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CROSS-CULTURAL ADAPTATION OF VISUAL REPRODUCTION SUBTEST OF WECHSLER MEMORY SCALE FOURTH EDITION (WMS-IV) TO A BRAZILIAN CONTEXT

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Abstract

Objective: Brazilian versions of instruments to evaluate non-verbal memory are scarce. The Visual Reproduction (VR) subscales I and II of the Wechsler Memory Scale are considered the gold standard among memory assessment measures. The aim of the present study was to develop a cross-cultural adaptation of the Visual Reproduction subtest of the Wechsler Memory Scale–fourth edition (VR-IV), suitable for Brazil, and to evaluate its preliminary psychometric properties.

Method: Participant assessment and data analysis followed the methodology recommended by the American Educational Research Association, the American Psychological Association, and the National Council on Measurement in Education (2009). Eighty-five healthy adult volunteers and 29 adult right-middle cerebral artery (RMCA) stroke patients were evaluated. The adaptation of the VR-IV involved a group of experts and translators who analysed conceptual, item, semantic, and operational equivalence. Some psychometric properties of the instrument were also evaluated.

Results: All the equivalence categories were achieved in the Portuguese adaptation. Significant healthy group correlation coefficients were also obtained. Scale reliability analyses showed moderate correlations that indicated the temporal stability of the instrument. The RMCA stroke patients obtained lower raw scores in all tasks of the VR-IV in comparison to the control group.

Conclusions: Our results indicate that the Portuguese adaptation of the VR-IV has cultural reliability and validity for use in Brazil. The performance of the RMCA stroke patients and paired controls was best evaluated using contrast scaled scores, in comparison to the performance using each variable separately. The contrast scaled scores enabled the observation that the RMCA stroke patients had limitations in encoding and retrieving learning information.

Key words*:* cross-cultural comparison, Wechsler Memory Scale, memory deficit, memory disorders, visual memory, middle cerebral artery stroke

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Introduction

Memory evaluation may facilitate diagnosis by characterizing the nature, extent, and severity of cognitive dysfunction. A correct diagnosis can contribute to treatment and help clinicians determine whether deficits are functional or organic. A great diversity of neurological impairments may affect memory, including those caused by infection, degenerative diseases, traumatic brain injury, stroke, and psychiatric disorders (Armien et al. 2010, Lim and Alexander 2009). Stroke is one of the most common neurological conditions (DATASUS 2007) in Brazil. Stroke increases the possibility of vascular dementia, and silent ischemic events also play an important role in the development of vascular dementia. The type of post-stroke dementia can also be determined by individual patient and stroke characteristics (Joray 2009). The major causes of stroke (haemorrhages, infarctions, and embolisms) can all produce dementia, although many single strokes leave little apparent cognitive deficit. When there are cognitive problems following a stroke, the site of the lesion usually determines the clinical prognosis. For example, a dominant middle cerebral artery (MCA) infarct results in dysphasia, dyscalculia, and dysgraphia (Brown and Rossor 2008). Memory is one of the commonly affected cognitive functions in stroke (Lezak et al. 2005, 2012), and the MCA is frequently involved (Paradiso et al. 2011, Szabo et al. 2009). In this type of injury, the patient may experience syndromes involving cognitive impairment such as visual neglect (Mort et al. 2003, Bird et al. 2006), visual agnosia and prosopagnosia (Benson 1974, Cals et al. 2002), constructional apraxia (Miyai et al. 1999), topographical disorientation (Min et al. 2000), among others. Psychiatric disorders are also reported, such as depression, confabulation, delirium, mental confusion, and decreased pleasure (Carmichael et al. 2004, Mohr et al. 2011). Impairment in nonverbal memory is attributed to lesions in the right hemisphere (Lezak et al. 2012).

There are very few visual memory assessment instruments specific to Brazil. We were able to find only seven instruments in the System of Evaluation of Psychological Tests (Federal Council of Psychology 2011). Among them, the Rey-Osterrieth Complex Figure (ROCF) is the only nonverbal evaluation instrument authorized for use with a Brazilian population. Data from the literature shows that the ROCF is more based on the organization of complex visual-spatial data than on visual memory skills when compared to the Visual Reproduction (VR) subtest. Furthermore, the immediate and delayed recalls evaluation in the ROCF are comparable to the VR's immediate recall (Dwarshuis et al. 1992).

Originally published more than 40 years ago (Wechsler 1945), the Wechsler Memory Scale was intended as a 'rapid, simple and practical memory examination'. The scale subtests measure several aspects of learning (short-and long-term memory, recognition, and copy) in the following domains: visual memory, auditory memory, visual working memory, and immediate and delayed memory. The WMS can be used to investigate the cognitive profile of patients with traumatic brain injury, mild cognitive impairment, Alzheimer's disease, major depressive disorder, anxiety disorder, and intellectual disability, among others (Wechsler 2008). The WMS is used worldwide for memory evaluation (Straus et al. 2006, Mitrushina 2005). The WMS—Third Edition was adapted for Danish, English (the US, Australia, and the UK), Finnish, French, Norwegian, Spanish, Swedish, Portuguese (Portugal), and Indian populations (see Pearson Assessment PsychCorp, website http://www.pearson.com). Although it is considered the gold standard instrument for memory assessment, no formal adaptation exists for use with a Brazilian population.

