Reliability study of the Behavioral Assessment of the Dysexecutive Syndrome adapted for a Brazilian sample of older-adult controls and probable early Alzheimer's disease patients

Um estudo de confiabilidade da Bateria de Avaliação da Síndrome Disexecutiva adaptada para uma amostra brasileira de idosos controles e pacientes com doença de Alzheimer provável em fase inicial

Fabíola Canali,[1] Sonia M. D. Brucki,[2,3] Paulo H. F. Bertolucci,[2] Orlando F. A. Bueno[2]

[1] Postgraduate student, Department of Psychobiology, Universidade Federal de São Paulo (UNIFESP), São Paulo, SP, Brazil
[2] Universidade Federal de São Paulo (UNIFESP), São Paulo, SP, Brazil
[3] Hospital Santa Marcelina, São Paulo, SP, Brazil

Abstract

Objective: Ecological tests are useful in assessing executive function deficits and may be of value in appraising response to treatment in Alzheimer's disease patients. Our aims were to examine executive function using the Behavioral Assessment of the Dysexecutive Syndrome for a Brazilian sample of older-adult controls and probable early Alzheimer's disease patients, and verify the applicability of this test battery. **Method:** Forty-one older-adult controls were matched with mild Alzheimer's disease patients by age, education, and gender. **Results:** There significant inter-group differences in overall profile and almost all subtests except temporal judgment, time spent on planning the first and second Zoo Map visit, number of errors when copying drawings, naming pictures and Six Modified Elements arithmetic, and dysexecutive questionnaire self-rating. The Behavioral Assessment of the Dysexecutive Syndrome item that best discriminated controls from patients was the Modified Six Elements - adapted (general index), with a sensitivity of 80% and specificity of 90%, (AUC = 0.91, $p < 0.001$). **Conclusion:** Behavioral Assessment of the Dysexecutive Syndrome was effective in detecting executive function deficits in mild Alzheimer's disease patients, particularly the task switching, time monitoring, and rule-shift subtests.

Descriptors: Alzheimer's disease; Executive functions; Dementia; Signs and symptoms; Neuropsychological tests

Resumo

Objetivo*: Testes ecológicos são os mais indicados para a avaliação dos déficits nas funções executivas, sendo importante também na avaliação da resposta ao tratamento de pacientes com doença de Alzheimer. O objetivo deste estudo é verificar o desempenho nas funções executivas usando a* Behavioural Assessment of the Dysexecutive Syndrome *em uma amostra brasileira de idosos controles e pacientes com doença de Alzheimer provável em fase inicial e a aplicabilidade desta bateria ecológica em nosso meio.* ***Método****: Avaliamos com a* Behavioural Assessment of the Dysexecutive Syndrome *41 idosos controles e 41 pacientes com doença de Alzheimer provável em fase inicial, sem diferença estatisticamente significativa em relação à idade, escolaridade e sexo.* ***Resultados****: Houve diferença estatisticamente significativa entre os grupos no escore total e em quase todos os subtestes da* Behavioural Assessment of the Dysexecutive Syndrome, não *ocorrendo o mesmo no subteste de Julgamento Temporal, no tempo gasto no planejamento da primeira e segunda visita no Mapa do Zoológico, no número de erros ao copiar os desenhos, na nomeação de figuras e na aritmética do Seis Elementos Modificado e no questionário disexecutivo autoavaliação.* ***Conclusão****: A* Behavioural Assessment of the Dysexecutive Syndrome *mostrou-se eficaz na detecção dos déficits em funções executivas em pacientes com doença de Alzheimer provável em fase inicial, particularmente em tarefas de alternância, monitoramento de tempo e subtestes de mudanças de regras.*

Descritores*: Doença de Alzheimer; Funções executivas; Demência; Sinais e sintomas; Testes neuropsicológicos*

Introduction

Dementia prevalence in Brazil ranges from 7.1% to 12.9%, Alzheimer's disease (AD) being the most frequent cause and accounting for 55.1% to 59.8% of cases.[1,2] AD presents a heterogeneous clinical condition with variable cognitive

Correspondence
Sonia M. D. Brucki
R. Rio Grande, 180 / 61
04018-000 São Paulo, SP, Brazil
Phone/Fax: (+ 55 11) 5579-7104
Email: sbrucki@uol.com.br

Submitted: August 3, 2010
Accepted: January 21, 2011

alterations; episodic memory deficit is usually the initial and most pronounced symptom, and other cognitive functions are progressively affected.

Some reviews of the literature on executive function (EF) alterations in AD patients found impairment of the four EF components[3,4] described by Lezak[5]: volition, planning, intentional actions, and effective performance, using formal neuropsychological tests such as clock drawing, verbal fluency, trail making parts A and B, and the Stroop test. A recent study by Espinosa et al. concluded that Behavioral Assessment of the Dysexecutive Syndrome (BADS) was an appropriate means of detecting executive deficits in early AD.[6] The battery was developed by Wilson et al. to evaluate subjects with executive deficits and the tasks used pose cognitive demands similar to those found in everyday living.[7] It was appropriate for assessing EF when compared with traditional neuropsychological tests.[8-12] A differential is its ability to assess several executive functions in a relatively short time (approx. 40 minutes), and it may be used to provide guidance for rehabilitation programs.[11] In Brazil, however, there are no reports of using BADS to assess EF in early AD cases. We believe this test will be highly useful for assessing EF ecologically and helping to advise caregivers in relation to about daily living activities.

