Original Article

Artigo Original

M1-Alpha test in normal subjects with low educational level: a pilot study

Aplicação do teste M1-Alpha em sujeitos normais com baixa escolaridade: estudo piloto

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Keywords

Aphasia
Language
Evaluation
Educational status
Cognition

ABSTRACT

Purpose: To determine the performance of normal subjects with low educational level on the M1-Alpha test, and to obtain parameters for potential use in the clinical evaluation of aphasic patients with low educational level. **Methods:** Participants were 30 normal subjects with low educational level (one to four years of schooling), 15 male and 15 female, with ages over 18 years and below 60 years. All subjects were submitted to the M1-Alpha test, which comprehends semi-directed interview and controlled tasks. One point was given for every correct answer. Data were statistically analyzed. **Results:** It was verified a higher number of errors, as well as greater variability of responses, in the following tasks: copying, writing to dictation, reading comprehension, and reading aloud. **Conclusion:** Low educational level influences the performance of subjects on the tasks copying, writing to dictation, reading aloud, and reading comprehension. It was possible to obtain reference data for potential clinical application of the M1-Alpha test in patients with low educational level.

Descritores

Afasia
Linguagem
Avaliação
Escolaridade
Cognição

RESUMO

Objetivo: Verificar o desempenho de sujeitos normais com baixa escolaridade no teste M1-Alpha e obter parâmetros que possam ser utilizados na avaliação clínica de pacientes afásicos com baixa escolaridade, expostos a este teste. **Métodos:** Foram selecionados 30 sujeitos normais de baixa escolaridade (um a quatro anos de estudo), com idade superior a 18 anos e inferior a 60 anos, sendo 15 do gênero masculino e 15 do gênero feminino. Todos foram submetidos à aplicação do teste M1-Alpha, que comporta entrevista semidirigida e provas controladas. Todas as respostas corretas receberam um ponto. Os dados foram submetidos a tratamento estatístico. **Resultados:** Foi verificado um maior número de erros, bem como uma maior variabilidade nas respostas, em tarefas de escrita copiada, ditado, leitura em voz alta e compreensão escrita. **Conclusão:** A baixa escolaridade influencia o desempenho dos indivíduos nas tarefas de escrita copiada, ditado, leitura em voz alta e compreensão escrita. Foi possível obter dados de referência, que poderão ser utilizados na aplicação clínica do teste M1-Alpha em pacientes com baixa escolaridade.

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INTRODUCTION

Language can be defined as a brain function that uses verbal, oral and graphic elements for human communication[1]. Aphasia is a disturbance in the processing of language secondary to brain lesion[2].

Language is strongly influenced by gender, age and schooling besides other sociocultural characteristics[3,4]. In neurolinguistics, the use of tests developed in other countries for diagnosing aphasia can hamper the interpretation of results due to language, demographic and cultural differences. Moreover, in a country like Brazil, with its huge social contrasts, schooling should always be considered since it exerts a strong influence on the language and cognitive abilities of normal individuals[3,4].

The most commonly used tests in Brazil for assessing language in aphasics are the Montreal-Toulouse test battery and the Boston Diagnostic Aphasia Examination. The performance of the healthy Brazilian population on the Boston test has been described extensively, taking into account factors such as age and schooling[3]. The influence of age and schooling has also been recently investigated in the application of the Modified MT Beta-86 protocol from the Montreal-Toulouse battery[4].

With regard to the M1-Alpha test, a preliminary study conducted in 35 aphasic patients in the 1990s showed that some line drawings and language stimuli were in need of review. More recently, a study carried out in 35 subjects without neurological disorders revealed the need for changes in the stimuli and pictographs while also suggested the inclusion of pragmatic and discursive tasks in the instrument[6]. In Brazil, a research group is adapting the Montreal-Toulouse aphasia assessment protocol to Brazilian Portuguese[7]. However, it is known that these studies, if done rigorously, take many years to complete since sociodemographic, psychometric and neuropsychological variables must be explored[8-10].

