVF. Years of education showed a modest correlation with SVP and PVF. Interestingly, test-retest validity shows a good correlation between letter B and PVF complete test. These results are similar to our study, where better results on discrimination for FAS test and F letter verbal fluency tests were found. In fact, F letter alone had the higher area under ROC, even than ΣFAS. This result suggests that, in the Brazilian context, F letter test only is sufficient to assess PVF, without the use of the other letters test (A and S).

Our results show a larger performance on number of words than investigation with ADHD children

8-9 years ADHD, a result that may be dependent on lexical development, clustering and phonemic and semantic switch (Halpern et al. 2011). Older children and adolescents are more able to produce more words and to switch between categories. The present results corroborate other works that show this control ability acquired with age seems to count to produce more clustering and higher scores on verbal fluency tests (Brucki and Rocha 2004, Tallberg et al. 2011).

FAS and SVF verbal fluency tests scores seems to be lower for ADHD groups. López-Campos et al. (2005) have found lower scores for both tests with 8 years ADHD children. The results showed differences between the three subtypes of ADHD and controls. Additionally they have applied other tests of executive function (EF) and the results showed an association EF tests and FAS/SVF. FAS test has been recognized as a measure of EF. In contrast SVP test results have been more associated with semantic memory (Perret 1974). A Mann-Whitney U comparison in our study showed that FAS and SVP scores were lower for ADHD group than controls, but with a higher difference of performance on FAS test. Besides, a moderated correlation was found for ΣFAS and SVP. Once we assessed ADHD adolescents to analyze discriminant validity of these tests, it is possible that this correlation is dependent on a more general IQ functioning, once ADHD participants had a lower IQ and FDI.

A direct and moderate correlation between F and ΣFAS with FDI shows that PVF tests are very dependent on executive function It is very important on ADHD neuropsychological assessment, once these patients has clearly EF impairments. F and ΣFAS tests showed larger area under ROC values, and were consequently more discriminant than A, S and SVP tests. An elegant review that investigated ADHD effects on executive functions showed greater phonemic fluency impairments (weighted effect size .68) when compared to semantic fluency (.34) (Walshaw et al. 2010). Our results suggest PVF tests may be useful for ADHD neuropsychological assessment and corroborate other studies that show more impairments for PVF than SVF tasks on ADHD (Geurts et al. 2004, Happe et al. 2006).

Finally our results have showed an inverse correlation between F/ ΣFAS and commission errors. Commission errors are linked to inhibition impairment and are dependent on frontal lobe areas. Our impression is once there is a deficit for block thinking intrusion, a number of productive PVF is decreased as a result of non-controlled thinking. These findings contribute to discriminant validity of verbal fluency tests compared with other tests of executive functions. Further investigations should help to analyze this correlation and should count for understand ADHD lower performance on PVF tests.

Our study showed some limitations. A reduced sample did not allowed a normal distribution. In despite of that, different and marked results were found for ADHD and control group. ROC analysis was possible and discriminant validity was conducted. These results showed that ADHD and typical development adolescents perform differently on SVF and PVF tests and suggest that F and ΣFAS scores are sufficient to assess verbal fluency in a neuropsychological assessment. Notwithstanding different results on semantic verbal fluency test, SVP had the lower area under the curve ROC. Implications for neuropsychological assessment were presented and indicate that on ADHD assessment, F and ΣFAS are useful instruments for supplementary ADHD diagnostic with Brazilian adolescents. Further investigation with others age groups and neurological and psychiatric diseases may contribute to the utility of FAS and SVP on neuropsychological assessment.

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