Objective

The present study used BADS (Brazilian version)[7] to assess EF performance in older-adult controls and probable-early AD patients, verify its applicability and sensitivity, and compare scores to traditional neuropsychological tests used in Brazil.

Method

1. Participants

We assessed 41 probable early AD patients from two specialized outpatient memory clinics (Hospital São Paulo (HSP) and Hospital Santa Marcelina (HSM)), all meeting NINCDS-ADRDA[13] and DSM-III criteria (for severity).[14] The healthy control group consisted of 41 elders living in community meeting the following inclusion criteria:

• Mini-Mental State Examination (MMSE) scores (S) equal to or higher than median values for persons of similar schooling (Y) in our milieu (1<Y<5 & S>25; 5<Y<9 & S>26,5; 9<Y<12 & S>28; 12<Y & S>29);[15]

• Functional Activity Questionnaire (FAQ)[16] scores below 2 points;

• No psychiatric and / or neurological complaints.

Both groups comprised individuals aged over 60 with at least four years schooling, both genders, scoring not more than 6 points on the 15-item Geriatric Depression Scale (GDS),[17] with corrected auditory or visual deficits, and no motor problems (due to orthopedic or rheumatic causes). A session lasting one and a half hours was arranged for a specific date to apply our research protocol of formal tests (random order) followed by the BADS.

The study was approved by the Research Ethics Committees at Hospital Santa Marcelina and UNIFESP (Case 0540/05). Volunteers and their caregivers were informed of the purpose of the study and signed a consent form.

2. Formal neuropsychological assessment

A formal comprehensive neuropsychological assessment was made consisting of the following:

• Forward Digit Span and Backward Digit Span[18] tests of short-term verbal memory and working memory.

• Brief Cognitive Screening Battery (BCSB)[19] - naming, visual perception, incidental memory, immediate memory, learning, delayed recall (after five minutes) and recognition (maximum score of 10 for each task).

• Trail Making Test[5] (parts A and B) – selective attention, motor speed, switching ability and inhibitory control.

• Stroop Test[5] – inhibitory control, vulnerability to interference and task switching ability.

• Verbal Fluency - Animal Category[20]: number of animals during 60 seconds; Action fluency[21]: 60 seconds, as many words as possible that indicate what a person can do, without using the same word for different combinations (e.g. eat, eating, eater), just one word instead of a sentence (e.g. eat, smell, etc.); Letter cancelling[22]: 60 seconds, as many words as possible except those starting with E and then A. These tests assess inhibitory control, switching ability, organization of thought and processing speed.

• Luria Motor Test[5]: sequence of three positions (wrist - palm - side of the hand) with the dominant hand. Three points are scored when the task is performed correctly on the first attempt, 2 points the second and 1 the third.

• Clock Test[23] - comprising two parts: Clox 1 and 2: verifying executive functions and visuoconstructive skills.

3. Ecological assessment of executive functions

The BADS consists of six subtests (maximum score four points each, overall profile score 24 points) and a questionnaire with two versions (patient and caregiver). An overall rating is obtained: impaired, borderline, low average, average, high average, superior. This battery assesses EFs such as inhibitory control, switching and updating ability, problem solving, searching for new strategies, judgment and abstract thought, planning (formulating and executing), organizing and monitoring behavior, using the following subtests:

• Rule Shift Cards - tests inhibitory control and switching ability.

Action Program - tests the ability of the subject to develop a plan to solve a new problem.

• Key Search - tests the ability to formulate effective strategy and extract implicit information from a situation in which subjects may monitor their own performance and modify it if they feel this is necessary.

• Temporal Judgment - comprises four questions on the duration of common events, asking the individual to estimate times. Tests abstract judgment and thinking.

• Zoo Map – comprises two parts, in both subjects are asked to plan and obey rules to visit six of twelve places in a zoo (we used giraffes instead of llamas, since the latter are not well known in

Brazil, and subjects had difficulty in pronouncing the word) while obeying certain rules shown above the zoo map. It tests planning (formulating and executing a plan).

• Adapted Modified Six Elements test[24] - In the original test, the subject has ten minutes (counted by a timer) to perform three different tasks (dictate personal events to a recorder, write names of figures and do arithmetic calculations using pencils, sheets of paper and rubber), divided into two parts (A and B), following rules written on an A4-size card placed at their side. We used the modification devised by Gouveia et al.[24] in which the first task (dictating personal events) is replaced by copying geometric designs in order to avoid embarrassing subjects unable to use a recording device, since most were from socially and culturally deprived backgrounds, and we decided to present similar tasks (all presented in blocks). Furthermore, the presentation of the original instructions was adapted to help AD patients understand the task and use mnemonics. The latter were placed in front of the subject on a card with two rules: (1) Do not do parts A and B of the same task one after the other; (2) Do not leave any block without doing at least a little of the block; and another card with the time for the task. Our scoring was based on the original approach emphasizing planning errors (total subtasks completed and total number of rules broken) and the one proposed by Gouveia et al.[24] which includes intra-task errors (copying a figure, naming and arithmetic) and the total number of items completed during the test, to produce an overall index. Subjects' ability to manage time, plan, organize and monitor their behavior was assessed.