The present study aimed to adapt and investigate the psychometric properties of the Visual Reproduction (VR-IV) subtest of the WMS-IV in a sample of Brazilian healthy adults and stroke patients. The VR-IV is designed to test non-verbal episodic memory; it is also an alternative measure to evaluate visual memory and constructive ability. It is expected that the assessment of immediate and delayed visual memory, praxis, recognition, and forgetfulness for non-verbal stimuli will be comparable between the Brazilian Portuguese version and the original American version.

Methods

Volunteer healthy adults and stroke patients

One hundred fourteen individuals (85 healthy adults and 29 ischemic stroke patients) recruited from the community and the Clinical Hospital of Ribeirão Preto, São Paulo (HC-FMRP), in south-eastern Brazil participated in this study. Healthy adult volunteers 20–59 years of age were eligible to participate in the study. Exclusion criteria were investigated by structured interview and included antecedents of psychiatric or sensory processing disorders, previous experience with the WMS test, non-native speakers of Brazilian Portuguese, drug or alcohol addiction, disabilities of the upper extremities that significantly affected motor performance, expressive or receptive aphasia, traumatic brain injury or loss of consciousness for a period longer than 20 minutes, significant depression or anxiety, and refusal to sign the informed consent. A subset of the healthy adults group was selected for test-retest reliability. An additional subset of the healthy sample was paired with the stroke sample based on age and education characteristics as a control group (paired controls) for the analysis of criteria validity.

For the RMCA stroke group, inclusion criteria were 18–59 years of age with a confirmed diagnosis with MRI or CT images of unilateral vascular lesion due to RMCA obstruction with a minimum of one year in stable clinical condition. Exclusion criteria for the stroke patients were lesions in the left hemisphere (or severe aphasia) and mental co-morbidity (dementia or psychiatric disorders) as determined by clinical and neurological evaluation and results from the Beck Depression and Anxiety scales and the Mini-Mental State Exam. All 29 stroke patients who met the criteria were recruited from the Clinic of Neurovascular Diseases of the Hospital of the Medical School of Ribeirão Preto (HC-FMRP) from May to December, 2011.

This research was approved by the Ethics Committee of the HC-FMRP-USP and conducted in accordance with the Declaration of Helsinki. Pearson Corporation authorized the authors to translate the original version of the scale to Portuguese and carry out a trans-cultural adaptation for Brazilian populations.

Instruments

A Brazilian version (Brucki et al. 2003) of the Mini-Mental State Exam (MMSE) (Folstein et al. 1975) was used for cognitive screening, and Brazilian versions of the Beck Depression (BDI) and Anxiety scales (BAI) (Cunha 2011) were used to screen for psychiatric disorders. In order to ensure quality control in testing procedures and to assist the development of the adapted version of the VR-IV, the examiner completed a training program that addressed the most frequent administration and scoring errors. The scoring studies for the VR-IV were attempted and compared to the original study. All screening instruments were administered verbally by the examiner. Each application took approximately 60 minutes. An interval of 20–30 days was used for the test-retested group.

WMS-IV: Visual Reproduction I (VR I) and Visual Reproduction II (VR II) subtests

The VR subtests of the Wechsler Memory Scale were originally developed to evaluate immediate recall. Revisions of the previous VR subtests produced the delayed recall form, which includes a delayed condition of 20–30 minutes for recall. Thus, the VR-IV consists of tasks divided into immediate and delayed recall (VR-I and VR-II).This subtest evaluates the memory for non-verbal visual stimuli. The revisions during the development of the WMS-IV excluded or modified some WMS-III subtests due to scoring, administration time, and psychometric issues. The new VR-IV version was faster, easier, and included a new oriented score procedure as compared to the previous version. Additionally, the VR-IV was changed from an optional to a primary subtest. The new VR-IV is composed of five items (cards), three of which contain a single figure on separated cards. The fourth and the fifth items consist of two designs each (designs A, B, C and D).

The examinees were to observe each figure for 10 seconds, and then draw it immediately from memory. This procedure is carried out for all items on immediate recall (VR I). In the delayed condition (VR II), the examinee is first asked to draw the designs shown during the immediate condition from memory in any order, 20–30 minutes after VR I. Next, the examinee is asked to choose which of the six designs on a page matches the original design shown during the immediate test (VR II Recognition). Third, the optional copy tasks can be performed; these consist of drawing the designs while looking at them.

