RESEARCH ARTICLE

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Test Your Memory—Spanish version (TYM-S): a validation study of a self-administered cognitive screening test

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Objectives: To develop the Test Your Memory (TYM)—Spanish version (TYM-S), a self-administered cognitive screening test, in a Chilean older sample and to estimate its psychometric properties and diagnostic accuracy.

Methods: The TYM was translated into Spanish and adapted for a Chilean population to develop the TYM-S. Measures of global cognitive impairment and executive dysfunction were administered to 30 controls, 30 dementia patients, and 14 subjects with mild cognitive impairment (MCI). All participants' proxies were interviewed with assessments of dementia severity, functionality in daily living activities, and cognitive change. Convergent validity and internal consistency reliability of the TYM-S were estimated. Cut-off points, sensitivity, and specificity were determined to test its diagnostic capacity for dementia or MCI.

Results: Regarding convergent validity, the TYM-S was significantly correlated ($p < 0.001$) with global cognitive impairment (Mini-Mental State Examination: $r = 0.902$; Addenbrooke's Cognitive Examination—Revised—Chilean version: $r = 0.922$; Montreal Cognitive Assessment: $r = 0.923$), executive dysfunction (Frontal Assessment Battery: $r = 0.862$), dementia severity (Clinical Dementia Rating: $r = -0.757$), functional capacity (Technology-Activities of Daily Living Questionnaire: $r = -0.864$; Pfeffer Functional Activities Questionnaire: $r = -0.748$; Instrumental Activities of Daily Living: $r = 0.769$), and cognitive change (Alzheimer's Disease 8—Chilean version: $r = -0.700$) measures. Regarding reliability, Cronbach's α was 0.776. Optimum cut-off scores of 39 and 44 distinguished dementia cases from controls (93.1% sensitivity, 82.2% specificity) and MCI cases from controls (85.7% sensitivity, 69% specificity), respectively. The extent of assistance required in the TYM-S and cognitive impairment was correlated.

Conclusions: The TYM-S is a valid and reliable instrument to assess cognitive impairment, showing good psychometric properties and diagnostic capacity to identify cases of dementia in a Spanish-speaking older cohort. Although its need for assistance may be limiting, its ability to quickly assess several cognitive domains supports widespread clinical use. Copyright © 2014 John Wiley & Sons, Ltd.

Key words: dementia; Alzheimer's disease; mild cognitive impairment; self-administered cognitive screening test; TYM; Test Your Memory—Spanish version
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Introduction

Dementia is a major public health concern of the 21st century for many reasons, chief among these being its high psychosocial impact (Thies and Bleiler, 2012). Prevalence of dementia increases exponentially with age, affecting approximately one in 10 people over the age of 65 years and half of people over 85 years (Evans *et al.*, 1989; Fitzpatrick *et al.*, 2004). Thirty-six million people worldwide are estimated to suffer from dementia nowadays, and this number is expected to triple by 2040 (Wimo and Prince, 2010; Reitz *et al.*, 2011). In 2011, an estimated 60% of dementia patients lived in low-income and middle-income countries, whereas by 2040, this percentage is expected to reach 71% (Prince *et al.*, 2007).

Proper screening tools for dementia that are sufficiently sensitive, yet easily administered, must be developed to overcome several hurdles in early diagnosis of these patients (Cullen *et al.*, 2007; Scharre *et al.*, 2010; Villarejo and Puertas-Martin, 2011). A large number of brief cognitive measures exist; however, many present disadvantages, such as requiring too much time and qualified personnel, whereas others are simply too cumbersome to administer in busy clinical settings (Boustani *et al.*, 2005). Moreover, potential drawbacks of informant-based assessments to identify early dementia are that patients are often assessed alone and may not have a reliable or accessible informant (Scharre *et al.*, 2010).