4. Assessment of Behavioral Symptoms (Caregivers that have been living with patients filled out behavioral questionnaires)

• Neuropsychiatric Inventory (NPI)[25]: Consisting of 12 behavioral domains (responded by caregiver). Maximum score 144 points.

• The BADS Dysexecutive Questionnaire (DEX) was used in two versions: DEX self-rating (patients) and DEX independent (caregivers) scales, consisting of 20 questions on the frequency of difficulties associated with dysexecutive syndrome as experienced by subjects in day-to-day living, maximum score 80 points on each questionnaire.

5. Statistical analysis

The Mann-Whitney U test (non-parametric) was used to detect difference between AD and control groups in relation to age and education variables, and test scores. Fisher's exact test was used for analysis of difference between genders in the groups and chi-square exact to find whether groups differed significantly on the overall BADS classification. Spearman's correlation test was used to investigate the relationship between total BADS and DEX with neuropsychological tests and scales, and results were adjusted using the bonferroni correction. The ROC curve was analyzed to determine which test best discriminated patients from controls (sensitivity and specificity). We used the Statistical Package for Social Sciences (SPSS), version 13.0 and Rv 5.1.1.

Results

There was no statistically significant differences between patients and controls in age (patients mean = 72.59, SD = 5.35 [range 60 to 83 years]; controls mean = 70.15, SD = 5.26 [range 61 to 82]; p = 0.06), years of education (patients mean = 8.83, SD = 5.31 [range 4 to 19]; controls mean = 10.17, SD = 4.48 [range 4 to 19]; p = 0. 23, Mann-Whitney test), or gender (Fisher's exact test, p = 0.82), with 58.54% (n = 24) and 63.41% (n = 26) of females on patient and control groups, respectively. There was a difference between groups in relation to depressive symptoms, with patients showing more symptoms (Mann-Whitney test, $p < 0.001$).

Patients and controls showed significant different performances on all neuropsychological tests, except Forward Digit Span, Trail A (number of errors), naming drawings on BCSB, and number of errors on Stroop Part I and II (Table 1). Co-variation by scores on GDS, all the results mentioned above remained similar except for Clox 2, where the difference disappeared.

Table 2 compares patient and control groups on the Ecological Assessment; the only parameters not showing significant differences were: (1) Temporal Judgment score; (2) Time spent on planning the second Zoo Map visit; (3) Number of errors when copying drawings, naming pictures and Six Modified Elements arithmetic; (4) DEX self-rating. All the abovementioned results remained similar after controlling by GDS scores, except the time spent planning the second Zoo Map visit, in which a significant difference emerged. Differences disappeared for: (1) score for execution and total errors on the second Zoo Map visit; (2) breaking rules of the Modified Six Elements.

We found that both formal tests for assessing EFs and BADS showed significant differences between the two groups in a similar way, except for poor performance on Temporal Judgment from both groups.

On the overall BADS rating, the groups differed ($p \leq 0.01$), with most patients (n = 26) rated impaired and the controls (n = 22) average (Table 3).

Correlations between BADS sub-scores and overall profile were weak or statistically insignificant for the patient group, except for overall profile on BADS and MMSE, CLOX 1 and 2, time on TMT-A, and number of errors on Stroop part 3. Strong correlations were observed between BADS overall profile and Rule Shift Cards, Modified Six Elements - Original Score and General Index, and time on Trail Making (part B) for the control group. Neither group showed significant correlation between BADS and FAQ and NPI depression scale (Table 4).

The Spearman correlation between total DEX self-rating and formal ecological neuropsychological assessment and depression scale and FAQ in the control group showed significant correlations, though low, only on some tests (Luria Test, r = -0.45; Clox 1, r = 0.45; Rule Shift Cards, r = 0.36). There was no correlation between results on the executive questionnaire, FAQ and depression scale. For the AD patients, Spearman's correlation between total DEX (self-evaluation and independent) and NPI with other evaluations showed strong correlations between DEX independent and FAQ

Table 1 - Groups compared on formal, mood and functional neuropsychological tests