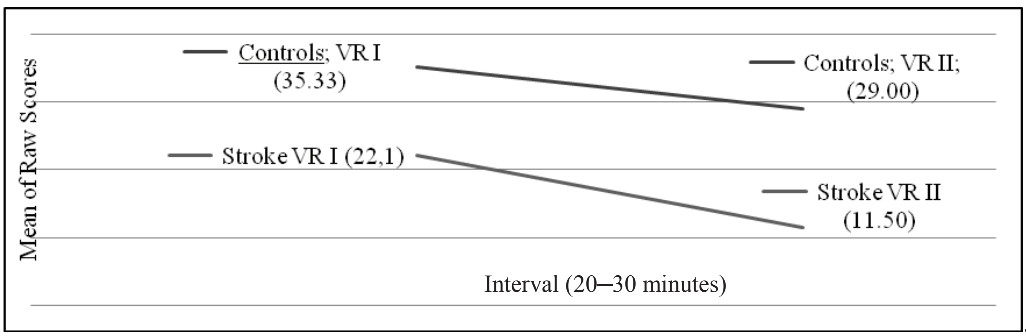
The raw scores for the VR subtests I and II were calculated according to the scoring system from the WMS-IV administrative and scoring manual. Each item has dichotomous scoring criteria: 1 point if correct, or 0 if incorrect. Raw subtest scores are obtained by summing the five items. The maximum raw scores for VR I, VR II Delayed Recall, and Copy are 43 points each. For the Recognition task, the maximum total score is 7 points. Each total raw score can be converted to scaled scores based on the examinee's test age. Each scaled score can be summed to obtain the index scores, depending upon the scoring approach. In the standard approach, when the VR-IV subtest is combined with other subtests, it is possible to obtain the Visual Memory Index (Designs and ∑VR-IV subtest—VR-I and VR-II), the Immediate Memory index (VR I, Designs I, Verbal Paired Associated I, and Logical Memory I), the Delayed Memory Index (VR II, Designs II, Verbal Paired Associated II, and Logical Memory II). Beyond these index scores, the WMS-IV provides the ability to compare an examinee's subtest scores in order to evaluate discrepancies and memory ability, and investigate the contrast scaled scores. The contrast scaled score evaluates the degree to which common variance may account for the performance of a determined score on a related score (Wechsler 2009). Thus, it can be possible to determine the loss of information from immediate to delayed memory, or forgetfulness (VR II Recognition vs. VR II Delayed Recall). The second qualitative comparison (Copy vs. VR I immediate recall) is an optional procedure that compares the examinee's memory performance to their visual-constructional ability, motor control, and attention to detail. The third comparison (VR I vs. VR II) indicates the ability to perform free recall without prompting. This can also indicate the ability to accurately recognize information previously learned, regardless of its free access.

Current theories (Szpunar, McDermott 2008) of episodic memory postulate that information must pass through semantic memory before it is encoded into episodic memory. This implies that previous knowledge influences the efficiency of the episodic memory system. From the perspective of this conceptual framework, the WMS-IV is primarily a measure of declarative episodic memory.

Translation and cross-cultural adaptation of the WMS-IV VR subtest

The cross-cultural adaptation of the VR-IV subtest was based on a modified standard method (Guillemin et al. 1993, Herdman et al. 1997, Beaton et al. 2000, Reichenheim and Moraes 2007). The process of cross-cultural adaptation consists of the following phases: conceptual, item, semantic, operational, measurement, and functional equivalents *(***Figure 1**). A multidisciplinary group was assembled of professional translators,

Figure 1. *Memory performance considering the 20–30-minute interval after administration, comparing the rates of forgetting of groups (VR I Immediate Recall and the task of VR II Delayed Recall)*



neurologists, psychologists, and neuropsychologists to study the adaptation. Conceptual and item equivalents consisted of the exploration of the construct of interest and the comparisons given to its different constituent domains between countries. Semantic equivalence involved the following steps: first, the administration and correction procedures of the American version of the Visual Reproduction I and II were translated into Brazilian Portuguese by three independent translators and psychologists fluent in American English. After translation, these three versions constituted one panel for analysis. The translated versions were judged by two expert professionals to establish the preliminary Brazilian Portuguese version. This version was back-translated to American English by a certified translator not familiar with the study, and then compared with the others.

A pilot study was then carried out with 24 randomly selected healthy adults in order to assess the clarity of the Brazilian Portuguese instructions. Subsequently, the committee of experts and a second professional translator made a formal evaluation of equivalence between the translation, back-translation, and original versions. Agreement among judges was considered satisfactory when it represented 80% of concordance.

Statistical analysis

The statistical analysis of VR-IV performance was conducted as in the original study. We intended to establish the degree of confidence with which interpretations of each individual RV-IV score could be made. All analysis used traditional values for significance ($p<0.05$ and $p<0.001$). The current study utilized the Standards for Educational and Psychological Testing (AERA 2008), the psychometric reference indicated by the original study in the Technical Manual of the WMS-IV and by Pearson's editors. The following reliability analyses were performed: a) Cronbach's alpha coefficient; b) Pearson's correlation for test-retest reliability.

