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RESEARCH REPORT

Validation of the abbreviated version of the Token Test in Latin American Spanish stroke patients

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Abstract

Background: The abbreviated version of the Token Test (aTT) is widely used to assess language comprehension deficits in stroke patients (SPs). However, aTT has not been validated for Latin American Spanish speakers, so clinicians tend to use cut-off scores for aTT validated in developed countries.

Aims: To provide normative data for the Spanish aTT (Sp-aTT) in healthy Chilean Spanish-speaking and SP, determining the influence of sociodemographic variables such as gender, age and education on Sp-aTT performance.

Methods & Procedures: A total of 210 healthy volunteers (age range = 18–88 years) and 197 SPs (age range = 23–94 years), all native speakers of Chilean Spanish, were recruited. The association of age, gender and years of education on the Sp-aTT performance was analysed. Specificity and sensibility analyses of the Sp-aTT to diagnose language comprehension deficits were completed.

Outcomes & Results: Only age ($p < 0.001$) and years of education ($p < 0.001$) impacted the total score of Sp-aTT. Gender did not show an association with Sp-aTT performance ($p = 0.181$). For SPs, the Sp-aTT score showed a significant positive correlation (rho = 0.4, $p < 0.001$) with the aphasia severity rating scale

(ASRS) score. For Sp-aTT, the area under the curve was 0.97, and the optimal cut-off score for the Sp-aTT was 30 (0.73 of sensitivity, 0.92 of specificity and a Youden index of 0.644).

Conclusions & Implications: Age and years of education are two key factors to be controlled for when determining the optimal cut-off points for the Sp-aTT. Our results also highlight the need for language-specific norms in stroke and aphasia research.

KEYWORDS
abbreviated Token Test, age, education, gender, Spanish

WHAT THIS PAPER ADDS

What is already known on the subject

- The aTT has been validated and adapted in several countries. Its properties in screening and detecting comprehensive deficits in SPs highlight its potential as a screening tool in clinical practice. Moreover, considering that stroke is the third largest cause of death worldwide, research and clinical practice have focused on how to improve early detection of deficits in these people, especially those related to cognition, language and functionality in SPs. Therefore, counting with validated and adapted tools is essential for clinicians because it could contribute to accurate intervention and classification of language disorders.

What this paper adds to the existing knowledge

- The main contribution of this study is to provide normative data for the aTT in Latin American Spanish speakers. No previous studies have focused on validating this test and analysing the influence of three critical variables (age, gender and years of education) on its performance in SPs from Latin America. In addition, we propose a classification of the severity of comprehension deficits in SPs. Finally, we found comprehension deficits in patients with right and left hemisphere stroke, which would imply that these deficits would not be exclusive to left hemisphere stroke.

What are the potential or actual clinical implications of this work?

- Contribute with validation of language comprehension tools, such as the aTT, could improve early diagnosis of patients with language disorders. This validation provides a test based on the sociodemographic characteristics of Latin American Speakers, which has yet to be established. Due to this, normative data considering the sociodemographic characteristics of the target population is crucial for accurately classifying comprehension deficits after brain damage.

BACKGROUND

Stroke is the third leading cause of death worldwide and the most frequent cause of disability in developed countries (Owolabi et al., 2022). Aphasia is present in nearly 30% of stroke patients (SPs), and its incidence increases with age (Flowers et al., 2016). It has been proposed that aphasia is a common, severe symptom in SP (Wu et al., 2020), and its initial severity is related to poor functional prognosis (Filipska-Blejder et al., 2023). Therefore, the literature suggests that early language assessment is essential to implement timely and proper rehabilitation in SP (Wang et al., 2022; El Hachioui et al., 2012).

Most evidence about language performance and comprehensive deficits has been focused on SP and aphasic patients with left hemisphere (LH) brain damage. Hachioui et al. (2017) suggest several screening tests for aphasic patients with left brain lesions, neglecting the right hemisphere's (RH) contribution to language processing. Despite this, a previous study (Gajardo-Vidal et al., 2018) highlights that SP with right brain damage could show impairment in language comprehension skills. Moreover, several studies aligned with this postulate show the importance of the RH in aphasia recovery and in determining comprehension abilities in SP's screening and diagnosis (Bakhtiar et al., 2023; Jung-Beeman, 2005; Mackenzie & Brady, 2008).

The original abbreviated version of the Token Test (aTT) (Renzi & Faglioni, 1978) is widely used to evaluate auditory language comprehension in SP. Jap and Arumsari (2017) highlight that the aTT is a simple, easy, objective and quickly administered tool (less than 15 min), making it useful in clinical practice. Also, a previous study (Egorova-Brumley et al., 2022) on aphasic SP shows that the aTT contributes to evaluating the presence and severity of aphasia and establishes correlations between comprehensive performance and structural brain damage.