Variable	Group						Mean comparison test
	Alzheimer			Control			
	Mean	Standard deviation	n	Mean	Standard deviation	n	p-value*
Mini Mental State Exam	23.83	2.76	41	28.17	1.41	41	≤ 0.01
Forward Digits	4.46	1.00	41	4.88	1.08	41	0.07
Backward Digits	2.90	0.94	41	3.66	0.73	41	≤0.01
Letter Canceling (E)	12.85	4.32	41	18.90	6.09	41	≤0.01
Letter Canceling (A)	11.78	4.76	41	18.34	5.26	41	≤0.01
Action Verbal Fluency	9.46	3.96	41	15.71	5.59	41	≤0.01
Verbal Fluency – Animals	10.41	2.69	41	17.68	4.25	41	≤0.01
Trails A- Errors	0.20	0.46	41	0.17	0.50	41	0.58
Trails A - Time (in seconds)	106.37	60.80	41	53.80	22.52	41	≤ 0.01
Trails B – Errors	2.18	1.38	33	0.88	1.05	41	≤ 0.01
Trails B - Time (in seconds)	271.35	165.91	33	159.90	93.75	41	≤0.01
Brief Cognitive Battery- Naming	9.98	0.16	41	9.98	0.16	41	1.00
Brief Cognitive Battery -Incidental	3.66	1.64	41	5.83	1.39	41	≤ 0.01
Brief Cognitive Battery - Immediate 1	5.37	1.43	41	7.93	0.98	41	≤ 0.01
Brief Cognitive Battery-Learning	5.80	1.50	41	8.80	1.19	41	≤ 0.01
Brief Cognitive Battery - Delayed Recall	2.90	2.49	41	7.80	1.57	41	≤ 0.01
Brief Cognitive Battery-Recognition	8.24	2.02	41	9.98	0.16	41	≤ 0.01
Stroop Part I-Time (in seconds)	31.63	20.01	39	18.93	4.60	41	≤ 0.01
Stroop Part I – Errors	0.18	0.81	39	0. 00	0. 00	41	0.08
Stroop Part II - Time (in seconds)	43.05	22.27	39	25.90	8.10	41	≤ 0.01
Stroop Part II – Errors	0.26	0.75	39	0.20	1.10	41	0.22
Stroop Part III - Time (in seconds)	69.54	36.43	39	41.61	13.61	41	≤ 0.01
Stroop Part III – Errors	5.18	5.92	39	1.32	2.07	41	≤ 0.01
Luria Test (wrist – palm - side)	1.44	1.12	41	2.27	1.00	41	≤ 0.01
Clox 1	11.56	3.28	41	13.34	1.09	41	≤ 0.01
Clox 2	12.90	2.80	41	14.10	0.80	41	≤0.01
FAQ	10.87	7.97	39	0.07	0.47	41	≤ 0.01
Depression Scale	3.10	1.58	41	1.51	1.58	41	≤ 0.01
Neuropsychiatric Inventory	14.90	20.30	39	_	_	_	_

** Mann-Whitney Test; p-value significant at one level ≤ 0.05.*

(r = 0.58), NPI and FAQ (r = 0.50). Our analysis of ROC curves (Table 5) was able to discriminate the control group from the patients through the cut-off value for variables (greatest value summing sensitivity and specificity for each variable). BADS scores were useful for discriminating between controls and early AD patients, in particular on the following scores: Rule Shift Cards, Action Program, Zoo Map, Modified Six Elements (original score and general index) and BADS total profile.

Discussion

Early AD patients and older adult controls differed on EF tests, showing impaired cognitive skills required for the proper performance, such as updating, task switching and inhibition, and taking longer to do tests. Some studies have shown that these tests are highly sensitive for diagnosing dementia and detecting executive impairment in early AD.[3,4,22,23,26-28]

These results demonstrate early EF alterations in early AD patients, who also performed worse than the control group on the BADS (all subtests), and were mostly rated as impaired. A similar result was found by Amanzio et al. using the BADS on AD patients as part of a cognitive testing procedure to examine the relationship between performance on the latter and comprehension of metaphors.[29] Amanzio et al. found that 95% of patients presented EF deficits, most of them rated impaired on their BADS overall profile, presenting difficulties on all subtests (even those in which there was no difference in our results, such as Temporal Judgment).[29] The Temporal Judgment test was the only BADS subtest that showed no significant difference for our sample. This finding may be due to cultural differences, as was the case of the BADS validation study for Australians.[10] Wilson et al. emphasize that because of its high cultural influence, this subtest is optional and does not affect the validity of the battery. In our case, both groups performed badly on this task.[7]

The Zoo Map showed good discriminative ability between patients and controls, particularly in the controls' ability to formulate and execute a predetermined plan. There was no difference between the groups in relation to planning time on the second zoo visit, although patients took longer to execute and made more mistakes. In the study by Allain et al.[30] AD patients differed from the control group on the first task in Zoo Map, for which their planning time was shorter, while for the second task it was longer, but on both tasks they made more mistakes and took longer. Our results corroborate those of Allain et al. who suggest that AD patients have planning difficulties not only in solving complex problems but also in following predetermined plans.[30] These data may provide important parameters for designing

Table 2 - Groups compared on BADS and DEX (self-rating and independent)

