**Correspondence:** Denise R. Fontoura. Universidade Federal do Rio Grande do Sul, Instituto de Psicologia, Departamento de Psicologia do Desenvolvimento e da Personalidade, Rua Ramiro Barcelos, nº 2600, sala 114, Bairro Santa Cecília, CEP 90035-003, Porto Alegre / RS / Brazil. Phone: +55-51-33085341, E-mail address: denisedafontoura@yahoo.com

**Funding:** This work was supported by grants from the FCT – Fundação para a Ciência e a Tecnologia (Portugal).

# Neuropsycholinguistic Profile of Patients Post-Stroke in the Left Hemisphere with Expressive Aphasia

**Denise R. Fontoura**
Linguistics Department, Nova de Lisboa University. Lisboa, Portugal.
Post-Graduate Program in Psychology, Federal University of Rio Grande do Sul. Porto Alegre, Brazil.

**Jaqueline C. Rodrigues**
Post-Graduate Program in Psychology, Federal University of Rio Grande do Sul. Porto Alegre, Brazil.

**Letícia Mansur**
University of São Paulo. São Paulo, Brazil.

**Ana Maria Monção**
Linguistics Department, Nova de Lisboa University. Lisboa, Portugal.

**Jerusa F. Salles**
Post-Graduate Program in Psychology, Federal University of Rio Grande do Sul. Porto Alegre, Brazil.

**Summary**

This study investigated the different performance of neuropsycholinguistic profiles in post-stroke patients in the left hemisphere (LH) with expressive aphasia, compared to healthy controls. We used the case-control study design with a sample consisting of 14 Brazilian adult patients (mean age 55.8; *SD* = 12.5), of both genders, with ischemic or hemorrhagic stroke in the LH and 16 healthy adults (mean age 56; *SD* = 10.9). All participants underwent neuropsycholinguistic evaluation. Statistically significant differences were found between the clinical group and the control group in the functions of attention, working memory, verbal episodic-semantic memory, constructive praxis, executive functions and expressive language skills. We concluded that the linguistic and non-linguistic cognitive skills and socio-demographic characteristics of the aphasic patients should be analyzed in detail to facilitate the development of more effective rehabilitation programs for aphasia.

*Key words:* Stroke, aphasia, neuropsychology, assessment, cognition.

**Perfil Neuropsicolinguístico de los Pacientes después del Accidente Cerebrovascular en el Hemisferio Izquierdo con Afasia Expressiva**

**Resumen**

Este estudio investigó el distinto rendimiento de los perfiles neuropsicolinguísticos en pacientes após accidente cerebrovascular en el hemisferio izquierdo (HI) con afasia expresiva, en comparación con los controles sanos. Se utilizó el diseño de estudio de casos y controles con una muestra compuesta por 14 pacientes adultos brasileños (55,8 edad media, SD = 12.5), de ambos sexos, que sufrieron accidente cerebrovascular isquémico o hemorrágico em lo HI y 16 adultos saludables (media de 56 años, SD = 10.9). Todos los participantes se sometieron a evaluación neuropsicolinguística. Se encontraron diferencias estadísticamente significativas entre el grupo clínico y el grupo control en las funciones de atención, memoria de trabajo, memoria episódica verbal semántica, praxis constructivas, funciones ejecutivas y habilidades de lenguaje expresivo. Llegamos a la conclusión de que las habilidades cognitivas lingüísticas y no lingüísticas y las características socio-demográficas de los pacientes afásicos deben ser analizadas en detalle para facilitar el desarrollo de programas de rehabilitación más eficaces para la afasia.

*Palabras clave:* Accidente cerebro vascular, afasia, neuropsicología, evaluación, cognición.

## Introduction

Stroke (or Cerebrovascular Accident, CVA) is one of the most common causes of acquired language disorders in adulthood (Barker-Collo & Feigin, 2006). Approximately two thirds of patients present with aphasia immediately after a brain injury in the region related to the middle cerebral artery. Thus, it can be considered that aphasia is a symptom resulting from a focal brain injury, which leads to deficits in various aspects of language in approximately 38% of acute cases (Girodo, Silveira, & Girodo, 2008). This acquired language disorder can affect both the expression and the understanding of language and is associated with serious long-term social damage (Alexander, 2003; Hillis, 2007; Saffran, 2003).

Most research on aphasia, such as studies involving therapeutic efficacy by Breier, Randle, Maher, and Papanicolaou (2010), Carlomagno, Pandolfi, Labruna, Colombo, and Razzano (2001), Lorenz and Ziegler (2009), Parkinson, Rayer, Chang, Fitzgerald, and Crosson (2009), among others, describe only the linguistic features of patients, often failing to mention the other neuropsychological functions that may be deficient such as memory, attention, visuospatial skills, time and spatial orientation, motor abilities and executive functions. However, it is known that many of these aspects may be altered in patients with aphasia, although they are difficult to evaluate because of the patients' language impairments.

The investigation of neuropsycholinguistic functions beyond language can assist in the design of more appropriate treatment plans, thus increasing the effectiveness of speech therapy (Bonini, 2010). There is evidence that aphasic patients perform better in non-linguistic tasks than in linguistic ones, and performance in questions involving attention, executive functions, memory and visuospatial processes can not be predicted based on language skills (Helm-Estabrooks, 2002). The severity of aphasia and the results batteries of non-verbal neuropsycholinguistic tasks do not correlate (Helm-Estabrooks, Bayles, Ramage, & Bryant, 1995).

In patients with global aphasia, neuropsycholinguistic skills in non-linguistic tasks vary among groups of patients that present good performance, and present varying deficits among patients who are not able to perform the tests (Van Mourik, Verschaeve, Boon, Paquier, & Van Harskamp, 1992). These results suggest a lack of homogeneity in the patients' cognitive profile and, once more, the need for a thorough, individualized neuropsycholinguistic review so as to enable the planning of an efficient therapy for patients with aphasia.

There is a positive correlation between working memory and language functions, and language comprehension skills is directly related to the working memory capacity in aphasic patients (Caspari, Parkinson, LaPointe, & Katz, 1998). Furthermore, it is known that after language, executive functions are the most vulnerable to the effects of brain damage associated with aphasia (Helm-Estabrooks, 2002).

Among patients who have suffered acute and chronic stroke in the left hemisphere (LH), there is evidence of deficits in of short-term (digit span) and long-term (associative matching and learning stories) verbal memory functions and short-term and long-term spatial memory (learning and Corsi span) (Burgio & Basso, 1997). Aphasic patients have shown worse cognitive abilities, when compared to non-aphasic patients but also with brain injury, in the tasks involving semantic fluency, gestural motor abilities, digit span (forward and reverse order), word learning, recalling constructive praxis, learning figures and clock drawing (Bonini, 2010). There is also evidence of damage in the functions of attention, sequencing, mental flexibility and processing, and visual memory among aphasics, with only the immediate visuospatial memory skill having been observed as less affected by the brain injury (Silva, 2009).

The literature, therefore, reports a heterogeneous profile of aphasic patients in the performance of neuropsycholinguistic tasks. However, there are trends suggesting a higher frequency of deficits in memory and executive functions, and of dissociations between verbal and nonverbal functions. Thus, the neuropsycholinguistic evaluation is extremely important for properly diagnosing the type of aphasia, for planning the treatment and for verifying the efficacy of the therapeutic rehabilitation technique used for each case treated. Therefore, the overall objective of this research is to investigate the different neuropsycholinguistic performance profiles in patients post-stroke in the LH with predominantly expressive aphasia, compared to healthy controls, matched for age, education and sex.