Impairment in auditory comprehension has been proposed as the most challenging symptom in post-stroke aphasic patients (Liw et al., 2021). Based on this, research (Bakhtiar et al., 2020; Jap & Arumsari, 2017; McNeil et al., 2015) has been conducted to validate and adapt the aTT in several languages (e.g., English speakers, Indonesian speakers and Cantonese speakers). Thus, some studies advance aTT as a control reference when validating new language protocols for detecting comprehension deficits in patients with aphasia (Brady et al., 2016; Raven-Takken et al., 2020).

Evidence available from Latin American speakers about normative data for the aTT has been focused paediatric population and healthy older adults (Carvalho et al., 2009; Gallardo et al., 2011; Moreira et al., 2011; Olabarrieta-Landa et al., 2017). Likewise, psychometric properties and usefulness of the aTT have been conducted to make online versions available in more than 30 languages (Bastiaanse et al., 2016). However, no previous studies have provided normative data on the aTT for Chilean speakers, challenging the interpretation and classification of deficits in SP and patients with aphasia.

In Chile, the stroke rate (first event) is 140.1 per 100,000 inhabitants (Lavados et al., 2007). Aphasia is diagnosed for 19.7% of Chilean SPs, with an incidence of 7.06 per 100,000 inhabitants that increases with age (González et al., 2017). Sociodemographic variables, such as age, years of education and gender, have been proposed as critical for language performance in SP or aphasic Chilean patients (González et al., 2017). Therefore, they must be considered when exploring aTT performance by Chilean subjects.

Previous validations of the aTT in Latin American Speakers have not found a gender effect (Aranciva et al., 2012; Moreira et al., 2011; Peña-Casanova et al., 2009). As for the effect of age on Spanish speakers, a negative impact has been reported, leading to lower aTT scores (Aranciva et al., 2012; Peña-Casanova et al., 2009). On the other hand, the validation conducted by Moreira et al. (2011) showed that education significantly impacts the aTT performance of Brazilian Portuguese speakers.

Interpreting aTT in the context of Chilean SP patients is still challenging due to the lack of normative data. Moreover, previous validation of the aTT in Latin American Speakers has not considered the differences in comprehension impairment in SP with left and right brain damage. Therefore, this study aims to provide normative data for the Spanish aTT (Sp-aTT) in healthy Chilean Spanish-speaking and SP, determining the influence of sociodemographic variables such as gender, age and education on Sp-aTT performance.

MATERIALS AND METHODS

Participants

A total of 210 healthy participants (HPs) and 197 SPs in the acute stage were recruited for this study. HPs were from five different regions of Chile (O'Higgins, Araucanía, Metropolitana and Magallanes regions) recruited using an open advertisement. Inclusion criteria were to be native Spanish speakers and older than 18 years old without antecedents of language difficulties, psychiatric, neurological and/or neurodegenerative diseases. Exclusion criteria for HPs were: (1) illiteracy, (2) severe hearing or visual impairment and (3) scoring under 21 points in the Mini-Mental State Examination (MMSE), following normative data for Chilean Speakers provided by Quiroga et al. (2004). SPs were recruited from the stroke units of two hospitals (Complejo Asistencial Sótero del Río and Red Salud UC-Christus). Inclusion criteria for SPs were to be native Spanish speakers, to be older than 18 years old and to be in the acute stage post-stroke (≤ 20 days after their first-ever intracerebral haemorrhage or infarction, confirmed by a neuroradiologist through inspection of CT or MRI scan) (Crofts et al., 2020). Exclusion criteria for SP were: (1) illiteracy, (2) severe hearing or visual impairment, (3) history of language difficulties, (4) severe dysarthria, (5) record of psychiatric, neurological and/or neurodegenerative diseases and (6) prior event of stroke.

All participants gave informed consent before enrolment. This study was approved by the Medical Ethical Committee (IDs 15-302 and 180319014).

Materials

The Sp-aTT included the same six items (36 instructions in total, six sections) as the original aTT (Renzi & Faglioni, 1978), each from 0 to 1 point. Items were scored as follows: 0 points were when participants gave an incorrect answer, 0.5 points for a correct answer after a clinician's repetition was required, and 1 point in case of a correct answer or participant's self-correction. Participants were assessed using a laminated page with the figures (circles and squares) printed on both sides for the first five items. The first side included only circles and squares of the same size, while the second side considered the figures in different sizes (small and big). Finally, for item six, all the participants were assessed using the circles and squares of melamine (30 mm in diameter and 2 mm thick). The cut-off score was 30 for HP and SP.