The M1-Alpha test is an important instrument for diagnosing aphasia through brief procedures such as screening in hospital settings. Although two studies have been carried out, one involving a normal population[6] and the other an aphasic population[5], a specific study in a population with low educational level was lacking. Schooling influences all cognitive functions[11,12] including language[4,13,14], and the M1-Alpha comprises stimuli which can be easily processed by populations with low educational level[15,16], largely owing to its visually-based stimuli[17,18].

Given that individual and sociocultural factors can influence performance on language-based tasks, the aim of this study was to determine the performance of normal individuals with low educational level on the M1-Alpha test in order to obtain parameters for use in assessing aphasic patients with similarly low level of education.

METHODS

The study was approved by the Research Ethics Committee of the Universidade Federal de São Paulo (UNIFESP), under process number 0816/08. A total of 30 individuals (15 males, 15 females), who were companions of patients assessed at the Speech Pathology outpatient unit of the Hospital São Paulo/ UNIFESP, took part in the study. Study participants were older than 18 years and younger than 60 years of age and had no prior history of psychiatric or neurologic disorders, alcoholism and/or use of psychotropic drugs. These data were collected by applying a questionnaire. Given that schooling can influence performance on language tasks, only subjects with one to four years of schooling were included in the study. Individuals were first invited to take part in the study and following agreement, gave consent by signing a Free and Informed Consent Form.

Regarding the sample characteristics, the casuistic assessed had a mean age of 46.06 years and a standard deviation of 8.46 years. Mean years of schooling of the population was 3.4 and standard deviation 0.8.

The M1-Alpha test is used to obtain data on the language behavior of aphasic patients. The instrument entails a semi-directed interview with controlled tests evaluating:

- Spontaneous discourse (semi-directed interview): subjects answer nine open questions, some containing subparts. Only oral comprehension is scored.
- Oral comprehension of words plus basic and complex sentences: task comprising 11 plates in total with each of the five word plates depicting six line drawings, and three basic and three complex sentence plates each containing four line drawings.
- Written comprehension of words plus basic and complex sentences: 11 plates are presented in total with each of the five word plates depicting six line drawings, and three basic and complex sentence plates each containing four line drawings. For each plate presented, the investigator also shows a written stimulus to be read silently by subject and matched with the corresponding figure.
- Sentence copying: subjects copy a written sentence. An identical or slavish copy was deemed incorrect.
- Dictation: the examiner dictates three words and one sentence which the subject writes down.
- Reading aloud: the subjects read a total of 11 stimuli, consisting of eight words and three sentences.
- Repetition: the subject repeats a total of 11 items, consisting of eight words and three sentences, which are transcribed by the examiner according to the utterances of the subject.
- Naming: the subject must name 12 drawings.

In all subtests, one point is given for each correct answer. The test was applied in strict accordance with the rules of the instrument in question. Thus, although a qualitative analysis of errors was envisaged, any answer diverging from that expected by the instrument was considered an error. These same criteria applied to all the different word and sentence stimuli and did not vary across tasks. For instance, if upon writing backyard, the subject wrote ¨backyaad", the stimuli was considered wrong and scored as zero. Since normal individuals were being assessed, it was important to follow these guidelines during the assessment in order to determine cut-off scores representative of the performance of a healthy population. This approach

Table 1. Performance of normal individuals with low educational level on tasks from the M1-Alpha test

	Directed interview	Oral comprehension	Written comprehension	Sentence copying	Dictation	Reading aloud	Repetition	Naming
Mean	8.83	9.67	8.57	0.43	1.77	8.57	9.80	11.33
SD	0.38	1.42	2.80	0.50	1.52	3.23	0.93	0.84
Minimum	8.00	6.00	0.00	0.00	0.00	0.00	8.00	9.00
Maximum	9.00	11.00	11.00	1.00	4.00	11.00	11.00	12.00
n	30	30	30	30	30	30	30	30

Note: SD = standard deviation

enabled the "schooling effect" to be differentiated from the "lesion effect" in aphasic patients with low educational level assessed by the instrument.

After calculating total scores on each task of the test, statistical analysis was performed to identify mean, standard deviation, as well as minimum and maximum scores. This yielded parameters for use in assessing aphasic individuals with low educational level submitted to the test. Thus, those tasks influenced by schooling were identified. The results shown compare performance between tasks by number of errors. Results were obtained by applying the Analysis of Variance (ANOVA) with repeated measures. The level of significance adopted was 5%. Least squares mean multiple comparisons were applied to identify differences.

