Normative data for the Brazilian population in the Boston Diagnostic Aphasia Examination: influence of schooling

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Abstract

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In Neurolinguistics, the use of diagnostic tests developed in other countries can create difficulties in the interpretation of results due to cultural, demographic and linguistic differences. In a country such as Brazil, with great social contrasts, schooling exerts a powerful influence on the abilities of normal individuals. The objective of the present study was to identify the influence of schooling on the performance of normal Brazilian individuals in the Boston Diagnostic Aphasia Examination (BDAE), in order to obtain reference values for the Brazilian population. We studied 107 normal subjects ranging in age from 15 to 84 years (mean ± SD = 47.2 ± 17.6 years), with educational level ranging from 1 to 24 years (9.9 ± 4.8 years). Subjects were compared for scores obtained in the 28 subtests of the BDAE after being divided into groups according to age (15 to 30, N = 24, 31 to 50, N = 33 and 51 years or more, N = 50) and education (1 to 4, N = 26, 5 to 8, N = 17 and 9 years or more, N = 61). Subjects with 4 years or less of education performed poorer in Word Discrimination, Visual Confrontation Naming, Reading of Sentences and Paragraphs, and Primer-Level Dictation (P < 0.05). When breakdown by schooling was 8 years or less, subjects performed poorer in all subtests (P < 0.05), except Responsive Naming, Word Recognition and Word-Picture Matching. The elderly performed poorer (P < 0.05) in Complex Ideational Material, Visual Confrontation Naming, Comprehension of Oral Spelling, Written Confrontation Naming, and Sentences to Dictation. We present the reference values for the cut-off scores according to educational level.

Introduction

Language abilities are strongly influenced by sociocultural characteristics. For this reason, we have been trying to determine the performance of the Brazilian population in tests of wide application in the diagnosis of aphasia, such as the Boston Diagnostic Aphasia Examination (BDAE) (1). In a previous study, we evaluated a sample of 60 normal

subjects and tried to determine which demographic variables could influence their performance in the BDAE, as well as to obtain reference values for our population (2).

In the original validation of the BDAE for the American population there was no specific concern about adjusting the scores for subgroups of different sociocultural levels. Yet Pineda et al. (3), in a study conducted in Colombia, observed the importance of this correction. In Brazil, a country in which social differences are also extreme, it is expected that educational level may represent a powerful influence on the performance of subjects in neuropsychological tests in general (4,5). However, in the study cited above (2) we were unable to find unequivocal differences. Thus, we realized that it was necessary to increase the sample size to include different educational levels.

The formation of the less educated group was not a straightforward task, because it is becoming increasingly harder to find participants less than 30 years old who report that they have not attended school, thanks to the implantation of policies to eradicate illiteracy in Brazil since the mid 1980's (6,7). However, these efforts do not guarantee that these individuals will score well in tasks that involve formal knowledge, and often these subjects are in the functional illiteracy range (8).

On the other hand, the modern world provides mass communication media that are accessible to all population segments, leading to high exposure to the literate world, thus minimizing in some ways the deficiency of knowledge acquisition at school and attenuating these differences to a certain degree.

The purpose of the present study was to determine in greater detail the influence of schooling on the performance of Brazilian subjects on the BDAE, and to obtain more precise reference values for our population derived from a sample larger than the one of the previous study (2).

Participants and Methods

The Portuguese version of the BDAE (1) was applied to 107 Brazilian volunteers (64 women and 43 men), who were healthy, independent regarding daily life activities, without neurological or psychiatric antecedents, and who were all native Portuguese speakers living in São Paulo for more than 10 years. Subjects were recruited among the relatives of speech therapy students, hospital employees and outpatients' relatives or caregivers, with care taken to form groups that could represent age and schooling influences on the performance of normal individuals. Functional and conversational fluency evaluations were not considered for this study.