Aphasia severity rating scale (ASRS) was used to characterize SPs' aphasia severity. ASRS is a 6-point scale, ranging from 0 (no usable speech or auditory comprehension) to 5 (minimal discernible speech handicap). A 4–5 ASRS score is categorized as mild aphasia severity, a score of 3 is labelled as moderate, and scores < 3 are classified as severe (Goodglass & Kaplan, 1972). Also, all SPs were categorized into LH or RH based on a report by a neuroradiologist, according to MRI scans and the presence of body lesions.

Finally, the Edinburg Handedness Inventory (EHI) was used to assess participants' handedness. The EHI consists of questions about the preference for using the left or right hand in daily activities. Scores range from strongly left-handed to strongly right-handed, with middle scores indicating ambidextrous tendency (Oldfield, 1971).

Adaptation procedure of the Sp-aTT

Both groups were evaluated using the short version of the aTT (Renzi & Faglioni, 1978), which was linguistically adapted into Chilean Spanish. The adaptation process involved a linguistic and cultural adaptation. We followed the WG-2 guidelines of the Collaboration of Aphasia Trialists (Fyndanis et al., 2017; Martínez-Ferreiro, Arslan, et al., 2024) and DuBay and Watson's steps for linguistic and cultural adaptations (DuBay & Watson, 2019). We adhere to the steps reported in our previous validation work (Martínez-Ferreiro, Quique, et al., 2024). The final version of Sp-aTT was subjected to an expert evaluation of 12 speech and language therapists and three clinical linguists with more than 10 years of experience in aphasia research (CVI Laswche = 0.85). As in the original version, the Sp-aTT consisted of 36 instructions grouped into six sections, with complexity increasing across sections. The original guidelines and scoring system were also preserved: 1 point for a correct answer, 0.5 points for a correct answer after a repetition or self-correction, and 0 points in the event of an incorrect answer. Stimuli in blue in the original version are presented in black in the SpaTT to avoid the possible effect of achromatopsia, commonly present in SPs (Spillmann et al., 2000). Melamine tokens 30 mm in diameter and 2 mm thick with a laminated page of the stimuli printed on both sides were used to present the stimuli.

Statistical analysis

A preliminary Kolmogorov–Smirnov test revealed that data were non-normally distributed. Therefore, non-parametric tests were used in the initial analysis. A Mann–Whitney–Wilcoxon test was run to determine the role of gender, age and education in the Sp-aTT within each group and to determine which variables were relevant to be included in the linear models. The Sp-aTT scores' relationship with age and schooling years was further explored with a Spearman correlation. Subsequently, linear regression analyses with non-linear effects were used to assess the relationship between the scores and the independent variables of age and years of education, both as continuous variables. Consequently, we obtained normative scores of the Sp-aTT from the results of a linear model that adjusts for age, education and the interaction between education and subject type (HP or SP).

To determine the optimal cut-off scores predicting the presence or absence of language comprehension problems, we established the diagnostic accuracy of the Sp-aTT by using a logistic regression classification model. From this classification model, the estimation of the area under the receiver operating characteristic curve (ROC curve) was calculated. The optimal cut-off value was based on a balance of sensitivity and specificity, grounded on the Youden index (Youden, 1950).

For the SP group, we determined the association between Sp-aTT performance and the ASRS with a Spearman correlation. Aphasia severity classification was established by splitting patients' scores into percentiles. This analysis was made with psychometrics and statistical packages in R, an open-source software (version 4.0.2). Statistical significance was established at $p < 0.05$.

RESULTS

Demographic data of participants

Demographic and clinical data were collected through anamnesis and clinical records. The demographic data of all participants are summarized in Table 1.

Among the HP, 24.3% were over 60, and 65.7% had over 12 years of schooling. In the SP group, 67.5% were over 60, and 4.5% had more than 12 years of formal education. As for the clinical profile, the most frequent aetiology was ischaemic stroke (87.3%), with most having a stroke in the LH (58.8%). A few patients (32) got fewer than 3 points in the ASRS, indicating moderate to severe aphasia, whereas 73.6% obtained scores of 4–5 (mild aphasia).

The role of gender, age and years of education on the performance of Sp-aTT

Non-parametric Mann–Whitney–Wilcoxon tests within each group and taking the total sample ($n = 407$) are shown in Table 2. This analysis confirmed that gender could be excluded for further analyses. In the SP group, age significantly influences performance in the Sp-aTT, whereas in the HP group, years of education play a role in Sp-aTT performance.

Comparing the differences between both groups (see Appendix A), SPs exhibited poorer performance and higher variability in Sp-aTT performance than HPs ($p < 0.001$). Conforming age, SPs had a similar dispersion with HPs but were older than the HP group ($p < 0.001$). Finally, SP had fewer years of education and less variability in education than the HPs ($p < 0.001$).