The evidence of validity based on relationships with other variables was based on validity criteria determined by comparing groups (stroke and paired controls). Mean, standard deviation, and standard scores (Cohen's *d*) were calculated for both stroke and normal groups to compare them in one normative sample. ANOVA and ANCOVA analyses were performed to investigate the variance between groups and the influence of demographic variables (sex, age, and education) in our results. SPSS® statistical software was used.

Results

Demographic data

Demographic data are shown in Table 1 for the three groups: all healthy samples (N = 85), stroke patients (N = 29), and the paired group (N = 30). Significant differences were found for all tasks of VR ($p < 0.001$) between the stroke and paired controls groups. The influence of education was found in VR-I and VR-II tasks ($p < 0.05$). Age was not found to be significant in the present study.

Cross-Cultural adaptation

Conceptual and item equivalence

The concepts of the constructs ('memory', 'visual memory', and their alterations associated with anatomical brain damage caused by CMA stroke) were equivalent between the American and Brazilian cultures. Because of their abstract nature, the designs were considered culturally neutral.

Semantic equivalence

The semantic equivalence of the Brazilian Portuguese version was evaluated by the judges and translators, resulting in a 93% rate of concordance. The pilot study was conducted with 24 individuals divided into two groups: 18–40 (50%) and 41–65 years (50%) of age (38% men, 62% women). Educational levels (years of formal school completed) were 2–6 (26%), 7–11 (26%), 2–15 (35%), and over 15 years (13%). The Brazilian Portuguese version of the instructions was understood by all participants with no suggestions for changes (90%). However, some comments were

Table 1. *Demographic data of the healthy, control, and stroke groups*

Group	Variable	Mean	SD	Min	Max
Total healthy sample	Education	10.2	3.2	2	19
N = 85	Age	40	10.3	18	58
	MMSE	29.2	0.9	23	30
Stroke Sample	Education	7.6	3.3	2	15
N = 29	Age	47.7	6.6	18	58
	MMSE	25.9	2.1	21	30
	Glasgow	14.9	0.2	14	15
Controls of Stroke Sample*	Education	8.4	3.3	4	15
N = 30	Age	47.7	7.6	27	58
	MMSE	28.3	1.5	20	30

Notes: *Paired controls for the stroke group (subset of the healthy group); SD = standard deviation; Min = minimum; Max = maximum; MMSE = Mini Mental State Exam; Glasgow: Glasgow Coma Scale

Table 2. *Mean (SD) and Cronbach's alpha for the sample of healthy controls*

Variables (N = 10)	Mean (SD)	Cronbach's Alpha
VR I_01	4.66 (1.03)	0.88
VR I_02	4.00 (1.32)	
VR I _03	5.89 (1.89)	
VR I _04	9.98 (3.74)	
VR I _05	7.25 (4.53)	
VR II_01	3.02 (2.25)	
VR II _02	3.34 (1.92)	
VR II _03	5.08 (2.69)	
VR II _04	7.89 (4.59)	
VR II _05	6.27 (5.14)	
Σ VR I	31.78 (10.60)	0.92
Σ VR II	25.60 (12.75)	

Notes: SD: standard deviation Delayed Recall; VRI_01: Figure 1 of Visual Reproduction Immediate Recall task; VRI_02: Figure 2 of Visual Reproduction Immediate Recall task; VRI_03: Figure 3 of Visual Reproduction Immediate Recall task; VRI_04: Figure 4 of Visual Reproduction Immediate Recall task; VRI_05: Figure 5 of Visual Reproduction Immediate Recall task; VRII_01: Figure 1 of Visual Reproduction Delayed Recall task; VRII_02: Figure 2 of Visual Reproduction Delayed Recall task; VRII_03: Figure 3 of Visual Reproduction Delayed Recall task; VR II_04: Visual Reproduction of Figure 4 Delayed Recall task; VR II_05: Figure 5 of Visual Reproduction Delayed Recall task.

made about the short exposure times for the designs, the complexity of the final design, and the need for notification about a late recall. All suggestions were discussed, but no sufficient reason was found to justify changes in the stimuli or instructions. In conclusion, the expert judges considered the adapted version to be connotatively and denotatively equivalent to the original version.

The format of the questions and statements was similar across regional versions. Graphics format and the arrangement of the designs were maintained as in the original because they were considered neutral with respect to cultural differences.

Table 3. *Stability coefficients (r) for all scores of RV and IMV*

Variables	Stability Coefficient (r)
VR-I	0.54**
VR-II	0.29
VR-II (Rec.)	0.43*
VR-II (Copy)	0.40*
VMI	0.43*

Notes: Significance level: ** $p < 0.001$, * $p < 0.05$, r: Pearson's correlation coefficient; VR- I: Visual Reproduction Immediate Recall; VR-II: Visual Reproduction Delayed Recall; VR-II (Rec.): Visual Reproduction Recognition; VMI: Visual Memory Index (Flexible Approach).