Speech therapy students were trained in the administration of the BDAE and applied the test using a uniform procedure while a speech therapy professor reviewed the scores obtained. Data were analyzed using the SPSS® version 10.0 and MedCalc® version 7.2.1.0 software. To evaluate the effect of formal education, the subjects were divided into two groups: up to 8 years of study (N = 43), and 9 years or more (N = 61). The group with up to 8 years of education was then further divided into two subgroups: up to 4 years (N = 26), and from 5 to 8 years (N = 17) of schooling for further comparison. In order to evaluate the age effect, the subjects were divided into three groups: A, 15 to 30 years (N = 24); B, 31 to 50 years (N = 33); C, 51 years or more (N = 50).

The distribution of the data for all the BDAE scores was tested by the Kolmogorov-Smirnov test, which showed a non-normal distribution. Since normal distribution could not be obtained after attempts at conversion, analysis was done using the non-parametric Kruskal-Wallis and Mann-Whitney tests to compare the performance of the different age and educational level subgroups in the various subtests. Inter-group differences were evaluated with the addition

of the Dunn's post-test to the previous analysis. The results for animal fluency (which had a normal distribution) were compared by ANOVA followed by the Tukey-Kramer post-test. A value of $P < 0.05$ was considered to be statistically significant for all analyses.

Results

The age of the normal subjects studied ranged from 15 to 84 years (mean ± SD = 47.2 ± 17.6 years), and educational level, defined as time devoted to formal study,

Table 1. Performance of subjects on the Boston Diagnostic Aphasia Examination (N = 107) and recommended cut-off scores as a function of years of schooling.

Subtest	Mean (SD)	95% confidence index	Range	Cut-off score (1-8 years)	Cut-off score (9 years or more)
Oral Comprehension					
Word Discrimination	70.6 (3.5)	69.9 to 71.3	48 to 72	60	68
Body-Part Identification	19.5 (0.9)	19.3 to 19.7	15.5 to 20	17	19
Commands	14.7 (1)	14.5 to 14.9	10 to 15	12	14
Complex Ideational Material	10.8 (1.5)	10.5 to 11	5 to 12	6	10
Oral Agility					
Nonverbal Agility	9.1 (2.1)	8.7 to 9.5	4 to 12	4	6
Verbal Agility	12.6 (1.7)	12.2 to 12.9	7 to 14	8	10
Automatized Sequences	7.8 (0.4)	7.8 to 8	6 to 8	7	7
Recitation	1.9 (0.4)	1.8 to 2	0 to 2	1	2
Repetition					
Words	9.9 (0.2)	9.9 to 10	8 to 10	9	10
High-Probability Phrases	7.8 (0.7)	7.6 to 7.9	6 to 8	6	7
Low-Probability Phrases	7.7 (0.7)	7.5 to 7.8	6 to 8	6	7
Naming					
Responsive	26.8 (0.6)	26.7 to 26.9	24 to 27	26	26
Visual Confrontation	111.2 (5.9)	110 to 112.3	74 to 114	92	106
Animal Fluency	21.3 (7.8)	19.7 to 22.9	7 to 47	5	8
Oral Reading					
Words	29.6 (1.4)	29.3 to 29.9	19 to 30	25	29
Sentences	9.8 (0.9)	9.6 to 10	3 to 10	7	9
Reading Comprehension					
Symbol Discrimination	9.9 (0.4)	9.8 to 9.9	8 to 10	9	10
Word Recognition	7.9 (0.4)	7.8 to 8	5 to 8	7	7
Comprehension of Oral Spelling	6.5 (2.1)	6.1 to 7	1 to 8	1	5
Word-Picture Matching	9.7 (1)	9.5 to 10	1 to 10	6	9
Sentences and Paragraphs	9.4 (1)	9.2 to 9.5	5 to 10	6	9
Writing					
Writing Mechanics	4.9 (0.5)	4.7 to 5	2 to 5	4	5
Serial Writing	45 (3.4)	44.3 to 45.6	21 to 47	34	43
Primer-Level Dictation	14.5 (1.3)	14.3 to 14.8	7 to 15	10	14
Spelling to Dictation	9.3 (1.5)	9 to 9.6	2 to 10	4	9
Written Confrontation Naming	9.6 (1.3)	9.4 to 9.9	6 to 10	5	9
Narrative Writing	4.5 (0.9)	4.4 to 4.7	2 to 5	2	4
Sentences to Dictation	11.6 (1.5)	11.3 to 11.9	6 to 12	6	11

ranged from 1 to 24 years (9.9 ± 4.8 years).