RESULTS

The results allow the verification of the performances of normal individuals with low educational level on the M1-Alpha test (Table 1).

Comparison of the tasks (Table 2) revealed the following order by frequency of errors committed by the individuals tested: Sentence copying < Dictation< Written comprehension = Reading aloud = Directed interview < Oral comprehension = Repetition < Naming. The results showed that the highest number of errors occurred on the sentence copying task whereas the lowest number was on the naming task. The global performance of the participants varied on all test tasks (Figure 1).

Table 2. Comparative performance of normal individuals on tasks from M1-Alpha test by frequency of errors

Comparison	p-value
Sentence copying x Dictation	0.0007*
Dictation x Written comprehension	<0.0001*
Written comprehension x Reading aloud	1.0000
Reading aloud x Directed interview	0.4902
Directed interview x Oral comprehension	0.0319*
Oral comprehension x Repetition	0.7300
Repetition x Naming	0.0001*

* Significant values (p≤0.05) – ANOVA

DISCUSSION

Schooling bands adopted had initially been based on those proposed in earlier studies[3,4]. In the present study, however, a specific schooling band of one to four years was researched.

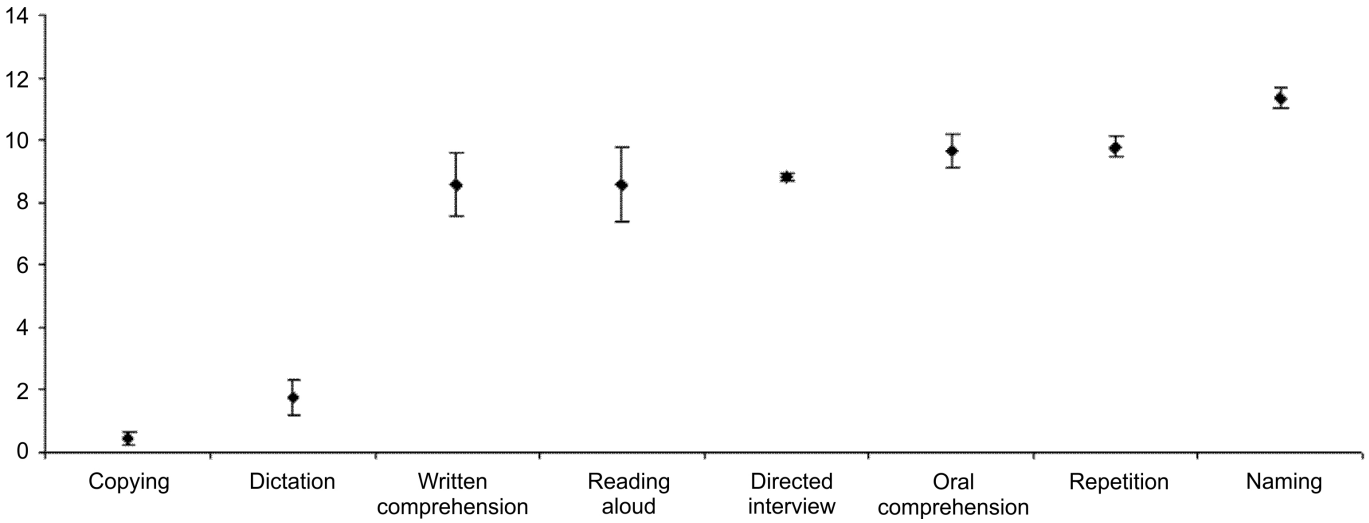

Figure 1. Performance of normal individuals with low educational level on tasks from the M1-Alpha test
Note: mean±1.96* (standard deviation / √(n-1))

With regard to the characteristics of the sample, both mean age and standard deviation of the participants was high, suggesting difficulties finding younger adults with low educational level. Although the sample comprised volunteers of both genders, this variable was not included in the analysis since numerous studies have reported that this aspect does not influence the language tasks assessed in this study[3,4,14,18].