Psychometric properties

Internal consistency

The mean, standard deviation, and coefficients are shown in Table 3. The coefficient of internal consistency among the variables—Cronbach's alpha coefficient—was 0.92 and 0.88 for all variables of VR-IV. In the present study, the coefficient of internal consistency (Cronbach's alpha) exceeded 0.70 for the tasks of immediate and delayed recall of the RV. This indicates a high internal consistency (Pasquali 2004).

Test-retest reliability

Test-retest reliability was calculated (Table 3). Pearson's correlation test showed that the measures of VR-I, VR-II Recognition, VR-II Copy and VMI showed some correlation ($r = 0.54$, $p < 0.001$ and $r = 0.43$, $p < 0.05$). This result revealed moderate correlations that indicate the temporal stability of this instrument.

Validity

Evidence based on response processes

The expert judges observed that the participants' performance during the pilot phase showed consistency regarding the constructs and items related to evocation, constructive abilities, perception, and praxis.

Criterion-related validity

The stroke patients obtained lower raw scores in all tasks of RV as compared to the control group (Table 4). It was also noted that the mean of performance in the Copy task and the total score were significantly higher in the paired controls when compared to the stroke patients. In sequence, the next figure compared the mean between the groups, considering retention time between VR-I and VR-II, and showing the forgetting rate in each group. Figure 1 shows that recall declined between VRI (immediate recall) and VR II (delayed recall) for both groups as time passed, showing the retention capacity of the material learned by each group. As expected, a decline was noticed as time went on. In each modality of the VR-IV, the tasks analyse the memories at different times. The comparison using scaled scores enables the investigation of our findings with an original normative sample. The performance of the VR-IV task in the stroke group revealed a low score when compared to the Brazilian and American samples of normal subjects. Contrast scaled scores showed that the stroke patients had difficulty retrieving the stored information. When Immediate Recall was compared with the Copy tasks, it was noticed that copying ability, attention to detail, and visuo-constructional memory were affected in the stroke patients. As expected, the specific paired controls selected to compare with the stroke patients performed similarly to the American normative sample with respect to the standard score, and the stroke patients demonstrated inferior performance. These results indicate the validity of the Portuguese translation of the VR-IV used in the present study.

Functional Equivalence

Our findings indicate that the VR of the WMS-IV is culturally similar in constructs, semantics terms, and psychometric properties between the original tool and the version adapted for use with a Brazilian sample.

Discussion

In order to propose a preliminary version of the VR-IV subtest of the WMS-IV, modified standard methods (Guillemin et al. 1993, Herdman et al. 1997, Beaton et al. 2000, Reichenheim and Moraes 2007) were followed because they were suggested for use in Brazil.

According to this theoretical approach, the first step is to establish conceptual and item equivalence. This analysis aimed to investigate whether the concepts and items of interest would be relevant and appropriate to the new, adapted context, considering the different areas inherent in the original instrument (Reichenheim and Moraes 2007). The designs of the VR-IV are based on visually recognizable geometric shapes, the names of which are well known in elementary schools in Brazil and the United States of America. The technical manual recommends that the geometric designs should be named so that the appointment facilitates the encoding (Wechsler 2009). These findings could give rise to the question of whether, if it can be named, the visual stimulus has a verbal mediation. Wechsler explained that to draw the figure, the participant must remember the size and spatial relationship between elements; a purely verbal strategy would be inefficient to perform adequately in this subtest (Wechsler 1945). These considerations are limited because they do not account for the participation of illiterate individuals in the present study, for which the minimum time at school was two years. It is important to consider that culture can affect the development of non-verbal skills, regardless of educational level (Rosselli and Ardila 2003). Semantic equivalence was obtained, considering that 93% of the translation was considered to be unchanged or equivalent by the expert judges. Interviews conducted during the pilot study indicated a level of understanding over 90%, as required in the literature (Herdman et al. 1997, Beaton et al. 2000, Reichenheim and Moraes 2007). The results of the pilot study supported the similarity between American and Brazilian cultures with regard to the identification and understanding of the figures. Based on the above observations, we conclude that although the pilot study documented participants' comprehension in our study region, we cannot disregard the heterogeneity of Brazilian culture; differences among the pre-tests could be revealed in future studies in other regions. Operational equivalence was maintained because no changes were made to the content and structure of the VR-IV. As previously mentioned, the measurement of equivalence is based

Table 4. *ANCOVA and ANOVA (copy) analysis of groups with stroke and paired controls: mean, standard deviation, scaled score, cumulative percentage, standard score, classification, significance (p), and mean difference of groups*

Group		Raw score	Scaled Score	Cumulative Percentage	Standard Score	Class
Stroke	Σ VR I	22.4 (1.5)	3		65	Extremely low
	Σ VR II	11.8 (1.3)	6		80	Low average
	Recogn.	2.8 (0.3)		≤2		Extremely low
	Copy	34.6 (8.5)		17–25		Low average
Controls	Σ VR I	35.0 (1.4)	10		100	Average
	Σ VR II	28.7 (1.3)	9		95	Average
	Recogn	5.7 (0.2)		3–9		Borderline
	Copy	42.1 (2.68)		26–50		Average
	p	All	variables	< 0.001		

Notes: SD = standard deviation; ΣVR I = total sum score Visual Reproduction Immediate Recall; ΣVR II: total sum score Visual Reproduction Delayed Recall; p = significance level.

on the investigation of the psychometric properties of the adapted instrument in comparison to those of the original instrument (Guillemin et al. 1993, Herdman et al. 1997, Beaton et al. 2000, Reichenheim and Moraes 2007). Preliminary Classical Test Theory analyses were performed as an essential part of the measurement of equivalence.