Three requirements for widespread use of a cognitive screening test by non-specialists have been identified: minimal administration time, assessment of a reasonable range of cognitive functions, and sensitivity to mild Alzheimer's disease (AD) (Brown *et al.*, 2009). Allowing patients to fill in a test themselves may overcome the paradox of thorough testing in minimal time. The Test Your Memory (TYM) (Brown *et al.*, 2009) is a self-administered cognitive screening test developed to fulfill the three aforementioned requirements to facilitate its broad use in clinical settings. It is a valid and reliable instrument with very good psychometric properties to identify dementia or cognitive impairment. Moreover, the TYM has been shown to better detect AD compared with more traditional cognitive screening tests, such as the Mini Mental State Examination (MMSE) and Addenbrooke's Cognitive Examination—Revised (ACE-R) (Brown *et al.*, 2009). Furthermore, the instrument has been validated in a large cohort of unselected English patients from cognitive clinics in addition to Afrikaans, Japanese, Chinese, and Polish populations (Brown *et al.*, 2009; Hancock and Larner, 2011; Hanyu *et al.*, 2011; Hou and Lee, 2011; van Schalkwyk *et al.*, 2012; Szczesniak *et al.*, 2013).

The aim of this study was to develop the TYM—Spanish version (TYM-S) and to study its psychometric properties and diagnostic utility for identifying dementia or mild cognitive impairment (MCI) in a Chilean older sample. To further validate the TYM-S, its scores were compared with those obtained on other measures of global cognitive impairment, executive dysfunction, dementia severity, functional capacity, and cognitive change.

Methods

Development of the Test Your Memory—Spanish version

To generate the TYM-S, the original TYM was translated into Spanish and later adapted for a Spanish context by a neurologist (ASC) and two psychologists (CMN and FHC). The resulting version was back-translated into English, showing clear consistency with the original instrument. Two sections of the original, Semantic Knowledge and Verbal Fluency, were modified to improve their comprehension and cultural adequacy for Spanish speakers and the Chilean population (Appendix A).

The TYM is presented on a double-sided sheet of paper with spaces for the patient to fill in. Its scores range from 1 to 50. The test comprises 10 tasks assessing 11 cognitive domains: orientation, copying (ability to copy a sentence), semantic knowledge (retrograde memory), calculation, verbal fluency (phonemic), abstraction (similarities), naming, visuospatial abilities, anterograde memory, and executive function (EF) or capacity to complete the test without help (Table 1). If necessary, patients can be assisted with any part of the test except the answers. There is no time limit. Detailed instructions of the TYM are described by Brown *et al.* (2009).

Table 1 Items of the Test Your Memory

Domain/task	Score
Orientation	10
Copying (ability to copy a sentence)	2
Semantic knowledge (retrograde memory)	3
Calculation	4
Verbal fluency (phonemic)	4
Abstraction (similarities)	4
Naming	5
Visuospatial abilities (letter W and clock drawing test)	7
Anterograde memory (recall of a copied sentence)	6
Executive function (capacity to complete the test without help)	5
Total	50

Participants

A convenience sample of Spanish speakers was recruited from the Cognitive Neurology and Dementia Unit of the Hospital del Salvador in Santiago, Chile. Inclusion criteria comprised subjects 65 years old or older without conditions that could preclude a neuropsychological assessment (e.g. sensory disturbances such as visual/auditory impairments). All participants had proxies who shared relevant information about participants' everyday activities and behavior, and provided informed consent prior to study inclusion. In cases of marked cognitive impairment where informed consent could be misunderstood, consent was provided by the collateral sources who took care of the patient. Exclusion criteria included illiteracy, debilitating cognitive impairment that could interfere with neuropsychological assessment, underlying medical or psychiatric illness that could affect cognition, and absence of a reliable proxy.

The sample was divided into three groups. There were 30 control participants without preexisting neurological or psychiatric disorders that could cause neuropsychological disturbance, 30 patients with dementia [20 with AD, 4 with frontotemporal dementia (FTD), 4 with dementia with Lewy bodies (DCL), and 2 with vascular dementia (VD)], and 14 participants with amnestic or multidomain MCI. All participants had appropriate Clinical Dementia Rating (CDR) scale scores (controls = 0, dementia $\geq$ 1, and MCI $\leq$ 0.5) (Hughes *et al.*, 1982; Morris, 1993).