Table 1 shows the overall results for the 28 BDAE subtests. We present a suggested cut-off score for use in Brazil, calculated as the mean minus two SD and corrected for educational level. Table 2 shows the overall distribution of the results in percentiles.

Table 2. Performance of subjects on the Boston Diagnostic Aphasia Examination.

Subtest	Percentile								
	0	5	10	25	50	75	90	95	100
Oral Comprehension									
Word Discrimination		62	67	72					
Body-Part Identification		17	18	19	20				
Commands		11	15						
Complex Ideational Material		8	9	10	11	12			
Oral Agility									
Nonverbal Agility		6		7	9	11	12		
Verbal Agility		9	10	12	13	14			
Automatized Sequences									
Recitation		1	2						
Repetition									
Words		10							
High-Probability Phrases		7		8					
Low-Probability Phrases		6	7	8					
Naming									
Responsive		26		27					
Visual Confrontation		98	105	111	114				
Animal Fluency		11	12	15	20	27	32	34	40
Oral Reading									
Words		27	29	30					
Sentences		9	10						
Reading Comprehension									
Symbol Discrimination		9		10					
Word Recognition		8							
Comprehension of Oral Spelling		1	3	6	8				
Word-Picture Matching		9	10						
Sentences and Paragraphs		8	8	9	10				
Writing									
Writing Mechanics		4		5					
Serial Writing		39	43	44	46	47			
Primer-Level Dictation		13	14	15					
Spelling to Dictation		6	8	9	10				
Written Confrontation Naming		8	9	10					
Narrative Writing		3		4	5				
Sentences to Dictation		9	11	12					

Data are reported for 107 subjects in percentile.

Comparison of performance among the three age groups revealed a significant difference in the Complex Ideational Material, Visual Confrontation Naming, Comprehension of Oral Spelling, Written Confrontation Naming, and Sentences to Dictation subtests (Table 3). The mean educational level for the three groups was 12.5 ± 2.3 years for group A, 10.7 ± 5.1 years for group B, and 7.8 ± 4.8 years for group C. There was a significant difference in average educational level among these groups, as follows: group A *vs* C (P < 0.001) and group B *vs* C (P = 0.019).

Educational level (1 to 8 *vs* 9 years or more) influenced performance in all subtests, except Responsive Naming, Word Recognition and Word-Picture Matching (Table 4). However, the comparison between the subgroups with 1 to 4 and 5 to 8 years revealed significant differences in Word Discrimination, Visual Confrontation Naming, Comprehension of Sentences and Paragraphs, and Primer-Level Dictation (Table 5).

Discussion

The content of a language test must reflect the basic linguistic knowledge of a particular social group. In fact, our results show that subjects with less than 8 years of education behave in a relatively homogeneous way. This becomes more evident as they are subdivided into subgroups of 1 to 4 and 5 to 8 years of education, when there are no differences in most of the subtests, except for Word Discrimination, Visual Confrontation Naming, Comprehension of Sentences and Paragraphs, and Primer-Level Dictation (Table 5). Indeed, Word Discrimination, Visual Confrontation Naming and Primer-Level Dictation are all tasks that demand a greater degree of semantic knowledge (especially because they involve geometric shapes and syntactically complex numbers), whereas the Comprehension of Sentences and Paragraphs task requires a reading ability, which im-

proves with increasing years of formal education.

