Neuropsychological Profile of Brazilian Older Adults with Heterogeneous Educational Backgrounds

Mônica S. Yassuada,b,*, Breno S.O. Diniza, Mariana K. Flaksa, Luciane F. Violaa, Fernanda S. Pereiraa, Paula V. Nunesa, Orestes V. Forlenzaa

aPsychogeriatric Unit, Laboratory of Neuroscience, Department and Institute of Psychiatry, Faculty of Medicine, University of São Paulo, São Paulo, Brazil
bDepartment of Gerontology, School of Arts, Sciences and Humanities, University of São Paulo, São Paulo, Brazil

Accepted 23 September 2008

Abstract

Education significantly impacts cognitive performance of older adults even in the absence of dementia. Some cognitive tests seem less vulnerable to the influence of education and thus may be more suitable for cognitive assessment of older adults with heterogeneous backgrounds. The objective of this study was to investigate which tests in a cognitive battery were less influenced by educational levels in a sample of cognitively unimpaired older Brazilians. In addition, we evaluated the impact of very high educational levels on cognitive performance. The cognitive battery consisted of the Mini Mental State Examination (MMSE), Cambridge Cognitive Test (CAMCOG), Clock Drawing Test, Short Cognitive Performance Test (SKT), Rivermead Behavioural Memory Test (RBMT), Fuld Object Memory Evaluation (FOME), Verbal Fluency Test (VF) fruit category, Trail Making Test A and B, WAIS-R Vocabulary, and Block Design. Education did not exert a significant influence on the RBMT, FOME, and VF (p < .05). Subjects with very high educational levels had similar performance on the latter tests when compared with those with intermediate and low levels of education. In conclusion, the RBMT, FOME, and VF fruit category seem to be appropriate tools for the assessment of cognitive function in elderly Brazilians with varying degrees of educational attainment.

Keywords: Cognitive tests; Neuropsychology; Elderly; Cognition; Cognitive aging; Literacy

Introduction

Age and education are variables known to affect cognitive performance. Generally, aging affects speed of information processing and memory-related functions. Cognitive changes can be documented as early as in the fourth decade of life. However, certain cognitive domains, such as semantic memory and general knowledge about the world, which are aspects of crystallized intelligence, are spared until much later in the life span (Anstey, Luszcz, Giles, & Andrews, 2001; Slimwinski & Buschke, 1999). Some of these findings may be, at least, in part, explained by structural changes that often occur within the aging brain, such as deep and periventricular white matter lesions, cerebral atrophy, impaired connectivity, and specific pathological changes to the medial temporal lobe (Chey, Na, Tae, Ryoo, & Hong, 2006; Cook et al., 2002; Paul et al., 2005). Nonetheless, there are substantial intra- and inter-individual differences both in the rate and pattern of age-related cognitive changes (Christensen, 2001).

It is well documented that education can modulate age-related changes on cognition. Older adults with lower education are at higher risk of developing cognitive impairment and dementia (Hototian et al., 2008; Katzman, 1993). Research has shown that learning to read and write in early childhood may change the architectural and functional status of the human brain, influencing
not only linguistic ability, but also information processing capacity and abstract reasoning (Brucki & Nitrini, 2008; Castro-Çaldas, Petersson, Reis, Stone-Elander, & Ingvar, 1998; Morais & Kolinsky, 2000; Petersson, Reis, & Ingvar, 2001). Low education is also associated with worse performance on phonological verbal fluency, calculation, and working memory (Ardila, Ostrosky-Solis, Rosselli, & Gomez, 2000; Ostrosky-Solis, Ardila, Rosselli, Lopez-Arango, & Uriel-Mendonza, 1998; Reis, Guerreiro, & Petersson, 2003). Yet, other domains such as non-verbal long-term memory, space orientation, and semantic category verbal fluency seem to be less influenced by education (Manly et al., 1999). Nitrini and colleagues (2004), for instance, have documented significant differences between literate and illiterate Brazilian older adults in an episodic memory test using 10 written words but absence of significant differences in a test using black-and-white line drawings.