The performance of normal individuals with low educational level on the different tasks of the M1-Alpha was observed. On the directed interview, participants had high mean correct answers and low response pattern variability. The ease of participants in answering the task questions was due to the interview structure, which contained basic everyday questions such as "How old are you?", "Do you have a good appetite?". This represents a straight forward task for subjects with low educational level and thus can be applied to aphasic subjects.

On the oral comprehension task, individuals achieved a high average rate of correct answers, with a low standard deviation (compared with other tasks).The highest number of errors occurred on complex sentence plates. Selecting the correct answer from four alternatives containing practically the same lexical items requires greater attention to grammatical structure than is needed for understanding basic words and sentences. Besides attention, short-term phrase retention is another cognitive component involved in this task and employs working memory. Thus, upon hearing the complete sentence, the individual has to temporarily organize it and then decode its syntactic structure in order to point out the corresponding drawing. Errors decoding any given element of the sentence can therefore lead to failures in decoding the sentence as a whole. Some authors have suggested that changes in working memory impact language processing and consequently sentence comprehension. This suggests that a failure in understanding complex sentences may stem from an impairment in short-term memory[20]. In addition, tasks which involve working memory may be influenced by schooling[21,22]. The fact that the line drawings from the test are in black and white, and that pictures for complex sentences are more detailed, may have hampered recognition. Indeed, line drawings are more challenging for normal individuals with low educational level because visual analysis of two-dimensional representations are tasks that typically require more years of education[18] .

On the repetition task, the sentences were the items on which subjects most frequently committed errors. Differing to other aphasia tests, there is no repetition of pseudowords or non-words in this instrument, words which enable phonologic processing to be specifically assessed. Only short and long words that occur frequently in the Portuguese language, as well as sentences, are repeated .In contrast to studies assessing individuals with low educational level using lists of pseudowords[22-24], the present study found good performance among participants, most likely because they were able to use the phonological lexical route to carry out repetition. The most frequent error occurred during phrase repetition, where subjects maintained the meaning of sentences but changed their structure by incorporating a new word or dropping a word from the sentence. Working memory deficits may also explain the sentence repetition problems encountered by the subjects, leading to difficulties memorizing the sentences together with their grammatical components in the exact order, and reproducing them.

Comparison of oral comprehension and repetition tasks revealed that individuals obtained a high mean number of correct answers and a low standard deviation on both tasks, with subjects proving able to carry out the tests satisfactorily. In a study of normal illiterate subjects[23], the authors noted greater difficulties on oral repetition and comprehension tasks. However, the cited investigation differed in terms of schooling and the instruments employed when compared to the present study. The previous study[23]instead employed the modified MT Beta 86 test, containing a greater number of sentences with non-canonic structure and in the passive voice, factors which most likely hampered understanding among illiterate individuals. In addition, the MT Beta 86 test includes repetition of pseudo- and non-words.

Repetition of non-words is carried out by the phonological route responsible for phonemic codification. Since this route is known to be less developed in subjects who are illiterate or have low educational level[22], it can be speculated that, upon exposure to repetition of non-words, these individuals perform such repetition by using the lexical route, which has a direct link with the semantic system. This may have caused the errors seen in illiterate subjects during the application of the modified MT Beta 86 test. The absence of pseudoword and non-word repetition on the M1-Alpha test, which contains only stimuli that exist in our milieu, rendered the test easier to perform by the individuals with low educational level assessed in this study.

Subjects with low educational level had difficulties performing the written comprehension subtest. On this task, individuals are required to match the written words with a given drawing. The complex sentences were those on which subject committed most errors. Difficulties in visual processing, commonly seen in this population[17], may have led to a greater number of errors on this task. On the other hand, some individuals attained only minimum scores on this task because they were unable to read. The difficulties seen during this study often occur in routine clinical practice, i.e. subjects report being able to read and write but are unable to properly perform the task.

Participants were classified into groups with one to four years of schooling. In some cases, individuals who reported two years of formal education performed better on reading and writing tasks than individuals with four years of formal schooling. Differences in school education, habits or social use of reading and writing might explain these differences. Thus, patients stating they were able to read and write prior to brain damage should be submitted to reading and writing tasks during the assessment. Only patients that report being unable to read and write need not perform these procedures.