When breakdown by schooling was 8 years or less we observed differences in all subtests, except for Responsive Naming, Word Recognition and Word-Picture Matching (Table 4). The tasks for which this difference was more marked were Word Discrimination, Body Part Identification, Complex Ideational Material, Animal Fluency, Comprehension of Oral Spelling, Comprehension of Sentences and Paragraphs, Spelling to Dictation, Written Confrontation Naming, and Sentences to Dictation. The Word Discrimination subtest involves semantic categories whose knowledge is related to the experience frequently acquired at school, like geometric shapes and details of body parts. The comprehension and memorization of texts, necessary for the Complex Ideational Material and Comprehension of Sentences and Paragraphs tasks, demand the establishment of complex semantic relations in order to derive their meaning. The comprehension of texts is based on the analysis of propositions on a logical basis, necessary in the making of inferences, indicating the subject's ability to transpose his personal experience, both factual and concrete (9). It can be noticed that this difficulty was observed as much in the comprehension of oral texts as in the written texts (Comprehension of Sentences and Paragraphs), not surprisingly given that the oral texts in this task were in fact previously devised in the written modality, so that the oral presentation maintains the characteristics of the written language, such as the absence of redundancies, among others.

The influence of schooling on the generation of lexical items in a particular semantic category (animal) had already been studied in the Brazilian population (10). The knowledge of semantic categories, supplied by formal education, probably helps the management and organization of the semantic groups, leading to the generation of a greater number of lexical items by the more educated subjects.

The differences observed in the written subtests (Spelling to Dictation, Written Con-

Table 3. Performance of subjects on the Boston Diagnostic Aphasia Examination by age.

Subtest	Age (years)		
	A (15-30)	B (31-50)	C (51 or more)
Oral Comprehension			
Word Discrimination	71.6 (1.4)	70.7 (3.2)	70.1 (4.2)
Body-Part Identification	19.5 (0.9)	19.5 (0.9)	19.4 (0.9)
Commands	15 (0)	14.7 (1.1)	14.5 (1.2)
Complex Ideational Material*	11.3 (1.2)	11.1 (1.4)	10.3 (1.6)
Oral Agility			
Nonverbal Agility	9.7 (1.8)	9.3 (2.1)	8.7 (2.2)
Verbal Agility	13.1 (1.2)	12.8 (1.6)	12.1 (1.9)
Automatized Sequences	7.9 (0.4)	7.8 (0.3)	7.7 (0.5)
Recitation	1.9 (0.2)	1.8 (0.4)	1.9 (0.2)
Repetition			
Words	10 (0)	10 (0)	9.9 (0.3)
High-Probability Phrases	7.9 (0.4)	7.8 (0.4)	7.7 (0.8)
Low-Probability Phrases	7.8 (0.4)	7.7 (0.6)	7.6 (0.9)
Naming			
Responsive	26.9 (0.2)	26.8 (0.6)	26.8 (0.7)
Visual Confrontation+	113.2 (1.8)	111.6 (4.2)	109.9 (7.7)
Animal Fluency	23.5 (9.7)	22.6 (6.7)	19.4 (7.3)
Oral Reading			
Words	29.8 (0.7)	29.8 (0.5)	29.4 (2)
Sentences	9.9 (0.2)	9.9 (0.3)	9.6 (1.3)
Reading Comprehension			
Symbol Discrimination	10 (0)	9.8 (0.4)	9.8 (0.4)
Word Recognition	8 (0.4)	7.9 (0.5)	7.9 (0.3)
Comprehension of Oral Spelling**	7.4 (1.5)	7 (1.6)	5.8 (2.4)
Word-Picture Matching	9.8 (0.6)	9.7 (1.6)	9.8 (0.8)
Sentences and Paragraphs	9.7 (0.5)	9.4 (0.7)	9.2 (1.3)
Writing			
Writing Mechanics	4.9 (0.3)	4.9 (0.4)	4.8 (0.5)
Serial Writing	45.9 (1.4)	45.5 (2)	44.2 (4.5)
Primer-Level Dictation	14.8 (0.5)	14.7 (1)	14.3 (1.7)
Spelling to Dictation	9.8 (0.4)	9.6 (0.9)	8.9 (2)
Written Confrontation Naming++	10 (0)	9.8 (0.7)	9.4 (1.7)
Narrative Writing	4.7 (0.6)	4.7 (0.7)	4.4 (1)
Sentences to Dictation#	12 (0)	11.9 (0.4)	11.2 (2.1)