Diagnostic criteria for dementia and other age-related cognitive syndromes, including mild cognitive impairment, require objective documentation of cognitive decline. This information is provided by instruments that may be strongly biased by education. This reinforces the need for tests that are less vulnerable to educational experience or for normative values corrected for education. A better understanding of the impact of education on performance in cognitive instruments is needed, particularly in developing countries (Ferri et al., 2005), where under-schooling is frequently observed among elders. According to a recent national survey, in Brazil, for instance, most of the older adults have 4 years of education (57%) and 18% have never attended school (Santos, Lopes, & Neri, 2007).

The aim of the current study was to describe the influence of education on performance in a set of neuropsychological and cognitive screening tests, in a sample of healthy older Brazilians with varying degrees of education. We hypothesized that older adults with lower education would have worse performance on most tests when compared with those who completed high-school, college, and graduate education. We expected that differences in cognitive performance might be minimized in tests that comprised “ecological” tasks, that is, that were similar to activities of the everyday life. We also hypothesized that older adults with the highest levels of education (graduate degrees) would outperform older adults with elementary, high-school, and undergraduate education.

Methods

Participants

Seventy-one cognitively unimpaired older adults participated in this study (77% women, mean age 68.66 ± 5.49 years, range 60–83). There was a larger representation of women in the sample, because there is a larger proportion of women in the older population in Brazil, as well as in other countries, and Brazilian women also look for medical assistance more frequently than men (Neri, 2007).

All participants were volunteers who annually undergo clinical and neuropsychological evaluations at a university-based memory clinic at the Institute of Psychiatry, University of São Paulo, part of a multidisciplinary prospective study on cognitive aging and dementia. For the current analysis, baseline data were used and therefore participants were not familiar with instruments.

For the total study sample, participants were recruited from community sources (community centers, newspaper, and radio ads), when a study on memory and aging was advertised. The sample also included participants who spontaneously sought medical attention related to memory complaints or who were referred from other hospital units for assessment of suspected cognitive decline. Few participants (less than 5%) were volunteers who wanted to donate their time for a research study, mainly relatives who came to accompany a family member with memory concerns. Most of this clinical sample was therefore composed of older adults who were concerned about possible cognitive decline. However, for the current analysis, only participants who were characterized as cognitively intact during consensus diagnosis were included.

Mean education in this sample was 12.71 ± 5.94 years (ranging from 2 to 26 years of formal schooling). Illiterates were not included in the overall sample because of concerns about floor effects in some of the cognitive tests. As the focus of the prospective study is to investigate mild forms of cognitive impairment and conversion to dementia, researchers were concerned illiteracy would generate an important confounding factor. Illiterates were referred to another hospital unit where illiteracy studies were being conducted. Patients with severe dementia and those with evidence of neurological or psychiatric comorbidities, as well as diseases that may generate cognitive decline, such as depression, syphilis, or AIDS, were also excluded. This study was approved by the Ethics Committee of the Medical School and was performed in accordance with the Helsinki Declaration.

The current educational system in Brazil includes 9 years of elementary school and 3 years of high school. Undergraduate studies take place in 4 or 5 years depending on the area and the required practical training. Graduate studies usually take 2 years for a master’s degree and 4 years for a doctorate degree. When this sample of older adults was at school age, a similar system was in place; nevertheless, public schools offered only the first four initial years of elementary school. Participants in this sample were not bilingual and the vast majority came from urban areas.
**Cognitive Assessment**

All participants selected for these analyses were considered cognitively unimpaired after undergoing screening, clinical, and neuropsychological examinations and having at least one longitudinal re-assessment. All information available was used to characterize cognitive preservation, or the presence of mild cognitive impairment or dementia during consensus meetings. The cognitive assessment protocol and the diagnostic criteria used to characterize normal cognitive function and rule out from this analysis cases of mild cognitive impairment and incipient dementia have been described in previous publications (Nunes et al., 2008; Diniz, Yassuda, Radanovic, Nunes, & Forlenza, 2007; Flaks et al., 2006).