## Method

### *Participants*

The sample consisted of two groups that were selected by a non-random convenience sample: 1) 14 adult Brazilian patients (33 – 71 years of age), with ischemic or hemorrhagic stroke in the LH (clinical group) and 2) 16 healthy adults (32-70 years of age), matched to the cases by age, gender and education (control group) (Table 1). This study follows the case-control design. The patients were selected from two hospitals in the cities of Porto Alegre and São Paulo (Brazil).

Table 1
*Demographic Characteristics of the Sample by Group*

| | **Clinical group (n = 14)** | **Control group (*n* = 16)** | | |
|---|---|---|---|---|
| | Mean (SD) | Mean (SD) | T | *p* |
| Age in years | 55.8 (12.5) | 56 (10.9) | -0.065 | 0.94 |
| Education (years) | 9.8 (5.5) | 10.5 (4.9) | -0.406 | 0.68 |
| Male/ Female (*n*) | 6/ 8 | 7/ 9 | | |
| Months post onset | 63.93 (41.14) | - | | |

**Note.** SD = standard deviation.

All participants were selected according to the following inclusion criteria: right-handers; Brazilian nationality and origin; minimum of four years of education; no psychiatric diagnosis or neurological diagnosis (except for the stroke, in the case of the clinical group); no history of or current drug abuse, including alcohol; no uncorrected vision and hearing impairments; age under 75 years.

For the clinical group (Table 2), the remaining inclusion criteria that guided the selection of post-stroke patients were as follows: medical diagnosis (performed by a neurologist) of ischemic or hemorrhagic stroke in the LH only (confirmed by computed tomography or magnetic resonance imaging) and presence of alterations in communication, characterizing predominantly expressive aphasia.

For the diagnosis of expressive aphasia and characterize the qualitative language alterations, the Boston Diagnostic Aphasia Examination Test - Short Form (Bonini, 2010; Goodglass, Kaplan, & Barresi, 2001a) was used. There were 14 patients in the sample who presented anomia (100%), 8 speech dyspraxia (57.1%), 6 agrammatism (42.8%), 4 paraphasia (28.5%), and 3 disartry (21.4%).

*General procedures*

This study was conducted according to the ethical principles of human research. The selection of participants and the application of the instruments were conducted by the speech therapist researcher and by two properly trained psychology students. All participants signed an informed consent form stating their agreement to participate. The clinical group evaluation lasted approximately three one-hour sessions, at the patients' homes or at the research institution (university or hospital). The same evaluation was performed for the control group, but with a mean duration of two 45-minute sessions.

The participants answered the questionnaire on sociodemographic and general health information, and were also evaluated to identify signs of severe depression, using Beck's Depression Inventory (Beck, Ward, Mendelson, Mock, & Erbaugh, 1961; Cunha, 2001) in the case of subjects under the age of 60 years.  For people over the age of 60, the Geriatric Depression Scale - short version (Geriatric

Depression Scale-GDS 15) was applied (Almeida & Almeida, 1999). This evaluation was necessary because transient neuropsycholinguistic alterations are known to present in people diagnosed with depression. Therefore, we sought to exclude participants who showed signs of severe depression, in order to avoid confusion between neuropsycholinguistic alterations caused by depression or by aphasia. Moreover, brain damage can lead to depression. It is also known that there is a high frequency of depression in post-stroke patients (Sagen et al., 2009), therefore this evaluation needed to be conducted.

Table 2
*Information about Patients Post-stroke in the LH (Clinical Group)*

| Patient | Age (years) | Education | SE | Etiology | Months post onset | Location of injury (LH) | Classification of Aphasia |
|---|---|---|---|---|---|---|---|
| PM 1 | 63 | 10 | C1 | H | 126 | insular and temporal | t. motor |
| PM 2 | 70 | 7 | B2 | I | 45 | frontal | t. motor |
| PM 3 | 53 | 5 | B2 | I | 125 | frontal temporal parietal | Broca's |
| PM 4 | 66 | 8 | C2 | I | 8 | frontal temporal | Broca's |
| PM 5 | 49 | 11 | C1 | H | 36 | insular and temporal | t. motor |
| PM 6 | 71 | 16 | A2 | I | 45 | temporal parietal | Broca's |
| PF 1 | 33 | 15 | NS | I | 40 | NS | t. motor |
| PF 2 | 46 | 9 | C1 | I | 70 | frontal temporal | Broca's |
| PF 3 | 48 | 15 | C2 | I | 60 | frontal temporal parietal | Broca's |
| PF 4 | 33 | 6 | B2 | I | 45 | temporal parietal | Broca's |
| PF 5 | 57 | 4 | D | I | 105 | frontal temporal | Broca's |
| PF 6 | 63 | 19 | A2 | I | 1 | frontal temporal | t. motor |
| PF 7 | 64 | 4 | A1 | I | 69 | temporal parietal | Broca's |
| PF 8 | 66 | 4 | C2 | I | 120 | frontal temporal parietal | Broca's |

**Note.** PM = male patient; PF= female patient; H = hemorrhagic stroke; I = ischemic stroke; t. motor = transcortical motor aphasia; Broca's = Broca's aphasia; SE = Socioeconomic class; NS = Non-specified.

Comprehensive and expressive language (oral and written) were investigated through the application of the Boston Diagnostic Aphasia Examination - Short Form (Goodglass et al., 2001a) Brazilian version published by Bonini (2010), and of the Token Test - short version (Fontanari, 1989; Moreira et al., 2011). The brief investigation of neuropsycholinguistic functions was performed using the Brief Neuropsycholinguistic Assessment Instrument NEUPSILIN-Af adapted for expressive aphasic patients (Fontoura, Rodrigues, Parente, Fonseca, & Salles, 2011).

The clinical diagnosis of expression aphasia was established after the application of the Boston Diagnostic Aphasia Examination - short form (Bonini, 2010; Goodglass et al., 2001a), and its criteria included the linguistic characteristics of patients during spontaneous speech, auditory comprehension and repetition. Patients who presented non-fluent speech who scored above 50% in the oral comprehension tasks from the Boston Diagnostic Aphasia

Examination - Short Form (Goodglass, Kaplan, & Barresi, 2001b) were characterized as suffering from expressive aphasia. The scores from the short Token Test were not taken into account for the inclusion criteria, since there was a great discrepancy between the Boston comprehension subtest and the Token Test scores, probably due to a greater interference of working memory in the latter.

## Results

The results of the language evaluations, by group, for the Token Test and the Boston Diagnostic Aphasia Examination can be found in Table 3, that presents the values for analyses across the groups. Values for $p \leq 0.005$ were considered as significant, because of the multiple comparisons conducted (Bonferroni correction). Altogether, regarding the oral and written language evaluation, it was observed that the performance in most expressive language skills assessed by the Boston Diagnostic Aphasia Examination and by Token test in the clinical group were found to be statistically lower than the control group.

The results of the evaluation of neuropsycholinguistic functions investigated by the Brief Neuropsycholinguistic Assessment Instrument for Expressive Aphasia NEUPSILIN-Af are shown in Table 4. All *p* values under or equal to 0.001 were considered to be significant, due to the multiple comparisons carried out (Bonferroni correction).

