Original Article

Preliminary analysis of the effect of age and education level of healthy adults on the performance in the Sydney Language Battery (Sydbat) in Chilean Spanish

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ABSTRACT

There are 3 variants of Primary Progressive Aphasia (PPA) characterized accordingly to the linguistic domain that is predominantly altered: non-fluent, logopenic, and semantic. A tool that helps in this classification is the Sydney Language Battery (Sydbat), which is not validated in Chile. This study analyzes the possible relationship between age and years of schooling and healthy adults' performance obtained in the Sydbat subtests. 38 healthy adults participated in the test. The average age was 56.8 years (SD = 8.3), with a mean of 13.8 years of schooling (SD = 3.9). They all resided in the Metropolitan Region. Pearson and Spearman's correlations were performed to explore the correlation between subtest performance, age, and schooling. Considering the variability in performance in the subtests, univariate and multivariate models were applied. Significant correlations were found between age and the comprehension subtest (p <0.05) and between years of schooling and the semantic association (p <0.001) and naming (p <0.01) subtests. In participants with more than 12 years of schooling, the score in the semantic association subtest varied approximately 2 points compared to people with less than 12 years of schooling (p <0.01). We conclude that the variations in test performance depend on age and education level. The older the participants are, the lower their performance on the comprehension subtest. The higher the schooling level, the higher the performance on the semantic association and naming subtests. The validation process for Sydbat should considerer these effects.

Keywords:
Primary Progressive Aphasia; Sydbat; dementia; aging; education level

Análisis preliminar del efecto de la edad y la escolaridad en adultos sanos en el rendimiento del Sydney Language Battery (Sydbat) en español de Chile

RESUMEN

Existen 3 variantes de afasia progresiva primaria (APP), que se distinguen según el dominio lingüístico predominantemente alterado: no fluente, logopénica y semántica. Una herramienta que ayuda a su clasificación es el Sydney Language Battery (Sydbat), el cual no se encuentra validado en Chile. El objetivo del presente trabajo es analizar la posible relación entre edad, años de escolaridad y rendimiento obtenido en las subpruebas del Sydbat en adultos sanos. Participaron 38 adultos sanos a los que se les aplicó el test. El promedio de edad fue 56,8 años (DE = 8,3) y tenían una media de 13,8 años de escolaridad (DE = 3,9). Todos provenían de la Región Metropolitana. Se realizaron correlaciones de Pearson y Spearman, para explorar la correlación entre el rendimiento en las subpruebas, la edad y la escolaridad. Considerando la variabilidad en el rendimiento en las subpruebas, se realizaron modelos uni y multivariados. Se encontraron correlaciones significativas entre edad y la subprueba comprensión (p<0,05) y los años de escolaridad con las subpruebas asociación semántica (p<0,001) y nominación (p<0,01). En personas con más de 12 años de escolaridad, el puntaje en la subprueba asociación semántica varió aproximadamente 2 puntos, con respecto a personas con menos de 12 años de escolaridad (p<0,01). Se concluye que las variaciones en el rendimiento del test, dependen la edad y la escolaridad. A mayor edad, menor es el rendimiento en la subprueba de comprensión. A mayor escolaridad, mayor es el rendimiento en las subpruebas de asociación semántica y nominación. El efecto mencionado debe ser considerado en el proceso de validación de Sydbat.

Palabras clave:
Afasia Progresiva Primaria; Sydbat; demencia; envejecimiento normal; nivel educacional

INTRODUCTION

Primary Progressive Aphasia (PPA) is characterized by linguistic alterations and cerebral atrophy in the perisylvian area. The cognitive alterations observed in APP are similar to other neurodegenerative disorders, such as Frontotemporal Dementia or Alzheimer's-type Dementia (Baeza et al., 2012; Gorno-Tempini et al., 2011; Matías-Guiu & García-Ramos, 2013; Serrano et al., 2005). The diagnosis of PPA focuses predominantly on language disturbances without the impairment of other cognitive functions. The clinical picture for PPA generally manifests between the ages of 40 and 70, which is why it is described as a type of early-onset dementia (Baeza et al., 2012). Current literature describes 3 variants of PPA: non-fluent, semantic, and logopenic variants (Gorno-Tempini et al., 2011). Each variant presents a different level of severity when it comes to disturbances at the comprehensive and expressive language (phonological, semantic, or syntactic level) (Custodio et al., 2012; Gorno-Tempini et al., 2011; Matías-Guiu & García-Ramos, 2013; Savage et al., 2013). The non-fluent variant is characterized by a disruption in grammatical processing that may eventually be accompanied by apraxia of speech. In the semantic variant, the most characteristic signs are severe anomia and impaired comprehension of isolated words, especially low-frequency words. Unlike the non-fluent variant, in the semantic variant, the language is fluent and grammatically adequate. Finally, the logopenic variant is characterized by the presence of phonological paraphasia both in naming tasks and spontaneous speech, and impairments in sentence repetition. However, no grammatical disturbances or articulatory problems are observed.