In the SP group, a Spearman correlation analysis revealed a negative correlation between total Sp-aTT score and years of education (rho = −0.24, $p = 0.001$) and age (rho = −0.11, $p = 0.114$). For the HP group, years of education showed a positive correlation with Sp-aTT performance (rho = 0.54, $p < 0.001$), while age showed a negative correlation (rho = −0.3, $p \leq 0.001$) (Figure 1). Interestingly, we found that, for SPs, the Sp-aTT score showed a significant positive correlation (rho = 0.4, $p < 0.001$) with the ASRS score, indicating that a higher ASRS score was related to higher Sp-aTT performance.

Regression models and adjusted scores

After evaluating non-linear effects, we observed that the model that best adjusts for age is the model with linear effects, and for education was the model with interactions (see Appendix B). Multiple regression models for the Sp-aTT (Table 3) reinforced that gender is not a relevant variable, while variables such as age and education are essential (see model 6). Education interacts with a heterogeneous effect on the performance of the Sp-aTT. The adjusted scores are described in Table 4.

Specificity and sensitivity of the Sp-aTT

Considering the total scores of HPs and SPs, the area under the curve (AUC) was 0.97. The optimal cut-off score for the Sp-aTT was 30, with 0.73 of sensitivity, 0.92 of specificity and a Youden index of 0.644. Figures below this cut-off indicate impaired auditive language comprehension.

Classification of comprehension deficits according to severity

Based on our Sp-aTT results, the rate of comprehension impairments in our SPs' sample was provided (Table 5). Most SPs presented auditory comprehension language deficits regardless of stroke localization. Interestingly, 54.8% of patients with RH stroke had comprehension deficits (severe to mild deficits), corresponding to 29% ($n = 40$) of the sample that presented impairments ($n = 137$).

DISCUSSION

This study examined the psychometric properties of the Sp-aTT in HPs and SPs in the acute stage (less than 20 days after stroke). We also aimed to determine the role of sociodemographic variables such as gender, age and years of education on test performance in both groups. Our results suggest that only age and years of schooling influence Sp-aTT performance, showing accurate psychometric properties for detecting comprehensive language deficits.

We explored three variables that could impact Sp-aTT performance. Our findings suggest that only two

TABLE 1 Participants' demographic characteristics.

	SP (***n*** **= 197**)	**HP** (***n*** **= 210**)	**Full sample** (***n*** **= 407**)
Age, years, mean (SD) [range]	65.4 (12.43) [23–94]	47.57 (16.40) [18–88]	56.2 (17.10) [18–94]
Education, years, mean (SD) [range]	6.3 (3.95) [0–16]	14.3 (3.93) [2–26]	10.5 (5.61) [0–26]
Gender, *n* (%)			
Female	77 (39.1)	118 (56.2)	195 (47.9)
Male	120 (60.9)	92 (43.8)	212 (52.1)
Handedness (EHI), *n* (%)			
Right-handed	183 (92.9)	151 (71.9)	334 (82.1)
Left-handed	12 (6.1)	9 (4.3)	21 (5.2)
Ambidextrous	0 (0)	2 (1)	2 (0.5)
Unknown	2 (1.0)	48 (22.9)	50 (12.3)
Level of education, *n* (%)			
Incomplete primary education	128 (65)	14 (6.7)	142 (34.9)
Primary education graduate	14 (7.1)	5 (2.4)	19 (4.7)
Incomplete secondary education	24 (12.2)	12 (5.7)	36 (8.8)
Secondary education graduate	13 (6.6)	39 (18.6)	52 (12.8)
Complete technical	3 (1.5)	25 (11.9)	28 (6.9)
Incomplete superior studies	3 (1.5)	12 (5.7)	15 (3.7)
University graduate	3 (1.5)	101 (48.1)	104 (25.5)
Unknown	9 (4.6)	2 (1)	11 (2.7)
Type of stroke, *n* (%)		–	
Ischaemic	172 (87.3)		172 (87.3)
Haemorrhage	25 (12.7)		25 (12.7)
Both (ischaemic and haemorrhage)	0 (0)		0 (0)
Localization of stroke, *n* (%)		–	
Left hemisphere	116 (58.8)		116 (58.8)
Right hemisphere	73 (37.1)		73 (37.1)
Bilateral	8 (4.1)		8 (4.1)
ASRS		–	
≤ 3	32 (16.2)		32 (16.2)
> 3	145 (73.6)		145 (73.6)
Unknown	20 (10.2)		20 (10.2)

Note: EHI = Edinburgh Handedness Inventory; HP = healthy participants; SP = stroke patients; SD = standard deviation; ASRS = Aphasia Severity Rating Scale.

contribute to performance (age and years of education). Our results did not reveal any effect of gender on Sp-aTT performance, which aligns with previous normative studies (Aranciva et al., 2012; Moreira et al., 2011; Peña-Casanova et al., 2009) reporting that gender distinctions do not impact either the likelihood of acquiring language alterations (comprehensive or expressive) or its degree of severity (Aranciva et al., 2012; Moreira et al., 2011; Peña-Casanova et al., 2009). In contrast, Kansaku and Kitazawa (2001) argued that women have a more bilateral organization of language than men. Therefore, female SPs could compensate for language disturbances better than men (Wallentin, 2018).