It is important to clarify our choice of RMCA stroke patients for this study. First, stroke is the second leading cause of death (5.7 million per year) worldwide (DATASUS 2007). Second, stroke is the primary cause of death of Brazil, totalling 31.9% of all deaths (DATASUS 2007). Brazil spent an estimated $2.7 billion of the national budget on heart disease, stroke, and diabetes care in 2005 (Cabral et al. 2009). The MCA is the largest branch of the internal carotid artery, and is the most frequently affected by stroke (Abbie 1934). Finally, we chose only right-handed middle cerebral artery stroke patients because the integrity of the left hemisphere did not allow any bias in the test design that could be related to a loss of motor strength in the right superior limb. It is expected that validation of this scale with these right-hemisphere stroke patients is sufficient to recommend the use of the scale for any other disease associated with memory disorder in Brazilians.

The WMS is indicated to investigate the cognitive profile of patients with traumatic brain injury, mild cognitive impairment, Alzheimer's disease, major depressive disorder, anxiety disorder, and intellectual disability, among others (Wechsler 2008). Studies on the factor loading of the VR subtest have shown that it has a strong relationship with the Visual Organization factor of the Wechsler Adult Intelligence Scale (Lezak 1995, Larrabee and Curtiss 1995, Williams et al. 1998).

As in the original study, the coefficient of internal consistency (Cronbach's alpha) for the tasks of immediate and delayed recall of the RV indicated a high internal consistency. The rates of internal consistency in the original study were between 0.93 and 0.97 (Wechsler 2009, Drozdick et al. 2011). Thus, our findings are consistent with the original American version of the VR, indicating equivalence between cultures when using the Portuguese translation that we created. The temporal stability of the original study (Wechsler 2009) was obtained from a sample of 173 healthy adults with a testing interval of 23 days (range 14–84 days). In this study, the temporal stability of the instrument was assessed in all variables of the RV: copy, recognition, and total RV. The results of the stability coefficient obtained in our study ($r = 0.54$ and $r = 0.29$, $p < 0.05$) as well as the original version ($r = 0.62$ and $r = 0.59$, $p < 0.05$) were particularly susceptible to the effect of practice (Drozdick 2011), which suggests that practice effects must be considered in administration within a short period (e.g. 1–3 months). As in most memory tests, the learning effect can occur (Lezak et al. 2005). However, assuming that these results were consistent with the original study, we can say that the measurement equivalence between the original instrument and the adapted version shows evidence of reliability, either by temporal stability, analysis of alpha coefficients, or correlations between the items and figures that make up the RV.

The validity of a test is simply the most important and fundamental criteria for the development and evaluation of an instrument (American Educational Research Association (AERA), American Psychological Association (APA), National Council on Measurement in Education (NCME) 2008). Evidence based on response processes was observed in the judges' theoretical and empirical analysis of the results of the examinees' performance. The consistency in the constructs and items related to evocation, constructive abilities, perception, and praxis was observed by the expert judges' analyses of the constructs.

The evidence based on relationships to other variables (test criteria) was investigated through the relationship between the stroke patients and normal controls. Considering that the memory system is complex and influenced by multiple factors including motor control, attention, and construction ability, we utilized contrast scaled scores to investigate how this system could be more impaired in patients with MCA stroke. As discussed in confirmatory factor analysis conducted in previous studies (Burton et al. 1993) with previous versions of the WMS, the measures of this scale presented separate but correlated memory functions. Thus, we believe that the contrast scaled scores provide the best type of analysis, because they were able to show that the groups with stroke patients had difficulty spontaneously recovering stored information; that is, they had difficulty with working memory. The scaled scores also showed reductions in their ability to copy, to perform visuo-constructional abilities, and to pay attention to details. Further, the scaled scores showed that the stroke patients' ability to recall and draw the pictures was preserved. Hemispheric specialization (considering the left and right temporal lobe structures separately for verbal and nonverbal declarative memory) is well accepted (Parkin 1997, Frisk and Milner 1990, Lee et al.1989, Martins et al. 2013). Injury to the left temporal lobe is associated with deficits in learning and verbal memory. Our validation study in MCA stroke patients aimed to reflect the methodological difficulty of developing a valid measure of non-verbal memory. The contrast scaled scores of the VR-IV are able to identify cognitive performance on a task and control for confounding factors caused by other cognitive domains, such as visuo-perceptual, constructional, and verbal components. The effect of memory impairment on different types and stages of information processing depends on the different neuroanatomical stroke sites. It is known that damage in the right hemisphere of the parietal lobe on the posterior division of the MCA can cause visuomotor apraxia, visuospatial disorders, and neglect syndrome (Martins et al. 2013). The contrast scaled scores of the VR-IV in the present study allowed further investigations in this vein, supporting our results. These results allow us to affirm that the Visual Reproduction test was sensitive for differentiating the MRC stroke group from the paired controls, thus indicating its validity. These findings support the evidence of validity based on relationships with other variables (test criteria).