Therefore, in the present study, the difficulties seen on the written comprehension tasks may be related to difficulties processing the visual components, decoding graphemes or lexemes or to problems in reading comprehension. Difficulties

on the written comprehension test among individuals with low educational level have been described in previous studies[3,13]. Further, the population of this study may be considered functionally illiterate. By definition, functional illiterates denote individuals who, despite having been to school, do not have the reading, writing or calculus skills needed for their personal and professional development[25]. Such difficulties understanding written content can be expected, and have previously been observed, in this population[26,27].

The mean number of correct answers on the oral and written comprehension tasks was not discrepant, but standard deviation was found to be significantly higher on the written comprehension task. This finding may have resulted from greater difficulty in adequate decoding of the stimuli which have to be read as opposed to only heard, since the answer for the two tasks is the same, i.e. matching the drawing that corresponds to the item requested. Another important factor differentiating the two tests is that, on the oral comprehension task, the individual need only hear the message, a task carried out in daily living. A prerequisite for the written comprehension test however, is that the individual can read, a skill requiring a formal setting to learn and also reading habits to become proficient. Fewer years of formal education or the absence of a reading or writing habit after this learning period are likely to lead to difficulties understanding the read content.

Some individuals also showed poor performance on the sentence copying task, in which subjects need to copy a single stimuli (basic sentence) and convert separate letter writing into joined up hand writing. Sentence copying errors may be due to problems recognizing letters and searching for the corresponding allograph, probably as a result of a lack of mastery over all the lettering styles, or transcribing some words in joined up hand writing and others in writing with separate letters or because of failure to include word accent marks in the sentence. Difficulties in use of accents have been reported in the literature[3]. It should be emphasized that the majority of errors are due to difficulties using allographic forms, while most participants mixed joined up with separate letter handwriting.

Concerning performance on the dictation test, minimum scores were again attained. This was not only due to writing difficulties but also to errors in writing down all the stimuli. On this task, participants had to write three words and a basic sentence. The words were both short and frequent in the Portuguese language, but reflect a complexity in the choice of the grapheme to be used because they are words with phonemes which have several graphemic representations. Thus, individuals with low educational level faced with several options of graphemes for the same phoneme, commit more errors, considered here as orthographic errors. Another common error was omitting the accent mark. However, the greatest difficulty occurred in the writing of the sentence itself, where errors were due to failure to use the plural and also to the probable unfamiliarity with some words leading to mistakes in the selection of graphemes. The difficulty of subjects with low educational level performing dictation tests has been reported in other studies[3,4].

Curiously, comparison of the results on both copying and dictation tasks revealed that individuals committed more errors during the copying activity. It should be considered that besides the difficulty with the allographic forms, when scoring the correct copy of the sentence with one point, individual words which have been correctly copied are not reflected in the score. In other words, the chance of errors was greater than in the dictation test, in which four words and one sentence were dictated. The M1-Alpha test is known to be one of the simplest tests for assessing aphasia, and that the small number of stimuli can often cause problems of reliable comparisons. This is this case for writing through auditory input (dictation activity) and writing through visual input (copying activity). Similarly, these results also suggest that the scoring of the original test must be reviewed and modified in order to provide a better quali-quantitative analysis, possibly by attributing one point to each correctly written item.

On the reading aloud task, a large variation was seen in the scoring of individuals in terms of maximum and minimum scores. This test entails reading short and long words, some frequently used in the Portuguese language and others less frequent, besides reading basic and complex sentences. Errors were more common for reading of low frequency words and reading of complex phrases. The lack of familiarity with some words contained in the sentences or the low frequency of occurrence of a phrasal element in the experience of the individual, such as closed class words (prepositions and articles) or verbs with uncommon conjugations, probably led to reading errors for the test sentence. It is also acknowledged that the greater the schooling years, the better the development of metalinguistic and metacognitive competencies (such as phonological processing), an important factor for reading. Since the study subjects had four years of schooling, it was expected for these competencies not to be fully developed, a factor which can lead to difficulties in carrying out tasks without contextual information[28,29].

On the denomination or naming test, a high mean number of correct answers were observed, a finding which may be explained by the fact that the M1-Alpha test contains only a few line drawings, all of which are highly familiar and frequent in our setting. This allows easy lexical access by the subject. The item with the highest number of errors by stimulus was the ear, a finding observed in a previous study[7] in which the authors implicated a problem in plate design.