In the analyses, we found a negative correlation of age with Sp-aTT performance in both groups, which has also been reported in previous studies that showed lower total scores as age increased (Aranciva et al., 2012; Ivnik et al., 1996; Peña-Casanova et al., 2009). The original aTT (Renzi & Faglioni, 1978) also showed a negative correlation between age and total test scores. Carvalho et al. (2009) also reported significant oral comprehension decline, showing that aTT scores in healthy ageing (≥ 60 years) worsen with

TABLE 2 Demographic differences for Sp-aTT performance.

	Mann–Whitney–Wilcoxon *p*-value
SP (TT = 23.75; *n* = 197)	
Gender (female versus male)	0.097
Age (< 60 versus > 60 years)	0.001
Education (< 12 versus > 12 years)	0.341
HP (TT = 33.9; *n* = 210)	
Gender (female versus male)	0.853
Age (< 60 versus > 60 years)	0.013
Education (< 12 versus > 12 years)	< 0.001
Full sample (TT = 28.7; *n* = 407)	
Gender (female versus male)	0.181
Age (< 60 versus > 60 years)	< 0.001
Education (< 12 versus > 12 years)	< 0.001

Note: Significant differences: $p < 0.05$.
HP = healthy participants; SP = stroke patients.

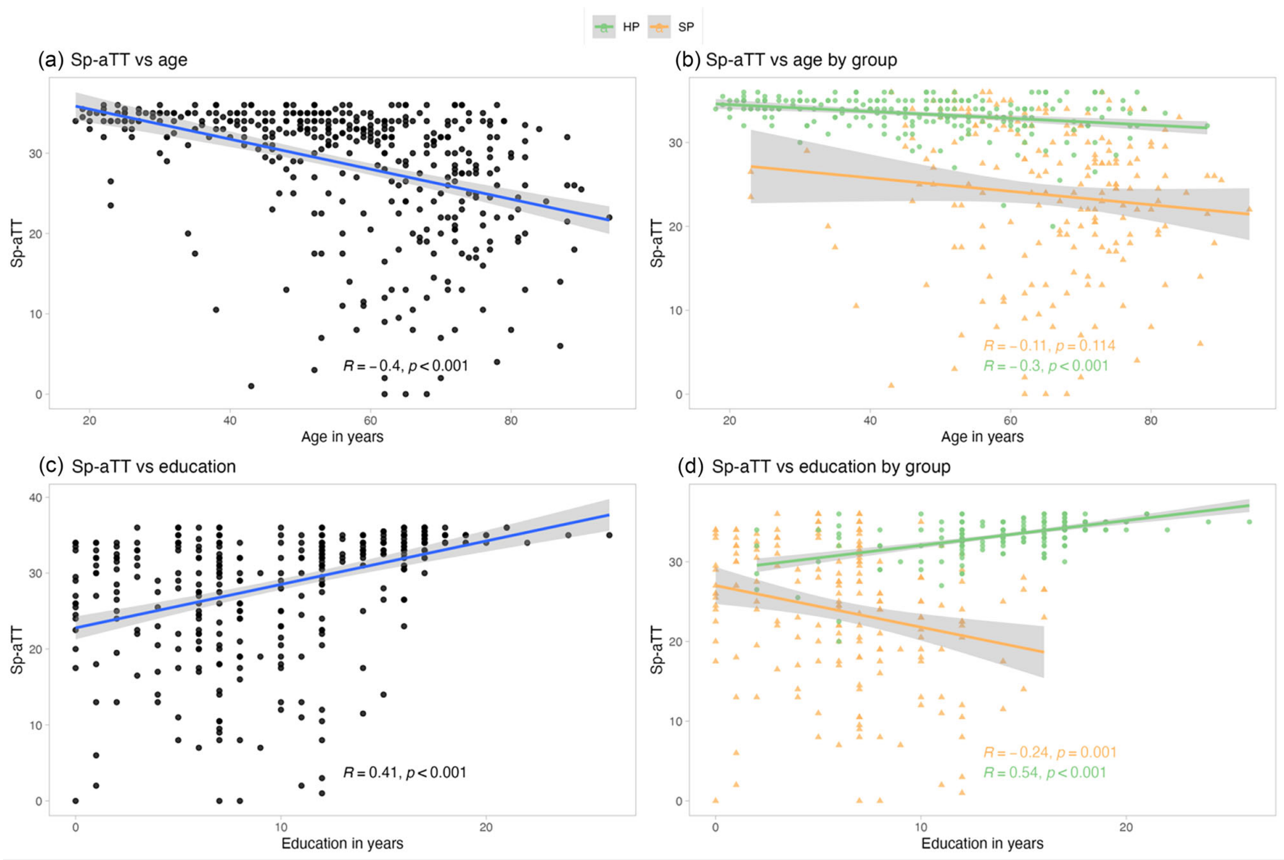

FIGURE 1 Lineal association for Sp-aTT performance by age and education.

age. Although strokes may affect linguistic abilities with independence of age (Brady et al., 2012), age is a significant risk factor for developing a stroke (Roy-O'Reilly & McCullough, 2018).

Otherwise, education had a heterogeneous effect on Sp-aTT performance; while SPs had a negative effect, HPs had a positive effect. This variable has been claimed to be a protective factor for oral comprehension decline in

TABLE 3 Multiple regression model for the Sp-aTT.

Variables	**Model 1** *Coeff.*	*SE*	*p-value*	**Model 2** *Coeff.*	*SE*	*p-value*	**Model 3** *Coeff.*	*SE*	*p-value*	**Model 4** *Coeff.*	*SE*	*p-value*	**Model 5** *Coeff.*	*SE*	*p-value*	**Model 6** *Coeff.*	*SE*	*p-value*
Intercept	33.39	0.16	**< 0.001**	33.14	0.32	**< 0.001**	35.73	0.81	**< 0.001**	38.15	1.69	**< 0.001**	31.71	1.45	**< 0.001**	31.78	1.46	**< 0.001**
SP	−9.64	0.65	**< 0.001**	−9.74	0.64	**< 0.001**	−8.77	0.75	**< 0.001**	−9.94	0.98	**< 0.001**	−2.30	1.49	0.124	−2.06	1.45	0.155