Patients were examined by clinicians specialized in the evaluation of dementia disorders, including geriatric psychiatrists, neurologists, and neuropsychologists. Psychiatrists performed general mental state examination with the Brazilian version of the Cambridge Cognitive Test (CAMCOG; Roth et al., 1986), which is a compilation of screening tests yielding a score of 0–107. The CAMCOG includes the Mini-Mental State Examination (MMSE; Brucki et al., 2003; Folstein, Folstein, & McHugh, 1975) and the Hachinski Ischemic Score (Hachinski et al., 1975). The Clock Drawing Test (CDT), which is also a part of the CAMCOG, was additionally scored according to Sunderland’s guidelines (Sunderland et al., 1989). The Brazilian version of the CAMCOG has shown adequate psychometric and diagnostic properties to detect dementia and mild cognitive impairment (Bottino et al., 1999; Nunes et al., 2008). The 21-item Hamilton Depression Scale was administered to rule out depressive symptoms (Hamilton, 1960).

Neuropsychological examinations were conducted by trained psychologists on a different day and included the following tests administered in the order they are presented: the Short Cognitive Performance Test (SKT) (Erzigkeit, 1991; Flaks et al., 2006), the Fuld Object Memory Evaluation (FOME; Diniz et al., 2008; Fuld, 1980), Verbal Fluency fruit category (Diniz et al., 2008), the Trail Making Test (TMT) A and B (Army Individual Test Battery, 1944; Diniz et al., 2008), the Wechsler Adult Intelligence Scale-Revised (WAIS-R) Vocabulary, and Block Design tests (Wechsler, 1981); and the Rivermead Behavioural Memory Test (RBMT) (Diniz et al., 2008; Oliveira & Schmidt, 1999; Wilson, Cockburn, & Baddeley, 1985; Yassuda et al., 2006).

The above tests were selected to compose the battery so that main areas of cognition could be assessed, namely episodic memory, attention, executive functions, language ability, and visuo-constructional ability. We included tests that at face value seemed appropriate to evaluate populations with heterogeneous educational backgrounds and that were not sufficiently studied with older populations in Brazil.

The RBMT yields two variables of interest: the “screening” score (range 0–12) and the “profile” score (range 0–24). The RBMT is regarded as an everyday memory test, because it requires the patient to perform tasks that are regularly performed in everyday life, such as memorizing the name of a person, faces, a short story, a route in the room, among other tasks. In this test, raw scores for each subtest are transformed into 0 or 1 (for perfect performance) for the screening score, and into 0, 1, or 2, for the profile score. A preliminary study (Yassuda et al., 2006) has shown that the Brazilian version of the RBMT has adequate internal consistency (Cronbach’s alpha = 0.91) and can adequately separate controls from patients diagnosed as having mild cognitive impairment (MCI) and Alzheimer’s disease (p < .001). According to the original published norms for the test, to be considered cognitively intact, participants had to score 10 and above in the screening score, and 22 and above in the profile score.

The FOME output includes the “total recall” score (the sum of five free recalls of 10 objects; 0–50) and the “delayed recall” score (range 0–10). It requires the patient to remember 10 everyday objects which are touched, visually recognized, named, and placed in a bag before recall trials. It is hypothesized that the fact that test stimuli encompass real objects instead of words or black-and-white pictures should reduce education bias. The Brazilian version of the FOME has undergone an adaptation process conducted by specialists in neuropsychology to make it more appropriate for Brazilian culture. The objects included in the bag were: pencil, coffee cup with a handle, comb, toothbrush, pacifier, button, wooden clothes-pin, match box, spoon, and a small solid ball. A recent analysis (Diniz et al., 2008) using the total sample of the prospective study has shown that this version of the FOME can adequately separate normal controls from patients with MCI and Alzheimer’s disease (p < .001). The FOME instrument also yields other variables which were not included in the present analyses. A participant was considered normal when scores were above 36 points (ages 60–69), 32 points (ages 70–79), and 24 points (ages 80 and above). These scores were based on international means for healthy older adults subtracting 1.5 standard deviations to be in agreement with Petersen’s MCI criteria (Petersen, 2004).

Verbal fluency (VF) corresponded to the total number of fruits spoken in one minute. VF is considered a measure of executive function, because it requires a guided mental search for target words within a established restriction. Fruit category has been found to generate smaller performance gaps among groups with differing levels of education (Reis et al., 2003). Studies conducted with Brazilian older adults have suggested that animal and fruit category fluency tasks generate similar results and both categories seem appropriate to detect cognitive decline (Radanovic et al., 2008). Brazilian norms suggest
that healthy seniors with 8 years of education or less generate in average 13 items, and seniors with more than 8 years generate in average 16 items (Brucki & Rocha, 2004).