Table 3
*Performance on Language Evaluation Tests (Token Test and Boston Diagnostic Aphasia Examination) by Group*

| **Linguistic Tasks** | | **Clinical Group (*n* = 13)** | **Control Group (*n* = 15)** | **Test *statistics*** | ***p*** |
|---|---|---|---|---|---|
| Token Test [a] | M (SD) | 21.15 (7.95) | 33.94 (1.34) | -5.73 | <0.001* |
| Simple Social Response [b] | M (SD) | 5.84 (2.07) | 7 (7) | -2.59 | 0.010 |
| | Md (IQR) | 7 (5; 7) | 0 (7; 7) | | |
| Word comprehension [b] | M (SD) | 14.53 (2.07) | 15.86 (0.35) | -2.36 | 0.018 |
| | Md (IQR) | 15.5 (13.25; 16) | 16 (16; 16) | | |
| Command comprehension [b] | M (SD) | 8.31 (2.46) | 9.80 (0.77) | -2.36 | 0.018 |
| | Md (IQR) | 10 (6; 10) | 10 (10; 10) | | |
| Complex Ideational Material [b] | M (SD) | 4.69 (1.75) | 5.46 (0.63) | -1.41 | 0.158 |
| | Md (IQR) | 5 (3.5; 6) | 6 (5; 6) | | |
| Automated sequences [b] | M (SD) | 2.84 (1.51) | 4 (0) | -3.19 | 0.001* |
| | Md (IQR) | 3 (2; 4) | 4 (4; 4) | | |
| Word repetition [b] | M (SD) | 3.23 (1.78) | 4.86 (0.35) | -3.17 | 0.001* |
| | Md (IQR) | 4 (2; 5) | 5 (5; 5) | | |
| Sentence repetition [b] | M (SD) | 0.92 (0.95) | 2 (0) | -3.49 | 0.001* |
| | Md (IQR) | 1 (0; 2) | 2 (2; 2) | | |
| Responsive naming [b] | M (SD) | 6.61 (3.93) | 9.93 (0.25) | -2.86 | 0.004* |
| | Md (IQR) | 7 (3; 10) | 10 (10; 10) | | |

| | | | | | |
|---|---|---|---|---|---|
| Naming [b] | M (SD) | 7.53 (5.04) | 12.53 (2.06) | -2.92 | 0.003* |
| | Md (IQR) | 9 (2; 12) | 13 (11; 14) | | |
| Screening of special categories [b] | M (SD) | 6.69 (5.23) | 12 (0) | -3.75 | <0.001* |
| | Md (IQR) | 9 (0; 12) | 12 (12; 12) | | |
| Maching Letters and Words [b] | M (SD) | 3.84 (0.37) | 4 (0) | -1.55 | 0.122 |
| | Md (IQR) | 4 (4; 4) | 4 (4; 4) | | |
| Matching numbers [b] | M (SD) | 3.84 (0.55) | 4 (0) | -1.07 | 0.283 |
| | Md (IQR) | 4 (4; 4) | 4 (4; 4) | | |
| Word discrimination [b] | M (SD) | 3.61 (0.65) | 3.80 (0.41) | -0.73 | 0.464 |
| | Md (IQR) | 4 (3; 4) | 4 (4; 4) | | |
| Orally reading of words [b] | M (SD) | 9.92 (6.86) | 15 (0) | -2.59 | 0.010 |
| | Md (IQR) | 15 (1.5; 15) | 15 (15; 15) | | |
| Orally reading of sentences [b] | M (SD) | 1.69 (2.13) | 4.86 (0.35) | -3.97 | <0.001* |
| | Md (IQR) | 0 (0; 4) | 5 (5; 5) | | |
| Oral reading of sentence comprehension [b] | M (SD) | 1.69 (1.25) | 2.60 (0.63) | -2.13 | 0.033 |
| | Md (IQR) | 2 (0; 3) | 3 (2; 3) | | |
| Reading comprehension: Paragraphs and sentences [b] | M (SD) | 2.07 (1.80) | 3.53 (0.51) | -2.12 | 0.034 |
| | Md (IQR) | 3 (0; 4) | 4 (3; 4) | | |
| Mechanics of writing: letter shapes [b] | M (SD) | 10.30 (3.32) | 13.80 (0.56) | -3.27 | 0.001* |
| | Md IQR | 10 (7; 14) | 14 (14; 14) | | |
| Mechanics of writing: correct choice of letters [b] | M (SD) | 16.53 (4.48) | 20.80 (0.41) | -3.14 | 0.002* |
| | Md (IQR) | 18 (13; 21) | 21 (21; 21) | | |
| Mechanics of writing: motor skills [b] | M (SD) | 9.53 (3.77) | 14 (0) | -3.76 | <0.001* |
| | Md (IQR) | 7 (6.5; 14) | 14 (14; 14) | | |
| Basic encoding skills: dictation of simple words [b] | M (SD) | 3.15 (1.28) | 3.86 (0.35) | -1.73 | 0.084 |
| | Md (IQR) | 4 (2; 4) | 4 (4; 4) | | |
| Basic encoding skills: dictation of regular words [b] | M (SD) | 1.15 (0.89) | 2 (0) | -3.19 | 0.001* |
| | Md (IQR) | 1 (0; 2) | 2 (2; 2) | | |
| Basic encoding skills: dictation of irregular words [b] | M (SD) | 2.07 (1.32) | 2.93 (0.25) | -2.12 | 0.034 |
| | Md (IQR) | 3 (0.5; 3) | 3 (3; 3) | | |
| Written picture naming [b] | M (SD) | 1.92 (1.65) | 3.66 (0.48) | -2.85 | 0.004* |
| | Md (IQR) | 2 (0; 4) | 4 (3; 4) | | |
| Written narrative [b] | M (SD) | 3.76 (3.78) | 9.93 (1.62) | -3.77 | <0.001* |
| | Md (IQR) | 4 (0; 6.5) | 10 (10; 11) | | |

**Note.** [a] reported with mean and standard deviation, using the t test; [b] reported with median and interquartile range (Q1; Q3), using the Mann-Whitney test; M = Mean; Md = Median; SD = standard deviation; IQR = Interquartile range.
* $p \leq 0.005$.

It was observed that the clinical group showed statistically lower scores than the control group on the functions of attention (digit sequence repetition), working memory (reverse ordering of digits and oral word span in sentences), verbal episodic-semantic memory (immediate and delayed recall), constructive praxis, and executive functions (spelling and semantic verbal fluency). Regarding verbal episodic-semantic memory, it is emphasized that only the recall skills (immediate and delayed) were found to present alterations in aphasics, while the recognition skills are preserved ($p$ = 0.02). The oral and written language functions were also found to be lower in the clinical group, when compared to the control group, with the exception of the functions of naming pictures and objects, oral comprehension of words, sentences and reading aloud (words/non-words) and copied writing of a sentence.