Some limitations of this research should be mentioned. The sample of healthy volunteers should be expanded with regard to age, education, and the inclusion of individuals from other regions of Brazil with differing cultural characteristics. Therefore, more extensive normative studies and psychometric analyses are needed in different populations and regions of Brazil using the translation we created. It is also recommended that other groups use the scale in different types of research. Inter-observer agreement studies are also necessary to confirm reproducibility when using the scale. Our findings strongly suggest that the version of the Visual Reproduction subtest of the WMS-IV adapted for use with a Brazilian sample is culturally similar in constructs, semantics terms, and psychometric properties to the original tool.

References

Abbie AA (1934). The Morphology of the Fore-Brain Arteries, with Especial Reference to the Evolution of the Basal Ganglia. *Journal of Anatomy* 64, 4, 433-470.

American Educational Research Association, American Psychological Association, & National Council of Measurement in Education (1999). *Standards for educational and psychological testing*. AERA,Washington, DC.

Armien, AG, Hu, S, Little, MR, Robinson, N, Lokensgard, JR, Low, WC, Cheeran, MCJ (2010). Chronic cortical and subcortical pathology with associated neurological deficits ensuing experimental herpes encephalitis. *Brain Pathology* 20, 4, 738-750.

Beaton DE, Bombardier C, Guillemin F, Ferraz MB (2000). Guidelines for the process of cross-cultural adaptation of self-report measures. *Spine* 25, 24, 3186-3191.

Benson D, S.J.A.M.L. (1974). Visual agnosia-prosopagnosia: A clinicopathologic correlation. *Archives of Neurology* 30, 4, 307-310.

Bird CM, Malhotra P, Parton A, Coulthard E, Rushworth MFS, Husain M (2006). Visual neglect after right posterior cerebral artery infarction. *Journal of Neurology, Neurosurgery & Psychiatry* 77, 9, 1008-1012.

Brown J and Rossor M (2008). Vascular and other dementias. Retrieved from: http://www.rcpsych,ac,uk/pdf/semOAPch5.pdf (15/02/2013).

Brucki S, Nitrini R, Caramelli P (2003). Sugestões para o uso do Mini-exame do estado mental no Brasil. *Arquivos de Neuropsiquiatria* 61, 3b, 777-781.

Burton, DB, Mittenberg, W, Burton, CA (1993). Confirmatory factor analysis of the Wechsler Memory Scale–Revised standardization sample. *Archives of Clinical Neuropsychology* 8, 467- 475.

Cabral NL, Gonçalves AR, Longo AL, Moro CH, Costa G, Amaral CH, Souza MV, Eluf-Neto J, Fonseca LA (2009). Trends in stroke incidence, mortality and case fatality rates in Joinville, Brazil: 1995-2006. *Journal of Neurology, Neurosurgery & Psychiatry* 80, 7, 749-754.

Cals N, Devuyst G, Afsar N, Karapanayiotides T, Bogousslavsky J (2002). Pure superficial posterior cerebral artery territory infarction in The Lausanne Stroke Registry. *Journal of Neurology* 249, 7, 855-861.

Carmichael ST, Tatsukawa K, Katsman D, Tsuyuguchi N, Kornblum HI (2004). Evolution of diaschisis in a focal stroke model. *Stroke* 35, 3, 758-763.

Cunha JA (2011). *Escalas Beck - Manual Técnico*. Casa do Psicólogo, Itatiba-SP.

DATASUS Ministério da saude - Departamento de Informática do SUS (2007) Hospital Information System SUS - SAI. Retrieved from http://www.datasus.gov.br.

Drozdick LW, Holdnack JA, Hilsabeck RC (2011). *Essentials of WMS-IV Assessment*. John Wiley & Sons, Inc. New Jersey.

Dwarshuis L, Waggoner C, Nelk K (1992). A comparison of the Wechsler memory scale-revised and the Rey Osterrieth complex figure design. *Archives of Clinical Neuropsychology* 7, 4, 325.

Folstein M, Folstein S, McHugh P (1975). Mini mental state: a practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research* 12, 189-198.

Frisk V, Milner B (1990). The role of the left hippocampal region in the acquisition and retention of story content. *Neuropsychologia* 28, 349-59.

Guillemin F, Bombardier C, Beaton D (1993). Cross-cultural adaptation of health-related quality of life measures: Literature review and proposed guidelines. *Journal of Clinical Epidemiology* 46, 12, 1417-1432.