For TMT-A and -B, the time needed to complete each trail was reported in seconds. Trail A is widely recognized as a visual attention test; yet, it may be affected by motor deficits or decline in visual acuity. Trail B requires mental control of two different sets of information (letters and numbers) and may require intact working memory for good performance. A recent study has suggested that these instruments can help identify early cognitive decline among Brazilian elderly (Diniz et al., 2008). However, our clinical experience has shown that Trail B results should be interpreted with caution when applied to older adults with less than 4 years of education. To determine cognitive intactness, international norms were used. A 1.5 standard deviation was added to the mean score (in seconds) for each age range. Therefore, intact participants should complete Trail A in less than 53.7 s (60–69 years), 68.3 s (70–74 years), 74.1 s (75–79 years), 99.7 s (80–85 years), and Trail B in less than 139 s (60–69 years), 219.7 s (60–74 years), 194.7 s (75–79 years), 276.9 s (80–85 years).

For the SKT, the total scaled score is reported (range: 0–27 with higher scores indicating worse cognitive functioning). SKT is a short cognitive battery which evaluates episodic memory and attention. SKT attention subtests rely on timed tasks and therefore, participants with slowed processing speed may generate lower scores. The Brazilian version of the SKT has shown good internal consistency, high inter-rater reliability, and high test–retest stability (Flaks et al., 2006). According to the original published norms, participants were considered unimpaired in the SKT when total score was four points or lower.

Raw scores were presented for WAIS-R Vocabulary (0–70), as a measure of linguistic ability, and Block Design (0–51), as a visuo-constructional measure. These subtests were administered to calculate estimated IQ scores in order to characterize the sample and to obtain SKT scaled scores. The more recent WAIS-III version was not used because when participants started to be assessed in 2002, it was not yet available in Brazil. The Brazilian WAIS-R version used was translated and adapted by a team of neuropsychologists at the institute where the present study was conducted.

Evidence of functional decline was based on the scores of the Informant Questionnaire of Cognitive Disorders of the Elderly (Jorm & Jacomb, 1989) and on the Blessed Dementia Scale (Blessed et al., 1968). Clinicians also took into account caregivers’ and patients’ reports on ADL limitations.

Laboratory tests were carried out for each patient to rule out potentially reversible causes of cognitive impairment, including thyroid function, complete blood count, blood chemistry, folic acid and vitamin B12, blood lipid profile, and syphilis tests. Neuroimaging studies (CT scans or MRI) were completed according to clinical judgment.

Consensus diagnoses were reached by the expert multi-disciplinary team, taking into account clinical, neuropsychological, and laboratorial and neuroimaging data. In the larger prospective study, participants were classified as normal controls, mild cognitive impairment, and dementia. Dementia was diagnosed according to DSM-IV criteria (American Psychiatric Association, 1994). Alzheimer’s disease was diagnosed according to the NINCDS-ADRDA criteria (McKhaan et al., 1984). Diagnosis of MCI was made according to Petersen’s (2004) criteria: (a) subjective cognitive complain, preferably corroborated by an informant; (b) objective impairment in the performance on the cognitive tests of the assessment battery, but not severe enough to reach dementia diagnosis; (c) preserved global intellectual function; (d) preserved or minimal impairments in activities of daily living.

For the present study, only normal controls were included in the sample. Normal controls were participants for whom there was no evidence of functional decline and who did not show significant deficits in the neuropsychological battery. In Brazil, some cognitive instruments suitable for dementia diagnosis have had their applicability and psychometric properties evaluated (MMSE, CERAD), however almost none have normative data for older adults. Therefore, evaluating MCI criteria was particularly challenging, due to the lack of Brazilian norms for the selected instruments. To overcome this limitation, objective test results from the neuropsychological battery were compared with international norms; however, clinical judgment taking into account patients’ educational and occupational backgrounds and our clinical experience with the instruments were used to determine whether performance was below normal parameters.