Table 4

*Performance on Subtests of the Brief Neuropsycholinguistic Assessment Instrument for Expressive Aphasia NEUPSILIN-Af by Group*

| **Neuropsycholinguistic tasks** | | **Clinical Group (*n* = 14)** | **Control Group (*n* = 15)** | ***Test statistics*** | ***p*** |
|---|---|---|---|---|---|
| **Time and spatial orientation** | | | | | |
| Total Time and Spatial Orientation Oral Response [b] | M (SD) | 5.42 (3.36) | 8 (0) | -3.05 | 0.002 |
| | Md (IQR) | 7 (1.5; 8) | 8 (8; 8) | | |
| Time orientation Oral Response [b] | M (SD) | 2.57 (1.65) | 4 (0) | -3.06 | 0.002 |
| | Md (IQR) | 3 (1.5; 4) | 4 (4; 4) | | |
| Spacial orientation Oral Response [b] | M (SD) | 2.85 (1.87) | 4 (0) | -2.19 | 0.028 |
| | Md (IQR) | 4 (0; 4) | 4 (4; 4) | | |
| Total Time and Spatial Orientation Motor Response [b] | M (SD) | 7.28 (1.63) | 8 (0) | -1.85 | 0.063 |
| | Md (IQR) | 8 (7.75; 8) | 8 (8; 8) | | |
| Time orientation Motor Response [b] | M (SD) | 3.71 (0.61) | 4 (0) | -1.85 | 0.063 |
| | Md (IQR) | 4 (3.75; 4) | 4 (4; 4) | | |
| Spacial orientation Motor Response [b] | M (SD) | 3.78 (0.57) | 4 (0) | -1.49 | 0.136 |
| | Md (IQR) | 4 (4; 4) | 4 (4; 4) | | |
| **Attention** [b] | M (SD) | 12.14 (10.80) | 25.20 (4.42) | -3.44 | 0.001* |
| | Md (IQR) | 9.5 (1.75; 24) | 25 (24; 27) | | |
| Reverse counting [b] | M (SD) | 9.71 (9.64) | 19.20 (2.83) | -3.02 | 0.003 |
| | Md (IQR) | 8.5 (0; 20) | 20 (20; 20) | | |
| Repetition of digit sequence [b] | M (SD) | 2.42 (1.74) | 6 (3.33) | -3.41 | 0.001* |
| | Md (IQR) | 2.5 (0.75; 4) | 5 (4; 7) | | |
| **Perception** [a] | M (SD) | 9.78 (1.62) | 10.33 (1.29) | -1 | 0.322 |
| Verification of Similarity and mismatch between lines [b] | M (SD) | 4.92 (1.14) | 5.40 (0.91) | -1.32 | 0.187 |
| | Md (IQR) | 5 (4; 6) | 6 (5; 6) | | |
| Visual hemineglect [b] | M (SD) | 1 (0) | 1 (0) | 0 | 1 |
| | Md (IQR) | 1 (1; 1) | 1 (1; 1) | | |
| Face perception [b] | M (SD) | 2.07 (0.61) | 1.93 (1.09) | -0.05 | 0.963 |
| | Md (IQR) | 2 (2; 2.25) | 2 (1; 3) | | |

| | | | | | |
|---|---|---|---|---|---|
| Face recognition [b] | M (SD)<br>Md (IQR) | 1.78 (0.42)<br>2 (1.75; 2) | 2 (0)<br>2 (2; 2) | -1.86 | 0.063 |
| **Memory** | | | | | |
| Total Memory - Oral Response [a] | M (SD) | 38.35 (10.53) | 58.53 (11.21) | -4.98 | <0.001* |
| Total Memory - Motor Response [b] | M (SD)<br>Md (IQR) | 39.78 (9.15)<br>40 (35; 46.5) | 58.53 (11.21)<br>59 (55; 65) | -3.80 | <0.001* |
| **Working memory** [a] | M (SD) | 13.14 (4.38) | 22.53 (5.93) | -4.81 | <0.001* |
| Reverse ordering of digits [b] | M (SD)<br>Md (IQR) | 2 (1.30)<br>2.5 (1; 3) | 5.20 (2.45)<br>5 (3; 7) | -3.42 | 0.001* |
| Oral word span in sentences [a] | M (SD) | 10.42 (4.7) | 17.33 (4.43) | -4.07 | <0.001* |
| Verbal **episodic- semantic memory** [a] | M (SD) | 18.35 (5.15) | 26.33 (6.14) | -3.77 | 0.001* |
| Immediate recall [a] | M (SD) | 3 (1.35) | 5.4 (1.72) | -4.14 | <0.001* |
| Delayed recall [b] | M (SD)<br>Md (IQR) | 1.28 (1.32)<br>1 (0; 2.25) | 4.06 (1.94)<br>4 (3; 5) | -3.5 | <0.001* |
| Recognition [a] | M (SD) | 14.07 (2.89) | 16.86 (2.99) | -2.55 | 0.017 |
| **Long-term semantic memory** | | | | | |
| Oral Response [b] | M (SD)<br>Md (IQR) | 3.07 (2.30)<br>4.5 (0; 5) | 4.93 (0.25)<br>5 (5; 5) | -2.7 | 0.007 |
| Motor Response [b] | M (SD)<br>Md (IQR) | 4.50 (0.75)<br>5 (4; 5) | 4.93 (0.25)<br>5 (5; 5) | -1.94 | 0.052 |
| **Short-term visual memory** [b] | M (SD)<br>Md (IQR) | 2.50 (0.65)<br>3 (2; 3) | 2.93 (0.25)<br>3 (3; 3) | -2.25 | 0.024 |
| **Prospective memory** [b] | M (SD)<br>Md (IQR) | 1.28 (0.72)<br>1 (1; 2) | 1.93 (0.25)<br>2 (2; 2) | -2.9 | 0.004 |
| **Arithmetic abilities** [b] | M (SD)<br>Md (IQR) | 4.57 (2.97)<br>5 (2; 8) | 7.40 (0.91)<br>8 (6; 8) | -2.75 | 0.006 |
| **Language** | | | | | |
| Total Language Oral Response [b] | M (SD)<br>Md (IQR) | 31.28 (16.91)<br>37 (12; 45.25) | 52.46 (2.79)<br>53 (51; 55) | -3.92 | <0.001* |
| Total Language Motor Response [b] | M (SD)<br>Md (IQR) | 32.21 (16.81)<br>37.5 (14; 47) | 52.73 (2.57)<br>54 (51; 55) | -3.88 | <0.001* |
| **Oral language** | | | | | |
| Total Oral Language Oral Response [b] | M (SD)<br>Md (IQR) | 15.21 (7.14)<br>17 (9; 20.5) | 23.46 (1.12)<br>24 (23; 24) | -4.15 | <0.001* |
| Total Oral Language Motor Response [b] | M (SD)<br>Md (IQR) | 16.14 (7.11)<br>18 (11; 22.2) | 23.73 (0.79)<br>24 (24; 24) | -4.28 | <0.001* |