All controls had normal cognition based on local normative data for the MMSE (González-Hernández *et al.*, 2009) and Frontal Assessment Battery (FAB) (Alegría, 2005), and were deemed cognitively normal by the neurologist. A neurologist diagnosed dementia and MCI based on detailed neurological, neuropsychological, laboratory, and neuroimaging data for each participant. The first step in diagnosing dementia was to determine the presence or absence of the disease using criteria in the Diagnostic and Statistical Manual of Mental Disorders (fourth edition, text revision) (American Psychiatric Association, 2000). If criteria were met, the specific type of dementia was specified using multiple diagnostic criteria: (i) National Institute of Neurological and Communicative Disorders and Stroke–AD and Related Disorders Association criteria for AD; (ii) the consensus criteria for FTD diagnosis; (iii) the third report of the Dementia with Lewy Bodies Consortium criteria for DCL; and (iv) AD Diagnostic and Treatment Centers criteria and National Institute of Neurological Disorders and Stroke criteria for VD (McKhann *et al.*, 1984; Roman *et al.*, 1993; Neary *et al.*, 1998; McKeith *et al.*, 2005). MCI diagnosis was established according to the International Working Group on MCI consensus criteria (Winblad *et al.*, 2004).

The CDR scale was administered to all proxies. Afterward, the proxies were asked to complete a set of questionnaires including assessments of functional capacity and cognitive change.

This study was approved by the Ethical and Scientific Committee of the Servicio de Salud Metropolitana Oriente in Santiago, Chile.

Assessment and materials

To study the convergent validity of the TYM-S, global cognitive impairment was measured in addition to three Chilean versions of neuropsychological instruments: the MMSE (González-Hernández *et al.*, 2009), the ACE-R (ACE-R-Ch) (Muñoz-Neira *et al.*, 2012), and the Montreal Cognitive Assessment (MoCA) (Araneda *et al.*, 2013). The FAB was considered a global measure of executive dysfunction (Dubois *et al.*, 2000; Alegría, 2005). To determine if the TYM-S was a valid measure of dementia severity, the CDR scale assessed clinical progression and stages of dementia. Proxies also completed three functionality scales: the Technology-Activities of Daily Living Questionnaire (T-ADLQ) (Munoz-Neira *et al.*, 2012), Pfeffer Functional Activities Questionnaire (PFAQ) (Pfeffer *et al.*, 1982), and Instrumental Activities of Daily Living (IADL) (Lawton, 1988). The AD8—Chilean version (AD8-Ch) was used as an indicator of cognitive change (Munoz *et al.*, 2010).

Procedures and statistical analysis

Descriptive and comparative analyses were conducted using either a one-way analysis of variance (ANOVA) to compare the three groups for continuous variables or the χ^2 test for categorical variables. A multiple regression analysis evaluated which demographic variables were associated with TYM-S performance in the entire sample. Additionally, a one-way multivariate ANOVA compared responses with TYM-S items across diagnostic categories. Convergent validity of the TYM-S was evaluated using Pearson correlation between TYM-S scores and results of the other instruments administered. Internal consistency was measured with Cronbach's α, which reflects the average inter-item correlation and thus increases when correlations among items increase (Bland and Altman, 1997). Two receiver operating characteristic (ROC)

analyses were performed to determine the ability of the TYM-S and the other cognitive assessments to discriminate between dementia patients (CDR ≥ 1) and controls (CDR = 0), and between MCI patients (CDR = 0.5) and controls (CDR = 0). Analyses were carried out to select an optimal TYM-S cut-off score, below which an individual has a very high chance of having dementia or MCI. The area under the curve (AUC) measured diagnostic utility of the TYM-S in distinguishing dementia or MCI patients from controls. AUC values less than perfect (1.0) were classified as having excellent (>0.9), good (>0.8), fair (>0.7), or poor (>0.6) utility (Gifford and Cummings, 1999). All analyses were conducted at $p < 0.05$ (two-tailed) using the Statistical Package for the Social Sciences (SPSS) version 20 for Windows (IBM Corp., Armonk, NY, USA). Effect sizes (Cohen's *d* statistic) were also calculated to determine the magnitude of group differences on the instrument. According to Cohen (1988), effect sizes are categorized as small (0.2 to 0.49), medium (0.5 to 0.79), or large (greater than 0.8). Positive effect sizes indicate lower performance in people with dementia and MCI compared with controls.