According to Moreira[30], the deficits seen in individuals with low educational level reflect a consistent correlation between low reading and low auditory comprehension skills. However, individuals in the present study exhibited more difficulties in reading and writing tasks and less difficulty on tasks requiring auditory comprehension. This could be explained by greater use of oral language than graphic because the use of oral language is part of daily routine, whereby individuals need only a stimulating environment in order to learn how to speak. With regard to acquisition of reading and writing skills however, individuals need to be engaged in formal learning for several years and adopt specific habits in order to attain proficiency.

Therefore, the tasks most influenced by level of schooling were those requiring metalanguage and metacognitive skills. Subjects with low educational level are less exposed to formal learning which involves reading aloud, dictation, sentence copying and written comprehension. The results of the present study confirm that schooling influences performance on a range of difference language skills.

Study limitations

The present investigation was a pilot study designed to collect normative data for use in assessing the language of aphasics with low educational level submitted to the M1-Alpha test. No other cognitive tests enabling comparison between language performance and performance on other cognitive functions by schooling level were conducted. Moreover, as the test was applied in its original form, no qualitative analysis of errors was performed, with one point assigned to each item/stimulus of the test. Furthermore, due to the scoring scheme of the test, the stimulus words (total eight) could not be differentiated from the phrases (total three) on the repetition and reading aloud tasks. Therefore, correct answers were analyzed on a quantitative basis only. The study results also pointed to the need for reviewing the instrument's scoring scheme. This could improve quali-quantitative assessment during test application .Future studies should be conducted that focus on these aspects.

CONCLUSION

The results of this study revealed an influence of schooling on the written copying, dictation, reading aloud and graphic comprehension tasks of the M1-Alpha test. The study served to provide normative reference values of a healthy Brazilian population for use in assessing aphasics with low educational level submitted to the test.