Herdman M, Fox-Rushby J, Badia X (1997). 'Equivalence' and the translation and adaptation of health-related quality of life questionnaires. *Quality of Life Research* 6, 3, 0-0.

Joray S, Ghikai J, Bogoussalvsky J (2009). Stroke: Clinical Manifestations and Pathogenesis. In Marc Fisher (eds) *Handbook of Clinical Neurology*, pp. 656. Elsevier Science Limited.

Larrabee GJ, Curtiss G (1995). Construct validity of various verbal and visual memory tests. *Journal of Clinical and Experimental Neuropsychology* 17, 4, 536-547.

Lee GP, Loring DW, Thompson JL (1989). Construct validity of material specific memory measures following unilateral temporal lobe ablations. *Psychological Assessment* 1, 192-197.

Lim C, Alexander MP (2009). Stroke and episodic memory disorders. *Neuropsychologia* 47, 14, 3045-3058.

Lezak MD (1995). Neuropsychological Assessment. Oxford University Press, New York.

Lezak MD (1995). *Neuropsychological Assessment*. Oxford University Press, New York.

Lezak MD, Howieson DB, Bigler ED, Tranel D (2005). *Neuropsychological Assessment*, 2th ed. Oxford University Press, New York.

Martins IP, Caieiro L, Ferro JM (2013). Cognitive and Behavioral disorders according to stroke and side. In Oliver Godefroy (eds) *The Behavioral and Cognitive of Stroke*. Cambridge University press, Cambridge.

Min WK, Park KK, Kim YS, Park HC, Kim JY, Park SP, Suh CK (2000). Atherothrombotic Middle Cerebral Artery Territory Infarction : Topographic Diversity With Common Occurrence of Concomitant Small Cortical and Subcortical Infarcts. *Stroke* 31, 9, 2055-2061.

Mitrushina M, Boone KB, Razani J, D'Elia LF (2005). *Handbook of Normative Data for Neuropsychological Assessment*, 2th ed. Oxford University Press, USA.

Miyai I, Suzuki T, Kang J, Kubota K, Volpe BT (1999). Middle Cerebral Artery Stroke That Includes the Premotor Cortex Reduces Mobility Outcome. *Stroke* 30, 7, 1380-1383.

Mohr P, Lazar R, Marshall R (2011). Middle cerebral artery disease. In Grotta, Wolf, Mohr, Moskowitz, Mayberg and V Kummer (eds) *Stroke*, pp. 384-424. Elsevier, New York.

Mort DJ, Malhotra P, Mannan SK, Rorden C, Pambakian A, Kennard C, Husain M (2003). The anatomy of visual neglect. *Brain* 126, 9, 1986-1997.

Paradiso S, Anderson BM, Boles Ponto LL, Tranel D, Robinson RG (2011). Altered Neural Activity and Emotions Following Right Middle Cerebral Artery Stroke. Journal of stroke and cerebrovascular diseases. *The official journal of National Stroke Association* 20, 2, 94-104.

Parkin A (1997). *Memory and amnesia: an introduction*, 2nd ed. Blackwell, Oxford.

Pasquali L (2004). *Psicometria: teoria dos testes na psicologia e na educação*, 2th ed. Vozes, Petrópolis.

Reichenheim M, Moraes C (2007). Operacionalização de adaptação transcultural de instrumentos de aferição usados em epidemiologia. *Revista de Saúde Pública* 41, 4, 665-673.

Rosselli M, Ardila A (2003). The impact of culture and education on non-verbal neuropsychological measurements: A critical review. *Brain and Cognition* 52, 3, 326-333.

Straus E, Sherman EMS and Spreen O (2006). *A Compendium of Neuropsychological Tests: Administration, Norms, and Commentary*, 3th ed. Oxford University Press, USA.

Szabo K, Forster A, Jager T, Kern R, Griebe M, Hennerici MG, Gass A (2009). Hippocampal lesion patterns in acute posterior cerebral artery stroke: clinical and MRI findings. *Stroke* 40, 6, 2042-2045.

Szpunar KK, McDermott KB (2008). Episodic future thought and its relation to remembering: Evidence from ratings of subjective experience. *Consciousness and Cognition* 17, 330-334.

Wechsler D (1945). A standardized memory scale for clinical use. *The Journal of Psychology* 19, 87-95.

Wechsler D (2008). *Wechler Memory Scale* - third edition. (WMS-III UK) Administration and Scoring Manual. The Psychological Corporation, Pearson, Inc. San Antonio, TX.

Wechsler D (2009). *Wechler Memory Scale* - fourth edition. (WMS-IV UK) Administration and Scoring Manual. The Psychological Corporation, Pearson, Inc. San Antonio, TX.

Williams MA, Rich MA, Reed LK, Jackson WT, La Marche JA, Boll TJ (1998). Visual reproduction subtest of the Wechsler Memory Scale-Revised: Analysis of construct validity. *Journal of Clinical Psychology* 54, 963-971.