Data are reported as means (SD) for 107 subjects.
*$P < 0.05$ for A *vs* C and B *vs* C. +$P < 0.05$ for A *vs* B and A *vs* C. **$P < 0.05$ for A *vs* C and B *vs* C; ++$P < 0.05$ for A *vs* C. #$P < 0.05$ for A *vs* C and B *vs* C (Kruskal-Wallis with Dunn's post-test).

frontation Naming and Sentences to Dictation) reflect the sensitivity of these tasks not only to the instrumental abilities related to the phoneme-grapheme conversion and spelling irregularities, but also to the ability of processing verbal material in short-term memory (11).

The results of the present study show that the continuum of changes effected by formal instruction goes beyond the first years of elementary school and reveal that the effects of its deprivation in language tasks can be felt throughout the "Fundamental Level" (the first 8 years of schooling in Brazil). In fact, 9 years of education are necessary for individuals to exhibit average scores that can almost equal the maximum possible score for each task - the expected result in a diagnostic test which has been designed to differentiate normal individuals from those neurologically impaired - where specificity is more important. It is interesting to note that the authors of the BDAE validated the test on a population whose education ranged from less than eight grade through college (12), and where the mean was within a fraction of a point of the maximum possible score in most subtests. The few exceptions are invariably found in the group of subjects over 60 years of age with fewer than 9 years of schooling (1).

Although there is wide propagation of knowledge by the communication media in modern life, thereby providing alternative ways for the acquisition of knowledge and for the cognitive functioning of less educated individuals, we observed that school attendance can still cause significant differences in the domain of metaknowledge requested by language tests such as the BDAE. In other words, this knowledge, although alternative, is not compensatory, as pointed out by Tfouni (13). On the other hand, formal education in school, by itself, does not guarantee the subject's engagement in the social practices that require the interpretation of complex texts or writing. Regarding this issue, it is well known that many individuals who attend school still exhibit poor linguistic skills and can be considered to be functional illiterates (when presenting reading competence compatible with 0 to 4 years of schooling) or to be marginally literate (com-

Table 4. Performance of subjects on the Boston Diagnostic Aphasia Examination by educational level.

Subtest	Years of schooling	
	1-8	9 or more
Oral Comprehension		
Word Discrimination	69.3 (4.8)	71.5 (1.6)*
Body-Part Identification	19.1 (1.1)	19.7 (0.6)*
Commands	14.4 (1.4)	14.9 (0.7)*
Complex Ideational Material	9.9 (1.8)	11.3 (0.9)*
Oral Agility		
Nonverbal Agility	8.6 (2.2)	9.6 (2)*
Verbal Agility	11.9 (2)	13 (1.3)*
Automatized Sequences	7.7 (0.6)	7.9 (0.3)*
Recitation	1.8 (0.4)	1.9 (0.2)*
Repetition		
Words	9.9 (0.4)	10 (0)*
High-Probability Phrases	7.6 (0.9)	7.9 (0.3)*
Low-Probability Phrases	7.5 (1)	7.8 (0.4)*
Naming		
Responsive	26.8 (0.6)	26.9 (0.5)
Visual Confrontation	109.2 (8.4)	112.4 (3)*
Animal Fluency	18.2 (6.5)	23.6 (8)*
Oral Reading		
Words	29.3 (2.2)	29.9 (0.5)*
Sentences	9.5 (1.4)	9.9 (0.2)*
Reading Comprehension		
Symbol Discrimination	9.7 (0.5)	9.9 (0.2)*
Word Recognition	7.9 (0.5)	8 (0.3)
Comprehension of Oral Spelling	5.4 (2.5)	7.3 (1.2)*
Word-Picture Matching	9.5 (1.6)	9.9 (0.4)
Sentences and Paragraphs	8.9 (1.3)	9.7 (0.5)*
Writing		
Writing Mechanics	4.7 (0.6)	4.9 (0.1)*
Serial Writing	43.7 (4.8)	45.8 (1.5)*
Primer-Level Dictation	14.1 (2)	14.8 (0.4)*
Spelling to Dictation	8.5 (2.2)	9.9 (0.3)*
Written Confrontation Naming	9.2 (1.9)	9.9 (0.2)*
Narrative Writing	4.2 (1.2)	4.8 (0.4)*
Sentences to Dictation	11 (2.3)	11.9 (0.2)*

Data are reported as means (SD).