Man				0.57	0.61	0.352	0.55	0.60	0.364	0.76	0.59	0.199	0.57	0.60	0.343			
Age							−0.05	0.02	**0.001**	−0.06	0.02	**< 0.001**	−0.04	0.02	**0.017**	−0.04	0.02	**0.018**
Educ.										−0.15	0.09	0.077	0.24	0.06	**< 0.001**	0.25	0.06	**< 0.001**
SP:Educ.													−0.77	0.17	**< 0.001**	−0.78	0.17	**< 0.001**
Observations	407			407			407			396			396			396		
R^2/R^2 adjusted	0.367/0.365			0.368/0.365			0.378/0.373			0.391/0.385			0.426/0.419			0.425/0.419		
AIC	2662.897			2664.104			2659.677			2575.998			2554.439			2553.284		
BIC	2674.923			2680.139			2679.721			2599.886			2582.309			2577.172		

Note: Heteroskedasticity consistent (HC1) robust standard error.
AIC = Akaike information criterion; BIC = Bayesian information criterion; SP = Stroke patients; Educ = years of education.

older people (Moreira et al., 2011). However, contrary to our results, previous research indicates that patients with lower levels of education are more likely to have cognitive impairments than those with higher levels of education (Elkins et al., 2006; González-Fernández et al., 2011). Also, several studies have reported moderate positive effects of years of schooling on Token Test performance (Jap & Arumsari, 2010; Moreira et al., 2011; Orgass & Poeck, 1966; Peña-Casanova et al., 2009). Future studies could include more sample characteristics to investigate the negative relationship found in the SP sample further.

The cut-off score obtained for the Sp-aTT is 30, similar to that proposed in the original version (Renzi & Faglioni, 1978) and a normative study in Brazil (Moreira et al., 2011). The required adjustments of the cut-off scores (according to age and years of education) revealed that years of education influence the Sp-aTT scores more than age. Similar effects have been documented in several cross-linguistic studies based on aTT performance. Moreira et al. (2011) showed that education had a more significant impact than age on aTT among healthy elderly Brazilian Portuguese speakers. Subtle effects of age, mostly restricted to older adults, have also been reported in previous studies (Ivnik et al., 1996; Peña-Casanova et al., 2009; Renzi & Faglioni, 1978; Swisher & Sarno, 1969), which found a more robust impact relative to years of education.