Variable	Group						Mean comparison tests
	Alzheimer			Control			
	Mean	Standard deviation	n	Mean	Standard deviation	n	p-value*
Rule Shift Cards	1.12	1.19	41	2.88	1.23	41	≤ 0.01
Action Program	2.05	1.50	41	3.39	1.02	41	≤ 0.01
Key Search	0.90	1.00	41	1.51	1.10	41	≤ 0.01
Temporal Judgment	2.00	0.89	41	2.00	0.87	41	0.86
Zoo Map	1.12	1.12	39	2.27	1.27	41	≤ 0.01
Formulation of plan (1st visit)	-0.44	4.43	39	2.98	3.74	41	≤ 0.01
Planning time (in seconds)	39.28	98.78	39	67.15	105.68	41	0.01
Execution time (in seconds)	374.64	205.85	39	167.80	94.26	41	≤ 0.01
Total errors	4.41	3.42	39	1.68	1.77	41	≤ 0.01
Follow predetermined plan (2nd visit)	5.56	2.92	39	6.80	2.12	41	0.02
Planning time (in seconds)	1.13	7.05	39	8.93	28.24	41	0.10
Execution time (in seconds)	206.38	161.66	39	84.49	42.61	41	≤ 0.01
Total errors	1.26	1.62	39	0.61	1.30	41	0.02
"Modified Six Elements " - Original Score	2.29	1.10	39	3.54	0.71	41	≤ 0.01
“Modified Six Elements” - Overall index	0.50	0.83	39	2.52	1.60	41	≤ 0.01
Total items	20.00	12.43	39	50.29	19.16	41	≤ 0.01
Total subtasks	5.40	1.10	39	5.85	0.79	41	0.01
Rule Breaking	3.83	3.99	39	0.63	0.94	41	≤ 0.01
Figure copying errors	0.53	0.91	39	0.44	0.84	41	0.71
Figure naming errors	0.68	1.12	39	0.68	0.93	41	0.56
Arithmetical errors	0.40	0.84	39	1.46	3.41	41	0.23
BADS - Total profile	9.51	4.09	41	15.58	3.24	41	≤ 0.01
DEX self-rating – Total	17.17	10.89	41	12.98	9.44	41	0.08
DEX independent – Total	29.58	16.76	40	-	-	-	-

** Mann-Whitney Test; p-value significant at one level ≤ 0.05.*

neuropsychological rehabilitation programs and for caregiver guidance, since reorganization techniques such as restructuring of functional activities in small steps are frequently used, but they must be inserted carefully. Allain et al. also failed to find any correlation between Zoo Map scores and severity of dementia or patient autonomy.[30]

Our control group showed greater difficulty in formulating a plan than executing, which is similar to the findings of Allain et al. in older-adult patients without neurological impairment.[31]

AD patients did fewer items than controls on the “Modified Six Elements” prompting differences in the total score (general index) suggested by Gouveia et al.[24] The absence of difference between groups for visuo-constructive skills, semantic and arithmetic shows that the latter do not have implications for the results (patients slower at completing tasks); this shows that the greatest difficulty for patients was in planning ability and corroborates the Zoo Map results.

The Rule Shift Cards subtest discriminated AD patients from controls better than the Key Search subtest. Lincoln et al. studied dementia patients and controls and found more sensitivity on the Rule Shift Cards than the Key Search, but no difference between groups on this subtest.[32]

The Action Program showed good discriminative ability for our sample. However, the six subtests of the BADS, the Modified Six Elements and the Rule Shift Cards test had more ability to discriminate in our sample, which shows that in early AD tasks assessing inhibitory control, strategy changes, maintaining action and planning may be more sensitive to detect alterations. The

Table 3 - Groups compared on BADS overall rating

Group	BADS overall rating						Total	p-value
	I	B	Ia	a	ha	s		
Alzheimer (%)	26 (63.41)	8 (19.51)	4 (9.76)	0	2 (4.88)	1 (2.44)	41 (100)	
Control (%)	3 (7.32)	4 (9.76)	22 (53.65)	6 (14.63)	6 (14.63)	0	41 (100)	≤ 0.01
Total (%)	29 (35.36)	12 (14.63)	26 (31.71)	6 (7.32)	8 (9.76)	1 (1.22)	82 (100)	

a = average; ha = high average; s = superior.

Table 4 - Spearman correlation between total profile BADS and formal ecological neuropsychological assessment

Variable	Group			
	Control		Alzheimer	
	r-value	p-value	r-value	p-value
Mini Mental State Exam	0.31	0.04	0.50	≤ 0.01
Forward Digits	0.35	0.02	ns	ns
Backward Digits	0.32	0.04	0.37	0.02
Letter Canceling (E)	0.42	≤ 0.01	ns	ns
Letter Canceling (A)	0.41	≤ 0.01	0.35	0.02
Action Verbal Fluency	0.30	0.05	0.46	≤ 0.01
Trails A- Errors	ns	ns	-0.37	0.02
Trails A - Time (in seconds)	ns	ns	-0.60	≤ 0.01
Trails B – Errors	-0.45	≤ 0.01	ns	ns
Trails B - Time (in seconds)	-0.56	≤ 0.01	ns	ns
Stroop Part II -Time (in seconds)	ns	ns	-0.39	≤ 0.01
Stroop Part III (Errors)	ns	ns	-0.51	≤ 0.01
Clox 1	ns	ns	0.51	≤ 0.01
Clox 2	0.35	0.03	0.57	≤ 0.01
Rule Shift Cards	0.62	≤ 0.01	0.36	0.02
Action Program	0.45	≤ 0.01	ns	ns
Modified Six Elements - original score	0.60	≤ 0.01	ns	ns
Modified Six Elements - general Index	0.66	≤ 0.01	0.39	≤ 0.01

ns = correlation not significant; p-value significant at one level ≤ 0. 002.