*P < 0.05 compared 1 to 8 years of schooling (Mann-Whitney test).

patible with 5 to 8 years of schooling) (8,14).

The analysis of performance by age subgroup showed that this variable had no influence on most subtests (Table 3). Although we detected differences in some tasks (Complex Ideational Material, Visual Confrontation Naming, Comprehension of Oral Spelling, Written Confrontation Naming, and Sentences to Dictation), the coexistence of statistically significant differences in educational level among these groups does not allow us to attribute these results to the variable age alone. All of these tasks were influenced by the educational level of the subjects.

Based on the differences in performance found in relation to schooling, we propose the use of two cut-off scores in our population, as shown in Table 1. Although this study was conducted in São Paulo, we believe that the reference values are valid for the Brazilian population as a whole, because the only lexical item that reflects a regional particularity for naming is "cactus", which in some regions of the country can also be named "mandacaru" or "palma". The remainder of the test contains items whose naming and meaning are the same for the whole country. It is worth emphasizing that the recognition of the limitations caused by the lack of education is essential in order to minimize the occurrence of false-positive results for less educated individuals, leading to an overdiagnosis of language disturbances in normal subjects.

Acknowledgments

Table 5. Performance of subjects on the Boston Diagnostic Aphasia Examination by educational level.

Subtest	Years of schooling	
	1-4	5-8
Oral Comprehension		
Word Discrimination	68 (5.7)	71.2 (1.7)*
Body-Part Identification	18.9 (1.3)	19.5 (0.6)
Commands	14.2 (1.6)	14.6 (1)
Complex Ideational Material	9.5 (2)	10.6 (1.3)
Oral Agility		
Nonverbal Agility	8.2 (2.1)	9.1 (2.3)
Verbal Agility	11.7 (1.6)	12.2 (2.7)
Automatized Sequences	7.7 (0.6)	7.6 (0.5)
Recitation	1.7 (0.5)	1.9 (0.2)
Repetition		
Words	9.8 (0.4)	10 (0)
High-Probability Phrases	7.5 (1.2)	7.7 (0.4)
Low-Probability Phrases	7.3 (1.2)	7.8 (0.4)
Naming		
Responsive	26.7 (0.6)	26.7 (0.5)
Visual Confrontation	106.9 (9.9)	112.9 (2.3)*
Animal Fluency	18 (7)	18.6 (5.2)
Oral Reading		
Words	28.9 (2.6)	29.8 (0.8)
Sentences	9.3 (1.8)	9.9 (0.3)
Reading Comprehension		
Symbol Discrimination	9.6 (0.6)	9.9 (0.2)
Word Recognition	7.8 (0.7)	8 (0)
Comprehension of Oral Spelling	5.1 (2.7)	5.7 (2.3)
Word-Picture Matching	9.2 (2)	10 (0)
Sentences and Paragraphs	8.5 (1.5)	9.5 (0.6)*
Writing		
Writing Mechanics	4.7 (0.7)	4.8 (0.4)
Serial Writing	43 (5.5)	44.6 (3.6)
Primer-Level Dictation	13.6 (2.4)	14.9 (0.3)*
Spelling to Dictation	8.2 (2.4)	9 (1.8)
Written Confrontation Naming	8.9 (2.3)	9.6 (1)
Narrative Writing	4 (1.3)	4.5 (0.7)
Sentences to Dictation	10.8 (2.7)	11.5 (1.5)

Data are reported as means (SD).
*P < 0.05 compared to 1-4 years of schooling (Mann-Whitney test).

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