Statistical Analysis

As the scores on cognitive tests did not display a normal distribution (skewness and/or kurtosis were identified for most variables), non-parametric tests (Mann–Whitney and Kruskal–Wallis) were used to compare median differences in cognitive scores. Post hoc analyses with Dunn’s test were performed when there were statistical differences in the Kruskal–Wallis output. All statistical analyses were performed using Statistical Package for Social Sciences, version 14 for Windows (SPSS, Inc., Chicago, IL).
Our results regarding memory are in accordance with previous findings from a Brazilian study (Nitrini et al., 2004) which also showed no education effect in an episodic memory test using black-and-white pictures. In the current study, RBMT and FOME did not vary significantly across the different educational groups. The scores on certain memory tests such as the RBMT and FOME did not vary significantly across the different educational groups.

As expected, several tests in the battery were strongly influenced by education, including tests of general cognitive functioning such as the MMSE, CAMCOG, and SKT. In Brazil, education-specific cutoff scores have been proposed for the MMSE (Nitrini et al., 2005), and the SKT is scored according to IQ stratified norms, which can at least partially correct for education bias. Although widely administered in clinical practice, no education-specific cutoff scores have so far been proposed for the CAMCOG, and the interpretation of its raw scores without taking into account the educational background may lead to false-positive diagnoses (Nunes et al., 2008).

The WAIS-R Vocabulary and Block Design subtests were also strongly influenced by the educational level. As shown in recent work to determine norms for the WAIS tests, such measures of intelligence are prone to an important effect of education (Amodio et al., 2002; Lange, Chelune, Taylor, Woodward, & Heaton, 2006). Schooling provides the individual with a knowledge bank that can be retained to older ages, and education may also lead to more efficient learning strategies to continue to acquire information, even after completing formal schooling.

The effect of education on cognitive function seems to have a logarithmic characteristic, that is, 1 or 2 years of education positively impact cognitive performance, with sharp improvement when a few more years are added, and little benefit after 12 years of education, which is possibly due to ceiling effects (Ardila, 2005). Brucki and Nitrini (2008), for instance, studied cognition among riverbank dwellers in the Amazon region and found that adults with minimum formal education (M = 0.8 years, SD = 1.6) significantly outperformed illiterates in a cancellation task (they were faster, more strategic, and made fewer mistakes).

Our results regarding memory are in accordance with previous findings from a Brazilian study (Nitrini et al., 2004) which also showed no education effect in an episodic memory test using black-and-white pictures. In the current study, RBMT and FOME did not vary significantly according to education, perhaps because both tests rely on pictures or real objects. It may be the case that an education effect is more easily found for memory tests when they involve written information, such as in the CERAD word list task.
Table 2. Scores for neuropsychological tests according to education

<table>
<thead>
<tr>
<th></th>
<th>RBMT screening</th>
<th>RBMT profile</th>
<th>FOME total</th>
<th>FOME delayed recall</th>
<th>Trail A</th>
<th>Trail B</th>
<th>Verbal fluency</th>
<th>SKT total score</th>
<th>WAIS-R vocabulary</th>
<th>WAIS-R block design</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;8 years (n = 22)</td>
<td>9.98 ± 1.55</td>
<td>20.99 ± 2.67</td>
<td>42.81 ± 3.49</td>
<td>9.15 ± .66</td>
<td>55.48 ± 28.88</td>
<td>132.13 ± 38.26</td>
<td>13.20 ± 2.99</td>
<td>3.49 ± 3.78</td>
<td>48.58 ± 11.30</td>
<td>19.76 ± 7.29</td>
</tr>
<tr>
<td>9–16 years (n = 23)</td>
<td>10.12 ± 1.57</td>
<td>21.74 ± 4.82</td>
<td>44.18 ± 3.30</td>
<td>9.39 ± 1.02</td>
<td>46.03 ± 5.96</td>
<td>93.19 ± 29.07b</td>
<td>14.31 ± 3.46</td>
<td>2.40 ± 2.96</td>
<td>59.46 ± 6.01a</td>
<td>25.06 ± 7.09</td>
</tr>
<tr>
<td>&gt;17 years (n = 26)</td>
<td>10.02 ± 1.30</td>
<td>22.14 ± 2.21</td>
<td>43.85 ± 2.41</td>
<td>9.17 ± .75</td>
<td>45.99 ± 10.44</td>
<td>103.17 ± 33.78b</td>
<td>15.22 ± 2.93</td>
<td>1.33 ± 1.09c</td>
<td>59.12 ± 5.30d</td>
<td>26.09 ± 7.29c</td>
</tr>
</tbody>
</table>