Given the diversity of linguistic disturbances between the variants, the diagnosis of subtypes poses a challenge. In addition, there is a lack of instruments to facilitate the detection of specific linguistic impairments (Sapolsky et al., 2014; Savage et al., 2013). To this day, there are no validated tools in Spanish for the specific linguistic assessment of the PPA's clinical picture. Objective instruments are essential for a clear and precise characterization of this type of aphasia (Gorno-Tempini et al., 2011; Knopman et al., 2007; Sapolsky et al., 2010). Commonly, the definition of the disturbances that patients with PPA present is carried out using 2 cognitive screening tests, the Montreal Cognitive Assessment (MoCA) (Delgado et al., 2019) and the Mini-mental State Examination (MMSE) (González-Hernández et al., 2009). Both tools have been designed to study dementia and cognitive impairment, and they are not intended to study language disorders (Delgado & Salinas, 2009). Furthermore, the literature reports that the cut-off scores in this type of instrument are affected by demographic variables such as years of schooling and age (González-Hernández et al., 2009).

Education level is a variable that should not be ignored when validating a tool since it is closely related to performance in language skills such as naming, word comprehension, and grammatical comprehension (Burke & Shafto, 2004; Véliz et al., 2010). Education level becomes relevant in the Chilean population because the average number of schooling years (12 years) decreases in older adults (*Ministerio de Desarrollo Social & Subsecretaría de Evaluación Social* [Ministry of Social Development & Subsecretariat of Social Evaluation], 2015). Also, age is relevant in linguistic performance; this is reflected in the differences found between young and older adults (López Higes et al., 2013; Soares & Ortiz, 2009).

In 2013, the "Sydney Language Battery" (Sydbat) was created in Australia to characterize the variants of PPA through 4 subtests: naming, semantic association, word comprehension, and repetition (Savage et al., 2013). This diagnostic tool proved to have good convergent validity, with Pearson correlation coefficients within a range of r = 0.67 for repetition and r = 0.95 for naming. Additionally, this test was shown to have good inter-rater reliability and be valid and reliable to determine PPA variants in English-speaking patients (Savage et al., 2013).

On the other hand, the test allows professionals involved in the diagnosis and treatment of PPA to implement a single battery to characterize the clinical linguistic symptoms of patients, thus avoiding extracting subtests from other diagnostic tests that are not designed for this type of user.

In Chile, the elderly population is highly likely to suffer from neurodegenerative diseases (Gajardo & Monsalves, 2013). Therefore, it is necessary to count on validated tools at a national level that facilitates the early diagnosis of dementia, including variants of PPA. The Chilean validation of the Sydbat will allow providing timely therapy to people with this condition, aimed at their specific cognitive and communication needs (Sapolsky et al., 2014).

This study aims to analyze the possible relationship between age and years of schooling and the performance in the subtests of the Chilean version of the Sydbat in healthy adults over 40 years of age in the Metropolitan Region.

METHODOLOGY

This pilot study is a cross-sectional, observational-analytical design. A convenience sample was used, inviting healthy Chilean adults over 40 years of age residing in the Metropolitan Region of Chile. The inclusion criteria were: a) to be a native Spanish speaker, b) over 40 years old, and c) to reside in the Metropolitan Region. The exclusion criteria were: a) having a severe hearing and/or visual disability, b) having a diagnosis of dyslexia, c) having a psychiatric or neurodegenerative disease, d) having a history of neurological diseases, and e) obtaining a score lower than 26 on the Montreal Cognitive Assessment (MoCA), which suggests the presence of cognitive impairment (Delgado et al., 2019).

Participants

A pilot was carried out on 10 healthy volunteers for the linguistic and cultural adaptation of the Sydbat battery in Chile. The expected sample size for the validation process was calculated from this piloting, corresponding to 62 participants. However, the sample size could not be completed due to the social events in the second half of 2019 in Chile. The activity could not be resumed in 2020 due to the COVID-19 pandemic. Despite the difficulties mentioned above, 51 people could participate in the study, of which 13 did not meet the cut-off score in the MoCA test. Therefore, the final sample consisted of 38 participants. The characteristics are presented in Table 1.