| | | | | | |
|---|---|---|---|---|---|
| Automatized Language [b] | M (SD) | 2.28 (1.54) | 4 (0) | -3.62 | <0.001* |
| | Md (IQR) | 2 (1.5; 4) | 4 (4; 4) | | |
| Naming [b] | M (SD) | 2.85 (1.61) | 3.93 (0.25) | -2.33 | 0.020 |
| | Md (IQR) | 4 (1; 4) | 4 (4; 4) | | |
| Repetition [b] | M (SD) | 6.50 (3.48) | 9.86 (0.35) | -3.42 | 0.001* |
| | Md (IQR) | 7 (4; 10) | 10 (10; 10) | | |
| Comprehension [b] | M (SD) | 2.5 (0.65) | 3 (0) | -2.79 | 0.005 |
| | Md (IQR) | 3 (2; 3) | 3 (3; 3) | | |
| Inferential processing | | | | | |
| Oral Response [b] | M (SD) | 1.07 (0.91) | 2.66 (0.72) | -3.82 | <0.001* |
| | Md (IQR) | 1 (0; 2) | 3 (3; 3) | | |
| Motor Response [b] | M (SD) | 2 (0.87) | 2.93 (0.25) | -3.52 | <0.001* |
| | Md (IQR) | 2 (1.75; 3) | 3 (3; 3) | | |
| **Written language** [b] | M (SD) | 16.07 (10.13) | 29 (1.96) | -3.95 | <0.001* |
| | Md (IQR) | 18.5 (3.75; 24.25) | 30 (27; 31) | | |
| Reading aloud [b] | M (SD) | 6.35 (4.89) | 11.80 (0.56) | -3.91 | <0.001* |
| | Md (IQR) | 6.5 (0; 11) | 12 (12; 12) | | |
| Written comprehension [b] | M (SD) | 2.42 (0.75) | 2.86 (0.35) | -1.84 | 0.066 |
| | Md (IQR) | 3 (2; 3) | 3 (3; 3) | | |
| Spontaneous writing [b] | M (SD) | 0.57 (0.75) | 1.66 (0.48) | -3.49 | <0.001* |
| | Md (IQR) | 0 (0; 1) | 2 (1; 2) | | |
| Copied writing [b] | M (SD) | 1.57 (0.64) | 1.66 (0.48) | -0.26 | 0.793 |
| | Md (IQR) | 2 (1; 2) | 2 (1; 2) | | |
| Dictated writing [b] | M (SD) | 5.14 (4.46) | 11 (1.13) | -3.84 | 0.000* |
| | Md (IQR) | 6 (0; 9) | 11 (10; 12) | | |
| **Motor abilities** [a] | M (SD) | 13.71 (3.83) | 18.66 (2.52) | -4.13 | <0.001* |
| Ideomotor [b] | M (SD) | 3 (0) | 3 (0) | 0 | 1 |
| | Md (IQR) | 3 (3; 3) | 3 (3; 3) | | |
| Construtive [a] | M (SD) | 9.71 (3.12) | 13.46 (2.32) | -3.68 | 0.001* |
| Reflexive [b] | M (SD) | 1 (1.17) | 2.33 (0.97) | -2.78 | 0.005 |
| | Md (IQR) | 1 (0; 1.5) | 3 (2; 3) | | |
| **Problem solving** | | | | | |
| Oral Response [b] | M (SD) | 1.14 (0.66) | 1.86 (0.35) | -3.16 | 0.002 |
| | Md (IQR) | 1 (1; 2) | 2 (2; 2) | | |
| Motor Response [b] | M (SD) | 1.28 (0.72) | 1.86 (0.35) | -2.51 | 0.012 |
| | Md (IQR) | 1 (1; 2) | 2 (2; 2) | | |
| **Executive functions (Verbal fluency)** | | | | | |
| Spelling Verbal fluency | M (SD) | 3.42 (3.52) | 23.80 (7.35) | -4.59 | 0.000* |

| | | | | | |
|---|---|---|---|---|---|
| (F) [b] | Md (IQR) | 3 (0; 5) | 24 (17; 30) | | |
| Semantic Verbal fluency (animals) [a] | M (SD) | 10.21 (7.61) | 28.46 (5.91) | -7.23 | 0.000* |

**Note.** [a] reported with mean and standard deviation. using the t test; [b] reported with median and interquartile range (Q1; Q3), using the Mann-Whitney test; M = Mean; Md = Median; SD = standard deviation; IQR = Interquartile range.
* $p \leq 0.001$.

With the aim of controlling the interference of language performance on some neuropsychological tasks (normally distributed) across the clinical and control groups, a variance analysis was performed, controlling covariates such as oral comprehension of words and commands, responsive naming, and naming (from the Boston Diagnostic Aphasia Examination). Thus, differences between the groups in the language comprehension variables assessed by the Token Test, $F(1.28) = 20.33$, $p < 0.001$, $\eta^2 = 0.48$, as well as semantic verbal fluency, $F(1.27) = 19.03$, $p < 0.001$, $\eta^2 = 0.47$, remained significant even after the effect of the linguistic covariates mentioned above was controlled. However, differences between the groups in the variables oral word span in sentences, $F(1.27) = 5.23$, $p = 0.033$, $\eta^2 = 0.20$, working memory, $F(1.27) = 8.29$, $p = 0.009$, $\eta^2 = 0.28$, immediate recall of verbal episodic-semantic memory, $F(1.27) = 3.54$, $p = 0.074$, $\eta^2 = 0.14$, verbal episodic-semantic memory, $F(1.27) = 2.23$, $p = 0.15$, $\eta^2 = 0.096$, and constructive praxis, $F(1.27) = 1.1$, $p = 0.305$, $\eta^2 = 0.05$, did not remain significant after controlling the effect of covariates, considering $p \leq 0.001$. However, it is noteworthy that the effect size that estimates the amount of variance for the first two dependent variables mentioned (oral word span in sentences and working memory) was 20% and 28%, respectively. That is, despite the lack of statistical significance after controlling for covariates, a substantial portion of variance could be attributed to the group variable.

The cluster analysis conducted for the performance in the variables attention, working memory, verbal episodic-semantic memory, and spelling and semantic verbal fluency evidenced the formation of three groups, as shown in Table 5: 1) aphasic group, 2) mixed group and 3) control group. In view of the multiple comparisons across groups (three comparisons for each variable), differences with $p \leq 0.016$ were defined as significant.

The differences among the three subgroups were significant ($p < 0.016$) for the variables working memory and executive functions (spelling and semantic verbal fluency) from the NEUPSILIN-Af. For the variables attention, verbal episodic-semantic memory, oral and written language and motor abilities no differences were found between the subgroups mixed (2) and control (3), but both showed differences from the aphasics group, which showed worse performance for these variables.

It is noticed that the subgroup of aphasic (1) shows lower scores in all functions, in comparison to the other subgroups and the mixed group (2) shows lower scores when compared to the controls subgroup (3). The eight participants in the aphasic group (1) were part of the clinical group, with seven of them characterized with Broca's aphasia (PM3, PM6, PF2, PF4, PF5, PF7, PF8) and one with transcortical motor aphasia (PM2). The mixed subgroup (2), however, was formed by six aphasic patients and 10 healthy individuals. Only one is characterized with Broca's aphasia (PM4), with the remaining patients being characterized with transcortical motor aphasia.

Table 5
*Performance on Neuropsycholinguistic Tasks for the overall Sample Divided by Subgroups based on the Cluster Analysis (overall n = 29)*

| **Neuropsycholinguistic tasks** | | **Aphasics group (1) (*n* = 8)** | **Mixed group (2) (*n* = 16)** | **Control group (3) (*n* = 5)** |
|---|---|---|---|---|
| Oral language | M (SD) | 11.12 (6.77) | 22.25 (2.17) | 24 (0) |
| | Md (IQR) | 11.50 (3.75; 16.75) | 23 (20.50; 24) | 24 (24; 24) |
| Written language | M (SD) | 8.87 (6.87) | 27.25 (2.51) | 30.60 (0.54) |
| | Md (IQR) | 7 (3; 14.75) | 27 (25; 29.75) | 31 (30; 31) |
| Attention | M (SD) | 3.5 (4.10) | 24 (3.22) | 27.20 (4.86) |
| | Md (IQR) | 2.5 (0.25; 6) | 24 (23.25; 25) | 24 (23.50; 32.50) |
| Working memory | M (SD) | 11.87 (4.48) | 17.50 (3.82) | 29.40 (4.09) |
| | Md (IQR) | 12.50 (10; 16) | 18.50 (13.50; 20) | 28 (26.50; 33) |
| Episodic-semantic memory | M (SD) | 16.25 (4.46) | 23.43 (5.85) | 29.40 (5.41) |
| | Md (IQR) | 17 (11.50; 20.75) | 25 (18.50; 28.50) | 27 (25.50; 34.50) |
| Motor abilities | M (SD) | 12.62 (4.10) | 16 (2.84) | 20.20 (2.68) |
| | Md (IQR) | 12.5 (9; 15.75) | 18 (15; 19) | 22 (17.50; 22) |
| Spelling fluency | M (SD) | 1.62 (1.59) | 14.50 (8.18) | 32 (3.53) |
| | Md (IQR) | 1.50 (0; 3) | 15 (6.25; 21) | 31 (29.50; 35) |
| Semantic fluency | M (SD) | 6.25 (5.92) | 22.06 (7.54) | 33.40 (4.50) |
| | Md (IQR) | 4.50 (0.50; 12.75) | 22.50 (16.50; 26.75) | 34 (29; 37.50) |