Literature suggests that education significantly influences cerebral plasticity and cognitive efficiency (Richards & Deary, 2005; Tucker-Drob et al., 2009). This could have critical repercussions in the recovery of cognitive–linguistic abilities after a stroke. Indeed, it has been observed that more years of education are related to more cognitive reserve, which contributes to maintaining an average cognitive performance despite brain damage (Stern, 2009; Zahodne et al., 2011). A greater cognitive reserve could allow subjects to deploy more efficient compensatory strategies to face cognitive–linguistic deficits and secondary cerebral damage (e.g., stroke). Moreover, these compensatory mechanisms could promote shorter processing speeds and cognitive–linguistic response times (Zahodne et al., 2011; Zahodne et al., 2014). However, it must be stressed that this correlation (reported in our results) does not necessarily involve causality. More research, longitudinal and intervention studies, is needed to understand better the negative relation between years of education and comprehensive performance and its clinical implications.

The Sp-aTT, as in the original version, has been demonstrated to be a sensitive and specific tool to assess comprehension impairments in SP. Our results yielded similar values to those of Renzi and Faglioni (1978) and other previous studies in different languages (Aranciva et al., 2012; Hula et al., 2006; Moreira et al., 2011; Peña-Casanova

TABLE 4 Adjusted Sp-aTT scores by age and years of education.

	Mean	SD	Minimum	Q.25	Media	Q.75	Maximum	*N*
Non-adjusted								
Full sample	28.7	8	0	25.3	32	34	36	407
HP	33.4	2.3	20	32.5	34	35	36	210
SP	23.8	8.8	0	19	25	31	36	197
Adjusted								
Full sample	28.8	5.2	18.2	23.7	30.7	33.5	36	407
HP	33.4	1.4	29.2	32.7	33.4	34.4	36	210
SP	23.7	2.1	18.2	22.4	23.5	25.6	27.9	197

Note: HP = healthy participants; SP = stroke patients.

TABLE 5 Severity of auditory comprehension language deficits in SP

Score	Impairment	Total SP ($n = 197$) *N* (%)	LH stroke ($n = 116$) *N* (%)	RH stroke ($n = 73$) *N* (%)	B stroke ($n = 8$) *N* (%)
≥ 30	No	60 (30.5)	24 (20.7)	33 (45.2)	3 (37.5)
26–29.5	Mild	36 (18.3)	20 (17.2)	15 (20.5)	1 (12.5)
18–25.5	Moderate	56 (28.4)	35 (30.2)	18 (24.7)	3 (37.5)
11–17.5	Severe	25 (12.7)	19 (16.4)	5 (6.8)	1 (12.5)
< 11	Very severe	20 (10.2)	18 (15.5)	2 (2.7)	0 (0)

Note: LH = left hemisphere; RH = right hemisphere; B = bilateral; SP = stroke patients.

et al., 2009), highlighting that the Sp-aTT has good psychometric properties that efficiently detect comprehension deficits in SP. Despite this, Spanish use in the Chilean population has sociocultural and linguistic characteristics that differ from other Spanish languages. These differences are mainly based on the location of people (e.g., rurality) and regions of Chile, where people mixed and employed several idioms not typical in other countries and cultures.

In this study, we evaluated all patients with stroke admitted to our units regardless of the suspected or confirmed presence of aphasia. Our results showed that regardless of stroke site, 70% of our enrolled patients had deficits in language comprehension. We found a significant positive correlation between ASRS and Sp-aTT scores, revealing that a higher score in the ASRS (better communication abilities in spontaneous speech) was correlated with a higher score in the Sp-aTT (less severity of comprehension deficits and aphasia post-stroke). The ASRS was preferred given the lack of validated aphasia tests for Spanish speakers and its common application in the acute setting of stroke evaluation.

Regarding severity with Sp-aTT, we observed that comprehension deficits appear in patients with LH and RH strokes. Most patients with an RH stroke demonstrated deficits according to their Sp-aTT performance. Impaired language processing occurs mainly after an LH stroke; however, some studies reported language and speech comprehension deficits after an RH stroke (Blake et al., 2002; Duque et al., 2021). Unlike standard SP evaluation, our results suggest that language comprehension assessment should be extended to patients with RH stroke, given that these deficits would not be exclusive to LH SP. Differentiation between comprehensive linguistic deficits related to damage in the RH and LH is crucial for accurate diagnosis and treatment approaches in SP (Martzoukou et al., 2023). Some investigations (Grodzinsky, 2000; Turkeltaub et al., 2012) have highlighted the differences in comprehension across these two groups of SPs, mentioning that SP with LH damage shows more deficits in comprehension skills related to syntax and semantic domains. In contrast, SP with RH damage could show difficulties in comprehension related to contextual knowledge and prosody. Therefore, these fundamental differences would be critical in establishing the best rehabilitation program or decision for clinicians for the recovery process (Lee & Pyun 2014; Gajardo-Vidal et al., 2018).