BADS showed good ability to discriminate AD patients from controls on almost all subtests, except Temporal Judgment.

Spearman's correlation analysis showed that total profile BADS score significantly correlated with most formal tests and their subtests despite low magnitudes in both groups. However correlations between BADS total profile and subtests were lower in the patient group than in the control group, which may be due to AD clinical heterogeneity at same severity. For overall cognitive loss, there was a strong positive correlation in the patient group, suggesting that the severity of dementia affects performance on the BADS. These correlations indicate that the BADS has good construct validity for testing executive dysfunctions. Similar results were found for other diseases.[9-11]

Diminished episodic memory capacity may interfere with tasks that involve EF.[24,27,33,34] However, given the correlations between memory tasks and BADS overall profile, we may infer that card rules placed in front of subjects as mnemonic clues must have minimized the influence of memory on their performance of the tasks.

The reliability and validity of DEX has been studied qualitatively and quantitatively in other countries for various diseases.[7,35-37] Shinagawa et al. used qualitative analysis and found that DEX was a reliable and valid instrument for AD patients in Japan, providing additional data on difficulties in day-to-day living associated with dysexecutive symptoms.[38] The correlations with DEX (self-evaluation and independent) found in the present study suggest the same in our milieu.

Although there is no statistically significant difference on DEX self-rating between patients and controls, patients scored higher and there was significant positive correlation, although low, between total DEX independent and DEX self-rating, suggesting that early AD patients conserve intact perception of difficulties attributed to executive dysfunction in their everyday lives, even when their self-assessment shows they believe they have fewer executive problems than those noted by their caregivers, as reported previously by Allain et al.[30] Loss of insight in AD patients has been related to later stages of the disease.[37,39] However, this impairment seems to appear after an action, turning the patient unable to self-monitor and self-correct during cognitive tasks.

The increase in depressive symptoms (even among individuals who had no scores suggesting depression) had a significant low positive correlation with patients' (DEX self-rating) and caregivers' (DEX independent) perceptions, referring to greater dysexecutive difficulty encountered in patients' everyday lives. This relationship between increased depressive symptoms and patients' perception of their difficulties corroborates findings in the literature.[37,39]

In addition, we found a strong positive correlation between the functional scale, DEX independent and the INP, showing that increased executive dysfunction and behavioral changes are associated with increased functional loss.

We found no correlation between ecological assessment and functional activities (measured by FAQ), probably because patients were able to cope with mild impairments by using external cues and internal strategies. Discrepancies between patient and caregiver responses may be due to overestimates by overburdened caregivers making for different objective and subjective evaluations.[40]

Table 5 - Cut-off values for BADS and DEX (self-rating and independent) in our sample

Variable				CI (95% Confidence Interval)		
	Cut-off	Sensitivity	Specificity	AUC	Limit lower	Limit upper
Rule Shift Cards	2	76%	80%	0.83*	0.74	0.92
Action Program	2	59%	90%	0.75*	0.64	0.86
Key Search	2	85%	46%	0.67*	0.55	0.79
Temporal Judgment	2	27%	73%	0.49†	0.36	0.62
Zoo Map	2	68%	76%	0.75*	0.64	0.85
Modified Six Elements- original Score	2	61%	93%	0.82*	0.72	0.91
Modified Six Elements- general Index	0.75	80%	90%	0.91*	0.84	0.97
BADS - Total Profile	12	83%	83%	0.87*	0.79	0.95
DEX self-rating – Total	18	49%	71%	0.61†	0.49	0.73

** p-value not significant at level < 0.001; ** p-value significant at level ≤ 0.05.*

The performance of our AD patients corroborates Duke & Kaszniak findings[3] on deficits in the three components (planning, intentional action and effective performance) for EF[6] in the early stage of the pathology, whereas volitional capacity relates to progression of the disease, and is initially less severe.

Our results show that the BADS may be suitable for precocious detection of executive deficit in early AD patients, and confirm results from other EF tests, with the advantage of concentrating on various ecologically valid tasks in order to assess executive dysfunctions, providing quantitative and qualitative data of great importance when guiding caregivers and patients, and seeking more efficient strategies to improve quality of life for both. The present study has some limitations given the cultural and educational influences on the Temporal Judgment subtest and the overall BADS rating. Therefore transcultural adaptation and validation studies of the battery are required to show its real effectiveness for assessing dysexecutive impairment in the local population.