All participants signed informed consent before the evaluation. In addition, the study was approved by the Scientific Ethics Committee of Health Sciences of *Pontificia Universidad Católica de Chile* (190510002).

Characteristics of the Sydbat Test

The Sydbat test assesses linguistic abilities at the level of isolated words, and for this, it uses four sub-tests: naming, repetition, word comprehension, and semantic association. Each subtest is scored 0 and 1, and the maximum score is 30 points. The stimuli are presented in digital form (tablet or computer) and are sequenced based on difficulty, according to linguistic parameters, imaginability, frequency, and syllabic complexity (Savage et al., 2013).

Table 1. Demographic Characteristics of the participants.

Variable	Volunteers (n = 38)
Age	
Years, mean, (SD), [range]	56,8, (8.3) [40-77]
Gender	
Female, n (%)	18 (47,3)
Male, n (%)	20 (52,6)
Laterality	
Right-handed, n (%)	33 (86,8)
Left-handed, n (%)	3 (7,8)
Ambidextrous	2 (5,2)
Years of Schooling	
Years, Mean, (SD), [range]	13,8 (3,9) [6 - 23]
< 12 years, n (%)	11 (28,9)
≥ 12 years, n (%)	27 (71)

SD: Standard deviation.

Chilean adaptation of the Sydbat Test

The Chilean Spanish adaptation of the Sydbat test was carried out by a committee of experts, composed of 2 Speech Therapists, 1 Neuropsychologist, and 2 Neurologists, with more than 10 years of experience in the evaluation and treatment of patients with dementia. It was carried out according to the variables internationally considered for the validation of health assessment instruments (Carvajal et al., 2011; Hilton & Skrutkowski, 2002).

The words for each subtest were calibrated according to frequency, length, and syllabic composition. The frequency of the words was determined using the frequency dictionary of Sadowsky & Martínez-Gamboa (2008). Length and syllabic structure were established by counting the syllables and analyzing the phonemes that make up each stimulus. The expert committee carried out three evaluation sessions. The final list of stimuli and their respective images were defined, eliminating contrast and backgrounds that could create confusion. The final version obtained a Lawshe content validity index (CVI) of 0.92 among the 5 expert judges.

Application of the Sydbat Test

The linguistic performance of the participants was assessed using the Sydbat Battery. The first subtest is the naming one, which consists of showing one image at a time. The participant must respond by naming what they see in the image. Omitting or making any phonetic, phonological or semantic error is

considered incorrect. Next, the repetition subtest is carried out, in which the participant must repeat the word that the evaluator mentions without visual support of the stimulus. Subsequently, the comprehension subtest is applied, in which the evaluator presents an auditory stimulus, and the participant must select an image within a group of visual stimuli. The group includes the target word plus six semantically related terms. Finally, the semantic association subtest is applied, where the evaluator says a word, and the participant must select the corresponding image among distractors.
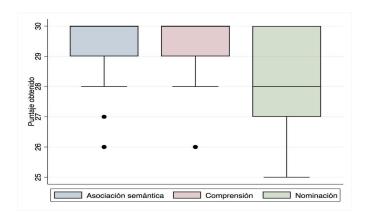
Statistical analysis

To evaluate the distribution of the study variables, the Shapiro-Wilk test was applied. Based on the normality distribution of the data, Pearson and Spearman's correlations were performed. Subsequently, univariate linear models were carried out between each subtest, age, and years of schooling. Based on the high variability of the comprehension variable, a multivariate linear model was applied with the variables age, years of schooling, and the comprehension subtest.

RESULTS

Participants

Figure 1 shows the scores of three of the subtests of the Sydbat Test. In semantic association and word comprehension, the median was located at the maximum score (30 points). There was more variability in the naming subtest, varying its scores between 25 and 30 points (Fig. 1). The score in the repetition subtest was not considered in the analysis since it presented a ceiling effect.

Figure 1. Sydbat subtest scores in a sample of healthy adults aged 40 years and over (n = 38). Y axis: Score Obtained. X axis: Semantic Association; Comprehension; Naming.

The age variable presented only a significant (negative) correlation with performance on the comprehension subtest. The older the age, the lower the score on this subtest. The educational variable had a moderate correlation with performance on the semantic association and naming subtests. The higher the level of education, the higher the score obtained in these subtests (Table 2).