**Note.** M = Mean; Md = Median; SD = standard deviation; IQR = Interquartile range.

All participants in the control subgroup (3) are healthy persons (CM6, CM7, CF3, CF4, and CF6). It is noteworthy that the healthy participants belonging to the mixed subgroup (2) (CM1, CM2, CM3, CM4, CF1, CF2, CF5, CF7, CF8, CF9) have a lower mean schooling than those of subgroup 3.

## Discussion

A comparison of the performance in the Boston Diagnostic Aphasia Examination between the clinical and the control groups showed significant differences only in the expression of oral and written language, showing no significant differences in its comprehension. Since the group consists of patients with predominantly expressive aphasia, these characteristics were already expected, confirming the inclusion criteria for the sample.

Even though there are no performance differences in word and command comprehension tasks between the clinical and control groups in the Boston Diagnostic Aphasia Examination, in the Token Test performance, a significantly lower performance was observed among aphasics, when compared to controls. It is known that even in so-called expressive aphasia, oral language comprehension may be slightly impaired (Helm-Estabrooks & Albert, 2004; Hillis, 2007; Peña-Casanova, Pamies, & Dieguez-Vide, 2005). Moreover, Fontanari (1989) has noted that aphasics perform worse than healthy persons in the Token Test, regardless of the type of aphasia. The Token Test, which is designed to assess oral language comprehension at the sentence level, is heavily influenced by the functions of attention and short-term memory (Fontanari), and it is likely to be more sensitive to detect the language impairment interface with attention and short-term memory, functions in which the aphasic patients in this study also showed impairment. Difficulties in language comprehension can also be observed in patients with deficits in working memory (Baddeley, 2003).

Reading comprehension showed no performance differences between the groups, thus indicating that there may be specific language deficits in oral language, without necessarily affecting the reading comprehension skills, especially in transcortical motor aphasia (Peña-Casanova et al., 2005). Another explanation could be the low sensitivity of the test to detect changes in reading. Our patients presented difficulties when there was a working memory overload, as shown above. It is possible that the reading comprehension subtest was not able to reach this threshold burden. Thus, the idea of an extra-language cognitive component that affects performance on linguistic tasks is reinforced.

Writing, however, in both motor aspects and expressive language skills (written naming, word dictation and narration), was impaired in the aphasics. In a multimodal vision, aphasia is characterized as a disorder that affects multiple modalities of language, encompassing the functions of a central language processor (Fontanari, 1989; Vieira, Roazzi, Queiroga, Asfora, & Valença, 2011). Thus, changes in the expression of language could affect both oral and written language. In expressive aphasias, suppressed or reduced writing, perseverations, agrammatisms, and paragraphies have been obsereved (Peña-Casanova et al., 2005), as well as difficulties in the phonological aspect of writing (Hillis, 2007). Furthermore, the patients in this study presented with motor deficits (hemiparesis on the right) and alterations in motor abilities (constructive praxis), which also explains the impairment to the motor skill of writing.

As for the other neuropsychological functions, the aphasics showed deficits (compared to controls) in the functions of attention, working memory, verbal episodic-semantic memory, (immediate and delayed recall), executive functions (verbal fluency) and constructive praxis. Attention has already been described in other studies as being compromised in aphasic patients (Bonini, 2010; Murray, 2012; Silva, 2009). Radanovic, Azambuja, Mansur, Porto and Scaff (2003), in a study with three patients suffering from left thalamic vascular injury, two of which had language impairments, have also showed alterations in their functions of attention and executive functions. Murray has shown that all forms of attention, both auditory and visual (sustained, selective and divided attention) are vulnerable to aphasia. The function of attention is among one of the most frequent impairments in patients with brain injury caused by a stroke (Alves et al., 2008), thus confirming the findings of this study.

Executive functions, as evaluated by the reasoning and verbal fluency (spelling and semantic) subtest, also showed impairments, a finding that agrees with Bonini (2010) (semantic fluency), Helm-Estabrooks (2002), Silva (2009) and Murray (2012). This is skill that requires oral output and lexical access, and expressive aphasic patients showed significant difficulty in performing this task. Expressive aphasia is associated with difficulty initiating speech, verbal inhibition and lexical access (Ardila, 2010; Helm-Estabrooks & Albert, 2004; Hillis, 2007; Peña-Casanova et al., 2005).

Knowing that the verbal fluency assesses not only executive functions but also language, the impairment shown by patients can be explained by alterations in articulatory components and speech initiation mechanisms (Lotufo, 2005). However, the differences between the clinical and control groups in the variable of semantic verbal fluency remained significant even after controlling for the effect of linguistic covariates, which accounts for the interpretation that, regardless of significant alterations, there is impairment in executive functions.

Regarding working memory, which was also impaired in the aphasic patients in this study, the literature has presented evidence of a strong relationship between language functions and working memory (Baddeley, 2003; Caspari et al., 1998; Jefferies, Lambon Ralph, & Baddeley, 2004, Jodzio & Taraszkiewicz, 1999). Working memory is divided into four subsystems (visuospatial sketchpad, episodic buffer, phonological loop and central executive system) and, therefore, interferes with language functions in different ways, both in its temporary storage aspect, as in management and execution (Baddeley). Caspari et al. have found a high positive correlation between working memory skills, reading comprehension and performance in oral language functions. The aphasic patients investigated by Senów, Litwin, and Lesniak (2009) and Potagas, Kasselimin, and Evdokimidis (2011) have also shown impairments in working memory, but in their visuospatial aspects. The latter authors have noted a strong correlation between the verbal and spatial aspects of working memory and the language skills (language fluency and auditory comprehension) of aphasic patients.

The output and comprehension of language depend on a large number of cognitive activities, including the ability to process, temporarily store and manipulate information (working memory) (Caspari et al., 1998). Stowe, Haverkort, and Zwarts (2004) have pointed out that the area of the left inferior frontal gyrus (Broca's area), formerly known only as the language expression area, also performs functions of temporary storage of information during verbal short-term memory verbal tasks and during the processing of sentences, storing the syntactic and lexical information. This could explain the deficits in the working memory function presented by the aphasic patients. Moreover, since working memory interferes with language functions, it is believed that the opposite may occur. When comparing the two groups (clinical and control) regarding the working memory variable, controlling for the linguistic covariates, the differences did not remain significant. Thus, we can conclude that the language difficulties presented by aphasic patients would be interfering with the performance of this function.