Disclosures

Writing group member	Employment	Research grant[1]	Other research grant or medical continuous education[2]	Speaker's honoraria	Ownership interest	Consultant/ Advisory board	Other[3]
Fabíola Canali	UNIFESP	-	-	-	-	-	-
Sonia M. D. Brucki	UNIFESP Hospital Santa Marcelina	-	-	Whyeth Novartis Apsen Janssen	-	-	-
Paulo H. F. Bertolucci	UNIFESP	-	-	-	-	-	-
Orlando F. A. Bueno	UNIFESP	-	-	-	-	-	-

** Modest*
*** Significant*
**** Significant: Amounts given to the author's institution or to a colleague for research in which the author has participation, not directly to the author.*
Note: UNIFESP = Universidade Federal de São Paulo.
For more information, see Instructions for Authors.

References

1. Herrera E, Caramelli P, Silveira ASB, Nitrini R. Epidemiologic survey of dementia in a community-dwelling Brazilian population. *Alzheimer Dis Assoc Disord.* 2002;16(2):103-8.
2. Bottino CM, Azevedo D Jr, Tatsch M, Hototian SR, Moscoso MA, Folquitto J, Scalco AZ, Bazzarella MC, Lopes MA, Litvoc J. Estimate of dementia prevalence in a community sample from São Paulo, Brazil. *Dement Geriatr Cogn Disord.* 2008;26(4):291-9.
3. Duke LM, Kaszniak AW. Executive control functions in degenerative dementias: a comparative review. *Neuropsychol Rev.* 2000;10(2):75-99.
4. Ávila R, Miotto EC. Funções executivas no envelhecimento normal e na doença de Alzheimer. *J Bras Psiquiatr.* 2003;52(1):53-63.
5. Lezak, M. D. *Neuropsychological assessment.* 4th ed. New York: Oxford University Press; 2004.
6. Espinosa A, Alegret M, Boada M, Vinyes G, Valero S, Martinez-Lage P, Penã-Casanova J, Becker JT, Wilson BA, Tarraga L. Ecological assessment of executive functions in mild cognitive impairment and mild Alzheimer's disease. *J Int Neuropsychol Soc.* 2009;15(5):751-7.
7. Wilson BA, Alderman N, Burguess PW, Emslie JJ. *Manual of the behavioural assessment of the dysexecutive syndrome.* Bury St Edmunds U.K.: Thames

Valley Test Company. Trans: Ricardo O. Souza, Sergio L. Schmidt. Rio de Janeiro: Cognição; 1996.

8. Chaytor N, Schmitter-Edgecombe M. The ecological validity of neuropsychological tests: A review of the literature on everyday cognitive skills. *Neuropsychol Rev.* 2003;13(4):181-97.

9. Wilson BA, Evans JJ, Emslie H, Alderman N, Burguess P. The development of an ecologically valid test for assessing patients with dysexecutive syndrome. *Neuropsycol Rehab.* 1998;8:213-28.

10. Norris G, Trate RL. The Behavioural Assessment of the Dysexecutive Syndrome (BADS): Ecological, concurrent and construct validity. *Neuropsychol Rehab.* 2000;10(1):33-45.

11. Bennet PC, Ong B, Ponsford J. Assessment of executive dysfunction following traumatic brain injury: Comparison of the BADS with other clinical neuropsychological measures. *J Int Neuropsychol Soc.* 2005;11(5):606-13.

12. Chamberlain E. Test Review – Behavioural Assessment of the Dysexecutive Syndrome (BADS). *J Occup Psychol Employment Disability.* 2003;5(2):33-7.

13. MacKhann G, Drachman D, Folstein M, Katzman R, Prince D, Stadlan EM. Clinical diagnosis of Alzheimer's disease: report of the NINCDS-ADRDA Work Group under the auspices of the Department of Health and Human Services Task Force on Alzheimer's Disease. *Neurology*. 1984;34(7):939-44.

14. The American Psychiatric Association. *DSM III-R. Manual de diagnóstico e estatística de distúrbios mentais* 3a ed. rev. São Paulo: Manole; 1989.

15. Brucki SMD, Nitrini R, Caramelli P, Bertolucci PHF, Okamoto IH. Sugestões para o uso do Mini-exame do estado mental no Brasil. *Arq Neuropsiquiatr.* 2003;61(3):777-81.

16. Pfeffer RI, Kurosaki TT, Harrah CH, Chance JM, Filos S. Measurement of functional activities in older adults in the community. *J Gerontol*. 1982;37(3):323-9.

17. Almeida OP, Almeida SA. Short versions of the geriatric depression scale: a study of their validity for the diagnosis of a major depressive episode according to ICD-10 and DSM-IV. *Int J Geriatr Psychiatry.* 1999;14(10):858-65.

18. Wechsler D. *Wechsler adult intelligence scale-revised*. New York: Psychological Corporation; 1981.

19. Nitrini R, Lefèvre BH, Mathias SC, Caramelli P, Carrilho PEM, Sauaia N, Massad E, Takiguti C, Da Silva IO, Porto CS, et al. Neuropsychological tests of simple application for diagnosing dementia. *Arq Neuropsiquiatr.* 1994;52(4):457-65.