Table 2. Matrix of correlation between subtests, age, and years of schooling (n=38).

	Semantic Association [a]	Naming [b]	Comprehension [a]
Age	0,01	-0,08	-0,37*
Years of schooling	0,56***	0,47**	0,27

[a] The Spearman correlation coefficient was obtained because the subtests of semantic association and comprehension had a biased distribution (the Shapiro-Wilk test verifies it).
[b] Pearson's correlation coefficient was estimated.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

In the univariate linear models (Table 3), age was shown to have a significant relationship with the comprehension subtest but not with the variables semantic association and naming. For each year of age of the participant, the score decreases by 0.04 points. The variable *years of schooling* were shown to have a significant relationship with the subtests of semantic association and nomination, showing a variation of 2 and 0.2 points, respectively, in people with more than 12 years of schooling.

The multivariate linear model was used in the comprehension subtest due to its high variability. In this model, only the age variable explained about 18% in the score variation in the comprehension subtest (Table 3).

Table 3. Univariate linear models to analyze the relationship between the subtests, age, and years of schooling (n=38) [a, b].

	Semantic Association	R^2	Naming	R^2	Comprehension [d]	R^2
Multivariate Models						
Age	0,01	<1,0	-0,02	<1,0	-0,04**	9,2
Years of schooling [c]	1,97**	34,1	0,19**	19,9	1,02	11
Multivariate Models						
Age	-	-	-	-	-0,04**	17,8
Years of schooling [c]	-	-	-	-	0,91	

[a] Results expressed as coefficients of the linear model (Beta).
[b] In the case of linear models in which the variable was the scores of the semantic association and comprehension subtests, a robust variance estimator was used.
[c] Results expressed for a number greater than 12 years of schooling.
[d] The years of schooling were included in the multivariate model since its significance value was p <0.1.
** p <0.01

DISCUSSION

The present study analyzed the relationship between the variables *age* and *years of schooling*, and the performance in three of the subtests of the Sydbat test (Spanish version for Chile) in healthy people over 40 years old, living in the Metropolitan Region. The results show that the *age* variable influences performance on the comprehension subtest, while *years of schooling* influence performance on the semantic association and naming subtests.

A significant negative relationship was found between *age* and *comprehension*, which indicates that the older the subject, the lower the score obtained in this subtest. These results align with what was stated in Saá (2006) study, which states that age causes a deterioration in central systems such as working memory, which impacts the attentional system and leads to an impairment of language comprehension. Regarding the skills of semantic association and naming, a significant positive correlation was evidenced with the *years of schooling* variable, which indicates that the higher the level of education, the higher the score obtained. Various studies (Lozano & Ostrosky-Solís, 2006; Paolieri et al., 2018; Zanin et al., 2010) report the effect of schooling on the lexical-semantic system and describe that the higher the education level, the better the performance on tests that assess said system. The reason for this effect is that the years of schooling promote metacognitive and verbal skills that enhance the development of the lexical-semantic system.

This work has two limitations, which are discussed below. One is that the sample size is small, reaching only 61% of the sample we proposed to validate this instrument. This restricted the analyzes that could be carried out to validate the test. The other limitation is related to the screening test used to control the presence of cognitive impairment (MoCA). This test provides additional points to people with a low level of formal education. Despite this, 26% of the initial sample with fewer years of education did not meet the cut-off score. This impacted the study, reducing the variability of years of schooling in the sample, which implied that the sample was made up of participants with a relevant number of schooling years. Therefore, it is necessary to consider this sampling bias for the validation process of the Sydbat test.

Future studies should take care of this bias, so using a clinical dementia scale such as the Hughes Clinical Dementia Rating is advisable. The scale mentioned above is an instrument that considers people with a low level of education since it controls for symptoms of cognitive deterioration (Morris, 1997).

Despite the limitations mentioned, the results obtained, although preliminary, serve as a guide for the validation process of the Sydbat test. In this regard, the need to complete the proposed sample size is highlighted, considering the variability of age and education level. In addition, it is expected to integrate volunteers from other regions of the country to obtain results that are more representative of the Chilean population.

CONCLUSION

The Sydbat test is an evaluation instrument designed to classify the subtypes of PPA. The preliminary results of the Chilean Spanish version of this test suggest that the validation process should reconsider the MoCA test for the selection of its participants and control the effect of the variables *age* and *years of schooling* in the subtests of semantic association, naming, and comprehension.

ACKNOWLEDGMENTS

The authors thank Eduardo Fuentes López for his support in the preliminary analysis carried out for this study.

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