This research has also shown impairment of the verbal episodic-semantic memory function (immediate and delayed recall) in patients with predominantly expressive aphasia. The same findings have been shown by Bonini (2010), who, like in the present study, has also found that aphasic patients showed better performance in the recognition task, in spite of deficits in recall tasks (immediate and delayed). Thus, it can be assumed that the ability for encoding information is relatively preserved in relation to spontaneous recall in aphasics. It has been established that the verbal memory recall is likely to suffer interference of expressive language alterations for response, or the difficulties in organizing spontaneous search strategies for stored information (executive functions) (Bonini) This interference was proved when it was found that the comparison between the performance of patients and controls in the verbal episodic-semantic memory task (immediate recall) did not remain significant after controlling for linguistic covariates. Likewise, no statistically significant difference was found between the clinical and control groups for the performance in the recognition task, which led us to conclude that verbal information is encoded and stored, but can not be spontaneously recalled by aphasics.

The function of constructive praxis also showed impairment among the aphasic patients in this study. The association between aphasia and apraxia could be explained by an injury to the neighboring structures in the left hemisphere, specialized in language skills and motor abilities (Papagno, Della Sala, & Basso, 1993). However, the differences between the clinical and control groups in the constructive praxis variable, did not remain significant after controlling the effect of linguistic covariates. It is possible that language skills may be interfering in constructive praxis skills, perhaps related to graphic expression, since the majority of patients had motor impairments (right hemiparesis). Still, the difficulty in verbalizing the action could be restricting the support to perform motor tasks.

Considering that the constructive praxis skill is the ability to play out or create pictures (in the case of this study, drawing), the patients require motor abilities to accomplish the task (Parente, 2009). Thus, with the motor impairments in the upper right limb, all the patients being right-handed, it is believed that this ability could also have been impaired by the patients' motor restriction.

It is noteworthy that nonverbal functions, such as visual perception and visual memory, were found to be adequate among the patients in this study. These results corroborate the findings of Helm-Estabrooks (2002), which has shown that aphasics performed better in non-linguistic tasks than in linguistic ones. However, the severity of aphasia and the results of batteries of nonverbal neuropsychological tasks do not correlate (Helm-Estabrooks et al., 1995), which emphasizes the importance of investigating these functions, regardless of the degree of language impairment of the patient.

In patients with aphasia, performance on non-linguistic neuropsychological tasks varies between groups of patients with good performance, with varying deficits and patients who are not able to perform the tests (Van Mourik et al., 1992). These results suggest the heterogeneity of the patients' cognitive profile and, again, the need for a thorough, individualized neuropsycholinguistic assessment in order to efficiently planning the therapy for patients with aphasia.

Cluster analysis enabled the generation of three subgroups, showing that, in addition to the obvious differences between group 1 (clinical) and 3 (control), there was an intermediate group (group 2: mixed) formed by patients with less severe cognitive deficits and controls with lower scores in neuropsycholinguistic tasks. Most patients in group 2 (mixed) were classified in the transcortical motor sub-type.

Comparing the performance of patients with Broca's aphasia to that of patients with transcortical motor aphasia, a greater severity of aphasia in the former was observed, as well as lower scores on attention, oral language (comprehension and expression), prospective memory and verbal fluency tasks. Transcortical motor aphasia presents many features of Broca's aphasia, but the repetition of sentences is relatively preserved and the brain injury occurs in areas adjacent to Broca's area (Hillis, 2007). Knowing that Broca's area also has functions related to working memory and the processing of sentences (Stowe et al., 2004), the most evident impairments in linguistic and attentional functions in patients with Broca's aphasia may be justified.

Regarding the healthy subjects belonging to the mixed group (2) who achieved lower scores (but still within the normal range) in the neuropsycholinguistic evaluation, all had limited access to formal education (four years), a condition that could justify the lower performance of this control group, when compared to the group of controls belonging to cluster 3.

## Conclusion

Statistically significant differences were found between the group of aphasic patients post-stroke in the LH (clinical group) and the healthy persons (control group) in the following neuropsycholinguistic functions: attention, working memory, verbal episodic-semantic memory (immediate and delayed recall), constructive praxis, and executive functions (spelling and semantic verbal fluency) and expressive language skills.

Considering the relevant variables (oral language, written language, attention, working memory, verbal episodic-semantic memory, spelling and semantic verbal fluency), three subgroups emerged from the sample of participants: clinical group, mixed group (clinical and control) and control group. Differences between the three groups were significant for the working memory and executive functions (spelling and semantic verbal fluency) variables. The mixed group was formed by mild aphasic patients, mostly with transcortical motor aphasia, and healthy people with lower level of scholling.

A trend toward greater severity of aphasia in patients with Broca's aphasia was observed, in comparison to patients with transcortical motor aphasia. The former showed lower scores on attention, expression and comprehension of oral language, prospective memory and verbal fluency tasks.

Therefore, despite the differences found between the clinical and control groups in the performance on neuropsycholinguistic tasks, the cluster analysis made the variability of damage and abilities in neuropsycholinguistic functions evident. The patients in this study presented brain injuries of different sizes and locations, though all were located in the left cerebral hemisphere. Furthermore, it is believed that other components besides injury location and classification of aphasia may influence the performance of neuropsycholinguistic tasks. It was found that the performance of each patient assessed could be associated with several variables, always emphasizing the need for a thorough neuropsycholinguistic review.

The neuropsycholinguistic performance (preserved and reduced skills) should be taken into account for the implementation of therapy in aphasic patients. However, many speech therapists are guided only by the language results. One should be aware of the fact that all cognitive components are recruited and used in varying degrees during the rehabilitation process (Helm-Estabrooks, 2002). Furthermore, it is not possible to predict the relative integrity of neuropsycholinguistic function based only on language functions performances (Helm-Estabrooks et al., 1995). For these reasons, the importance of a thorough and detailed evaluation in aphasic patients is underscored.

Thus, it is concluded that the linguistic and non-linguistic cognitive abilities and the socio-demographic characteristics of aphasic patients post-stroke in the left cerebral hemisphere must be analyzed in detail, in order to facilitate the development of more effective rehabilitation programs for aphasia.

## References

Alexander, M. P. (2003). Aphasia: clinical and anatomic aspects. In T. E. Feinberg, & M. J. Farah (Eds.), *Behavioral neurology and neuropsychology* (2nd ed.). USA: Copyrighted Material.

Almeida, O. P., & Almeida, S. A. (1999). Confiabilidade da versão brasileira da escala de depressão em geriatria (GDS) versão reduzida. *Arquivos de Neuro-Psiquiatria, 57*(2B), 421-426.

Alves, G. S, Alves, C. E. O., Lanna, M. E., Moreira, D. M., Engelhardt, E., & Laks, J. (2008). Subcortical ischemic vascular disease and cognition: A systematic review. *Dementia & Neuropsychologia, 2*(2), 82-90.

Ardila, A. (2010). A proposed reinterpretation and reclassification of aphasic syndrome. *Aphasiology, 24*(3), 363-394.

Baddeley, A. (2003). Working memory and language: An overview. *Journal of Communication Disorders, 36*, 189-208.

Barker-Collo, S., & Feigin, V. (2006). The impact of neuropsychological deficits on functional stroke outcomes. *Neuropsychological Review, 16*, 53-64. doi: 10.1007/s11065-006-9007-5

Beck, A. T., Ward, C. H., Mendelson, M., Mock, J., & Erbaugh, G. (1961). An inventory for measuring depression. *Archives of General Psychiatry, 4*, 53-63.

Bonini, M. V. (2010). *Relação entre alterações de linguagem e déficits cognitivos não lingüísticos em indivíduos afásicos após Acidente Vascular Encefálico.* Unpublished master’s thesis, Faculdade de Medicina da Universidade Federal de São Paulo, São Paulo, SP, Brasil.