CONCLUSIONS

The Sp-aTT is a tool that can discriminate between Chilean HPs and SPs. It stands out as a valuable and easy tool that detects comprehension deficits, regardless of the damaged hemisphere post-stroke. Our results highlight the need for language-specific norms in aphasia research as well.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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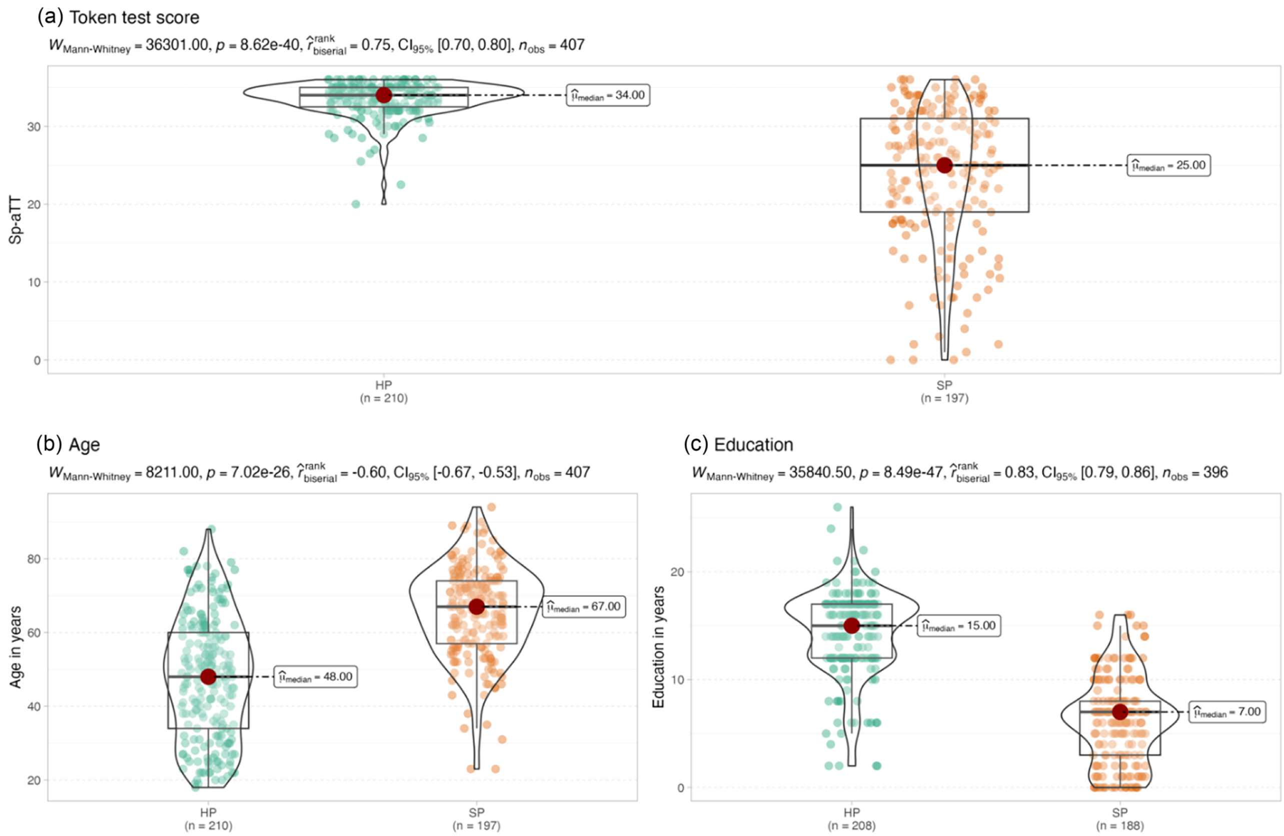
APPENDIX A: Group comparison for Sp-aTT performance, age and education.



Note: SP = Stroke Patients; HP = Healthy Participants.

APPENDIX B: Comparison of no linear specification effects evaluated for the Sp-aTT.

	Age				Education		
Models	**Linear**	**Cuadractic**	**Logarithm**	**Interaction**	**Linear**	**Cuadractic**	**Interaction**
R^2/R^2 adjusted	0.377/0.374	0.378/0.373	0.375/0.372	0.378/0.373	0.377/0.373	0.396/0.392	0.420/0.415
AIC	2658.430	2659.826	2659.633	2659.658	2581.190	2570.497	2554.808
BIC	2674.466	2679.870	2675.668	2679.702	2597.116	2590.404	2574.715

Note: R^2 = R squared; AIC = Akaike information criterion; BIC = Bayesian information criterion.