20. Brucki SM, Malheiros SM, Okamoto IH, Bertolucci PH. Normative data on the verbal fluency test in the animal category in our milieu. *Arq Neuropsiquiatr.* 1997;55(1):57-60.

21. Piatt AL, Fields JA, Paolo AM. Lexical, semantic and action verbal fluency in Parkinson's disease with and without dementia. *J Clin Exp Neuropsychol*. 1999;21(4):435-43.

22. Hughes DL, Bryan J. Adult age differences in strategy use during verbal fluency performance. *J Clin Exp Neuropsychol.* 2002;24(5):642-54.

23. Royall DR, Cordes JA, Polk M. CLOX: an executive clock drawing task. *J Neurol Neurosurg Psychiatry.* 1998;64:588-94.

24. Gouveia PA, Brucki SM, Malheiros SM, Bueno OF. Disorders in planning and strategy application in frontal lobe lesion patients. *Brain Cogn*. 2007;63(3):240-6.

25. Camozzato AL, Kochhann R, Simeoni C, Konrath CA, Franz AP, Carvalho A, Chaves ML. Reliability of the Brazilian Portuguese version of the Neuropsychiatric Inventory (NPI) for Alzheimer's disease patients and their caregivers. *Int Psychogeriatr.* 2008;20(2):383-93.

26. Chen P, Ratcliff G, Belle SH, Cauley JA, DeKosky ST, Ganguli M. Cognitive tests that best discriminate between presymptomatic AD and those who remain nondemented. *Neurology.* 2000;55(12):1847-53.

27. Buckner RL. Memory and executive function in aging AD: multiple factors that cause decline and reserve factors that compensate. *Neuron.* 2004;44(1):195-208.

28. Matioli MNPS. *Estudo comparativo do desempenho em testes neuropsicológicos de pacientes com diagnóstico de doença de Alzheimer e demência vascular* [Dissertação]..São Paulo: Faculdade de Medicina, Universidade de São Paulo; 2005.

29. Amanzio M, Geminiani G, Leotta D, Cappa S. Metaphor comprehension in Alzheimer's disease: novelty matters. *Brain Lang.* 2008;107(1):1-10.

30. Allain P, Chaudet H, Nicoleau S, Etcharry-Bouyx F, Barré J, Dubas F, Berrut G, Le Gall D. Étude de la planification de l'action au moyen du test du plan du zoo dans la maladie d'Alzheimer. *Rev Neurol* (Paris). 2007;163(2):222-30.

31. Allain P, Nicoleau S, Pinon K, Etcharry-Bouyx F, Barré J, Berrut G, Dubas F, Le Gall D. Executive functioning in normal aging: a study of action planning using the Zoo Map Test. *Brain Cogn*. 2005;57(1):4-7.

32. Lincoln NB, Radford KA, Lee E, Reay AC. The assessment of fitness to drive in people with dementia. *Int J Geriatr Psychiatry.* 2006;21(11):1044-51.

33. Baudic S, Barba GD, Thibaudet MC, Smagghe A, Remy P, Traykov L. Executive function deficits in early Alzheimer's disease and their relations with episodic memory. *Arch Clin Neuropsychol.* 2006;11(1):15-21.

34. Busch MR, Booth JE, McBride A, Vanderploeg RD, Curtiss G, Duchnick JJ. Role of executive functioning in verbal and visual memory. *Neuropsychology.* 2005;19(2):171-80.

35. Mathias JL. Neurobehavioral functioning of persons with Parkinson's disease. *Neuropsychology.* 2003;10(2):57-68.

36. Chan RCK, Manly T. The application of "dysexecutive syndrome" measures across cultures: Performance and checklist assessment in neurologically healthy and traumatically brain-injured Hong Kong Chinese volunteers. *J Int Neuropsychol Soc.* 2002;8(6):771-80.

37. Harwood DG, Sultzer DL, Wheatley MV. Impaired insight in Alzheimer disease: association with cognitive deficits, psychiatric symptoms, and behavioral disturbances. *Neuropsychiatr Neuropsychol Behav Neurol.* 2000;13(2):83-8.

38. Shinagawa Y, Nakaaki S, Hongo J, Murata Y, Sato J, Matsui T, Tatsumi H, Akechi T, Furukawa TA. Reliability and validity of the Japanese version of the Dysexecutive Questionnaire (DEX) in Alzheimer's disease: validation of a behavioral rating scale to assess dysexecutive symptoms in Japanese patients with Alzheimer's disease. *Int J Geriatr Psychiatry.* 2007;22(10):951-6.

39. Antoine C, Antoine P, Guermonprez P, Frigard B. Awareness of deficits and anosognosia in Alzheimer's disease. *Encephale.* 2004;30(6):570-7.

40. Zanetti O, Geroldi C, Frisoni GB, Bianchetti A, Trabucchi M. Contrasting results between caregiver's report and direct assessment of activities of daily living in patients affected by mild and very mild dementia: the contribution of the caregiver's personal characteristics. *J Am Geriatr Soc.* 1999;47(2):196-202.