Breier, J. I., Randle, S., Maher, L. M., & Papanicolaou, A. C. (2010). Changes in maps of language activity activation following melodic intonation therapy using magnetoencephalography: Two case studies. *Journal of Clinical and*

*Experimental Neuropsychology, 32*(3), 309-314.

Burgio, F., & Basso, A. (1997). Memory and afasia. *Neuropsychologia, 32*(6), 759-766.

Carlomagno, S., Pandolfi, M., Labruna, L., Colombo, A., & Razzano, C. (2001). Recovery from moderate aphasia in the first year poststroke: Effect of type of therapy. *Archives Physical Medical Rehabilitation, 82*(8), 1073-1080.

Caspari, I., Parkinson, S. R., LaPointe, L. L., & Katz, R. C. (1998). Working memory and aphasia. *Brain and Cognition, 37*, 205-223.

Cunha, J. A. (2001). *Manual da versão em português das Escalas Beck*. São Paulo: Casa do Psicólogo.

Fontanari, J. L. (1989). O “Token Test” elegância e concisão na avaliação da compreensão do afásico. Validação da versão reduzida de De Renzi para o português. *Neurobiologia, 52*(3), 177-218.

Fontoura, D. R., Rodrigues, J. C., Parente, M. A. P. P., Fonseca, R., & Salles, J. F. (2011). Adaptação do Instrumento de Avaliação Neuropsicológica Breve NEUPSILIN para avaliar pacientes com afasia expressiva: NEUPSILIN-Af. *Ciências & Cognição, 16*(3), 78-94.

Girodo, C. M., Silveira, V. N. S., & Girodo, G. A. M. (2008). Afasias. In D. Fuentes, L. F. Malloy-Diniz, C. H. Camargo, R. M. & Cozenza (Eds.), *Neuropsicologia: Teoria e prática* (pp. 119-135). Porto Alegre: Artmed.

Goodglass, H., Kaplan, E., & Barresi, B. (2001a). *Boston Diagnostic Aphasia Examination Short Form.* Philadelphia, USA: Lippincott Williams & Wilkins.

Goodglass, H., Kaplan, E., & Barresi, B. (2001b). *The assessment of aphasia and related disorders.* (3nd ed). Philadelphia: Lippincott Williams & Wilkins.

Helm-Estabrooks, N. (2002). Cognition and aphasia: A discussion and a study. *Journal of Communication Disorders, 35*(2), 171-186.

Helm-Estabrooks, N., & Albert, M. L. (2004). *Manual of aphasia and aphasia therapy.* Austin: Pro-Ed.

Helm-Estabrooks, N., Bayles, K., Ramage, A., & Bryant S. (1995). Relationship between cognitive performance and aphasia severity, age and education: females versus males. *Brain and Language*, *51*(1), 139-141.

Hillis, A. E. (2007). Aphasia: Progress in the last quarter of a century. *Neurology, 69*, 200-213.

Jefferies E., Lambon Ralph, M. A., & Baddeley A. D. (2004). Automatic and controlled processing in sentence recall: The role of long-term and working memory. *Journal of Memory and Language, 51*, 623-643.

Jodzio, K., & Taraszkiewicz, W. (1999). Short-term memory impairment: Evidence from aphasia. *Psychology of Language and Communication, 3*(2), 39-48.

Lorenz, A., & Ziegler, W. (2009). Semantic vs. word-form specific techniques in anomia treatment: A multiple single-case study. *Journal of Neurolinguistics, 22*(6), 515-537.

Lotufo, P. A. (2005). Stroke in Brazil: A neglected disease. *São Paulo Medical Journal, 123*(1), 3-4.

Moreira, L., Schlottfeldt, C., G., Paula, J. J., Daniel, M. T., Paiva, A., Cazita, V. M., et al. (2011). Estudo normativo do Token Test versão reduzida: Dados preliminares para uma população de idosos brasileiros. *Revista de Psiquiatria Clínica, 38*(3), 97-101.

Murray, L. L. (2012). Attention and other cognitive deficits in aphasia: Presence and relation to language and communication measures. *Americam Journal of Speech-Language Pathology, 21*, 51-64.

Papagno, C., Della Sala, S., & Basso, A. (1993). Ideomotor apraxia without afasia and afasia without apraxia: The anatomical support for a double dissociation. *Journal of Neurology, Neurosurgery and Psychiatry, 56*, 286-289.

Parente, M. A. M. P. (2009). Pressupostos teóricos que embasaram a construção do NEUPSILIN. In R. P. Fonseca, J. F. Salles, & M. A. Parente (Eds.), *NEUPSILIN: Instrumento de Avaliação Neuropsicológica Breve* (pp. 13-22). São Paulo: Vetor.

Parkinson, R. B., Raymer, A., Chang, Y. L., Fitzgerald, D. B., & Crosson, B. (2009). Lesion characteristics related to treatment improvement in object and action naming for patients with chronic aphasia. *Brain and Language, 110*(2), 61-70.

Peña-Casanova, J., Pamies, M. P., & Diéguez-Vide, F. (2005). Tipos clínicos clássicos de afasias e alterações associadas. In J. Peña-Casanova, & M. P. Pamies (Eds.), *Reabilitação das afasias e transtornos associados* (pp. 64-88). Barueri, SP: Manole.

Potagas, C., Kasselimin, D., & Evdokimidis, I. (2011). Short-term and working memory impairments in aphasia. *Neuropsychologia, 49*, 2874-2878.

Radanovic, M., Azambuja, M., Mansur, L. L., Porto, C. S., & Scaff, M. (2003). Thalamus and language: Interface with attention, memory and executive functions. *Arquivos de Neuropsiquiatria, 61*(1), 34-42.

Saffran, E. M. (2003). Aphasia: Cognitive neuropsychological aspects. In T. E. Feinberg, & M. J. Farah (Eds.), *Behavioral neurology and neuropsychology* (2nd ed., pp. 133–150). USA: McGraw-Hill.

Sagen, U., Vik, T. G., Moum, T., Mørland, T., Finset, A., & Dammen, T. (2009). Screening for anxiety and depression after stroke: Comparison of the hospital anxiety and depression scale and the Montgomery and Asberg depression rating scale. *Journal of Psychosomatic Research, 67*(4), 325-332.

Senów, J., Litwin, M., & Lesniak, M. (2009). The relationship between non-linguistic cognitive deficits and language recovery in patients with aphasia. *Journal of the Neurological Sciences, 283*, 91-94.

Silva, C. D. (2009). *Um estudo de funções executivas em indivíduos afásicos.* Unpublished manuscript, Monografia de Graduação do Curso de Fonoaudiologia, Universidade Federal de Minas Gerais, Faculdade de Medicina. Belo Horizonte, Brasil.

Stowe, L. A., Haverkort, M., & Zwarts, F. (2004). Rethinking the neurological basis of language. *Lingua, 115*, 997-1042.

Van Mourik, M, Verschaeve, M., Boon, P., Paquier, P., & Van Harskamp, F. (1992). Cognition in global aphasia: Indicators for therapy. *Aphasiology, 6*(5), 491-499.

Vieira, A. C. C., Roazzi, A., Queiroga, B. M., Asfora, R., & Valença, M. M. (2011). Afasias e áreas cerebrais: Argumentos prós e contras à perspectiva localizacionista. *Psicologia: Reflexão e Crítica, 24*(3), 588-596.