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REFERENCES

1. Mendonça LI. Contribuições da neurologia no estudo da linguagem. In: Ortiz KZ. Distúrbios neurológicos adquiridos: linguagem e cognição. Barueri: Manole; 2010. p.1-33.
2. Ortiz KZ, Peroni C. Compreensão de fala em situação de mensagem competitiva em afásicos. Rev CEFAC. 2008;10(2):226-32.
3. Radanovic M, Mansur LL, Scaff M. Normative data for the Brazilian population in the Boston Diagnostic Aphasia Examination: influence of schooling. Braz J Med Biol Res. 2004;37(11):1731-8.
4. Soares EC, Ortiz KZ. Influence of schooling on language abilities of adults without linguistic disorders. São Paulo Med J. 2009;127(3):134-9.
5. Ortiz KZ, Osborn E, Chiari BM. O teste M1-Alpha como instrumento de avaliação da afasia. Pró-Fono. 1993;5(1):23-9.
6. Garcia FC, Takayanagui OM. Exame de Afasia M1-Alpha: uma proposta de readequação ao português [resumo]. O Dendrito. 2007;13:27-8.
7. Soares EC, Fonseca RP, Scherer LC, Parente MA, Ortiz KZ, Joanette Y, et al. Protocolo Montreal-Toulouse de exame linguístico da afasia MT-86: estudos e perspectivas futuras. In: Ortiz KZ, Mendonça LI, Foz A, Dos Santos CB, Fuentes D, Azambuja DA, organizadores. Avaliação neuropsicológica: panorama interdisciplinar dos estudos na normatização e validação de instrumentos no Brasil. São Paulo: Vetor; 2008. p.275-89.
8. Fonseca RP, Parente, MA, Côté H, Joanette Y. Processo de adaptação da bateria Montreal de avaliação da comunicação: bateria MAC - ao português brasileiro. Psicol Reflex Crít. 2007;20(2):259-67.
9. Fonseca RP, Joanette Y, Côté H, Ska B, Giroux F, Fachel JM, et al.Brazilian version of the Protocole Montréal d'Evaluation de la Communication (Protocole MEC): normative and reliability data. Span J Psychol. 2008;11(2):678-88.
10. Fonseca RP, Salles JF, Parente MA. Development and content validity of the Brazilian Brief Neuropsychological Assessment Battery Neupsilin. Psychol Neurosci. 2008;1(1):55-62.
11. De Luccia G, Ortiz KZ. Performance of a Brazilian population in the EC 301 calculation and number processing battery: a pilot study. Arq Neuropsiquiatr. 2009;67(2B):432-8.
12. Teruya LC, Ortiz KZ, Minett TS. Performance of normal adults on Rey Auditory Learning Test: a pilot study. Arq Neuropsiquiatr. 2009;67(2A):224-8.
13. Fichman HC, Fernandes CS, Nitrini R, Lourenço RA, Paradela EM, Carthery-Goulart MT, et al.Age and educational level effects on the performance of normal elderly on category verbal fluency tasks. Dement Neuropsychol. 2009;3(1):49-54.
14. Soares EC, Ortiz KZ. Influence of brain lesion and educational background on language tests in aphasic subjects. Dement Neuropsychol. 2008;2(4):321-7.
15. Parente MA, Fonseca RP, Scherer LC. Literacy as a determining factor for brain organization: from Lecours' contribution to the present day. Dement Neuropsychol. 2008;2(3):165-72.
16. Parente MA, Scherer LC, Zimmermann N, Fonseca RP. Evidências do papel da escolaridade na organização cerebral. Rev Neuropsicol Latinoam. 2009;1(1):72-80.
17. Potagas C, Kasselimis D, Evdokumidis I. Short-term Memory and Working Memory Impairments in aphasia. Neuropsychologia. 2011;(49):2874-8.
18. Reis A, Guerreiro M, Castro-Caldas A. Influence of educational level of non brain-damaged subjects on visual naming capacities. J Clin Exp Neuropsychol. 1994;16(6):939-42.
19. Ortiz KZ, Bertolucci PH. Alterações de linguagem nas fases iniciais da doença de Alzheimer. Arq Neuropsiquiatr. 2005;63(2a):311-7.
20. de Lira JO, Ortiz KZ, Campanha AC, Bertolucci PH, Minett TS. Microlinguistic aspects of the oral narrative in patients with Alzheimer's disease. Int Psychogeriatr. 2011;23(3):404-12.
21. Ardila A, Rosselli M, Rosas P. Neuropsychological assessment in illiterates: visuospatial and memory abilities. Brain Cogn. 1989;11(2):147-66.
22. Reis A, Castro-Caldas A. Illiteracy: a bias for cognitive development. J Int Neuropsychol Soc. 1997;3:444-50.
23. Ortiz KZ, Ferreira CP, Bento AC. Aplicação do teste Beta 86 (protocolo Mt modificado) em analfabetos. Fono Atual. 2006;8(35):65-73.
24. Petersson KM, Reis A, Askelöf S, Castro-Caldas A, Ingvar M. Languageprocessing modulated by literacy: a network analysis of verbal repetition inliterate and illiterate subjects. J Cogn Neurosci. 2000;12(3):364-82.
25. Eme E, Lacroix A, Almecija Y. Oral narrative skills in french adults who are functionally illiterate: linguistic features and discourse organization. J Speech Lang Hear Res. 2010;53(5):1349-71.
26. Carthery-Goulart MT, Anghinah R, Areza-Fegyveres R, Bahia VS, Brucki SM, Damin A. Performance of a Brazilian population on the test of functional health literacy in adults. Rev Saúde Publica. 2009;43(4):631-8.
27. Ardila A, Bertolucci PH, Braga LW, Castro-Caldas A, Judd T, Kosmidis MH, et al. Illiteracy: the neuropsychology of cognition without reading. Arch Clin Neuropsychol. 2010;25(8):689-712.

28. Tfouni LV. Adultos não alfabetizados: o avesso do avesso. Campinas: Pontes; 1988.
29. Salles JF, Parente MA. As dificuldades de leitura e escrita em crianças/adolescentes: abordagem neuropsicológica cognitiva. In: Haase VG, Ferreira FO, Penna F, organizadores. Aspectos biopsicossocias da saúde na infância e adolescência. Belo Horizonte: COOPMED; 2009, p. 553-74.
30. Moreira DA. Analfabetismo funcional: O mal nosso de cada dia. São Paulo: Thomson; 2003.