\( ^a \text{< 8 years vs. 9–16 years, } p < .0001. \)
\( ^b \text{< 8 years vs. >17 years, } p < .05. \)
\( ^c \text{< 8 years vs. >17 years, } p < .01. \)
\( ^d \text{< 8 years vs. >17 years, } p < .0001. \)
A possible explanation for the small impact of education on these memory tests is that they resemble tasks that are carried out routinely by older adults and therefore may be regarded as more “ecological”. Ecological tests are designed to assess cognitive domains as a proxy measure of the subject’s capacity to perform everyday activities (verisimilitude tasks; Chayton & Schmitter-Edgecombe, 2001) and it is expected that education may influence the performance less in such tasks. An alternative explanation is that memory itself may be less modulated by education, when tested in a context which offers adequate stimuli and test conditions for the sample studied. In the present study, both the RMBT and the FOME utilize concrete meaningful stimuli and untimed tasks.

In the present sample, the influence of education on the TMT-A and the CDT scores was less important than reported previously. The TMT-A scores did not vary significantly across the studied groups, but significant differences were observed for the TMT-B. This may be explained by different task demands, because the TMT-A involves mainly visual search processes and basic knowledge of numbers, whereas the TMT-B recruits working memory due to the necessary cognitive alternation and knowledge of numbers and letters. Our experience with TMT-B has shown that Brazilian older adults with less than 4 years of education have difficulty understanding the instructions and remembering alphabet sequence and therefore the effect of education on TMT-B was expected. A recent study has also shown a larger effect of education on TMT-B than on TMT-A (Ashendorf et al., 2008). Present results for the TMT-B test are also in accordance with previous findings for other populations (Hashimoto et al., 2006; Lezak, Howieson, & Loring, 2004), and therefore this test should be used with caution in the assessment of individuals with limited education.

Some methodological aspects of this study must be addressed. First, the present sample did not include illiterates and the proportion of individuals with very limited education was low, rendering the composition of the present group not representative of the whole Brazilian population, especially considering those who live in rural areas. On the other hand, there is a considerably large population that shares the demographic characteristic of the current sample, at least within the most developed urban areas, to whom the current findings will be clinically relevant. This study is strengthened by the fact that subjects did not have any detectable cognitive impairment. This may have been the case in previous studies that addressed the effect of education on cognitive screening tests, particularly those that compared demented to non-demented subjects, the latter group possibly bearing a proportion of individuals with mild cognitive impairment.

In addition, this is to our knowledge the first study addressing the influence of very high educational attainment in a sample of cognitively unimpaired older Brazilians. This sub-sample had a mean educational level of more than 18 years of education which corresponds to graduate education in Brazil. As previously reported (Ardilla, 2005), we observed that the groups with high and very high education did not display significant differences in cognitive performance. One possible explanation is that the tests in the battery may have been too simple for both groups, failing to capture abilities tailored by additional years of education. In order to overcome this issue, more complex tests should be administered to evaluate the cognitive performance of such subjects. Ceiling effects may also have occurred in some tests, such as the RBMT. Alternatively, one could hypothesize the existence of a threshold effect, that is, additional years of schooling after college would not result in further benefits to basic cognitive skills nor incremental changes in brain architecture. However, this hypothesis seems unlikely, given recent neuroimaging studies conducted with healthy older adults. In such studies, better cognitive performance was correlated to patterns of brain activation (indicative of higher reserve) and was associated to years of education (Cabeza, Anderson, Locantore, & McIntosh, 2005; Stern et al., 2005).

Limitations of the current study include: the small sample size, which may have favored the absence of significant differences among the three groups of participants; the use of international norms for cognitive tests, which may have produced a sample of older adults with unusually high performance levels; and the exclusion of illiterates. Present results should be replicated in larger samples, with a representative proportion of older adults in each educational stratum, in different regions of the country.

In conclusion, our results support the notion that clinicians should carefully select tests when assessing cognitive complaints in populations with low educational background. Tests that resemble activities of daily living, such as the RBMT, the FOME, and VF (fruit category), may be better tools for the assessment of older adults with such characteristics.

Funding

This work was supported by grants from FAPESP process no. 02/12633-7 and from the Associação Beneficente Alzira Denise Hertzog da Silva (ABADHS).

Conflict of Interest

The authors report no conflict of interest.
References