Results

Demographic and clinical data

The total sample included 74 participants (42 men and 32 women). Table 2 summarizes their demographic characteristics and clinical profiles. No significant differences ($p > 0.05$) were found among groups with respect to age ($F_{(2,\ 73)} = 0.164$, $p = 0.849$), years of education ($F_{(2,\ 73)} = 0.957$, $p = 0.389$), or sex ($\chi^2 = 1.088$, GL = 2, $p = 0.581$). The three groups did differ significantly in measures of global cognitive impairment (MMSE: $F_{(2,\ 73)} = 56.820$; ACE-R-Ch: $F_{(2,\ 73)} = 74.492$; MoCA: $F_{(2,\ 73)} = 55.702$; all *p*'s 0.001), executive dysfunction (FAB: $F_{(2,\ 73)} = 28.916$, $p < 0.001$), dementia severity (CDR: $F_{(2,\ 73)} = 103.905$, $p < 0.001$), functional capacity (T-ADLQ: $F_{(2,\ 73)} = 47.106$; PFAQ: $F_{(2,\ 73)} = 48.374$; IADL: $F_{(2,\ 73)} = 47.472$; all *p*'s < 0.001), and cognitive change (AD8-Ch: $F_{(2,\ 73)} = 47.915$, $p < 0.001$). Details of the post-hoc analysis are specified in Table 2. Dementia patients performed significantly worse than MCI patients and controls, whereas MCI patients performed significantly worse than controls on measures of global cognitive impairment,

Table 2 Demographic characteristics and clinical profiles of the sample

	Descriptive statistics by group			Comparison		
Parameter	Control (*n* = 30)	Dementia (*n* = 30)	MCI (*n* = 14)	Dementia versus control	Dementia versus MCI	MCI versus control
Age[b]	71.93 ± 7.06	72.80 ± 6.90	71.71 ± 7.16	*ns*	*ns*	*ns*
Years of education[b]	14.00 ± 4.20	12.70 ± 3.15	12.79 ± 4.59	*ns*	*ns*	*ns*
Sex[a]				*ns*	*ns*	*ns*
%Men (*n*)	50.00% (15)	6.30% (19)	57.10% (8)			
%Women (*n*)	50.00% (15)	36.70% (11)	42.90% (6)			
TYM-S	43.93 ± 5.55 (30–50)	22.50 ± 11.29 (2–42)	36.50 ± 6.81 (23–47)	*	*	*
MMSE	28.77 ± 1.14 (27–30)	20.90 ± 4.15 (13–29)	26.29 ± 2.13 (22–29)	*	*	*
ACE-R-Ch	91.50 ± 6.85 (77–100)	59.47 ± 13.69 (34–87)	79.50 ± 6.95 (68–92)	*	*	*
MoCA	25.07 ± 3.25 (18–30)	13.90 ± 5.17 (5–23)	19.93 ± 2.95 (16–26)	*	*	*
FAB	16.00 ± 1.71 (12–18)	11.17 ± 3.01 (6–17)	14.21 ± 2.36 (10–17)	*	*	*ns*
CDR scale	0.00 ± 0.00 (0–0)	1.67 ± 0.71 (0.5–0.5)	0.50 ± 0.00 (1–3)	*	*	*
T-ADLQ	12.00 ± 10.39 (0–36)	46.21 ± 18.33 (12–82)	19.93 ± 8.54 (9–32)	*	*	*
PFAQ	0.63 ± 1.38 (0–6)	13.53 ± 8.37 (0–27)	1.21 ± 1.53 (0–4)	*	*	*ns*
IADL scale	7.40 ± 0.93 (5–8)	3.87 ± 1.91 (0–7)	7.07 ± 1.44 (4–8)	*	*	*ns*
AD8-Ch[b]	1.47 ± 1.98 (0–8)	6.30 ± 1.95 (2–8)	3.29 ± 1.73 (1–6)	*	*	*

Note. Results are expressed as *M* ± *SD*. MCI, mild cognitive impairment; TYM-S, Test Your Memory—Spanish version; MMSE, Mini Mental State Examination; ACE-R-Ch, Addenbrooke's Cognitive Examination—Revised—Chilean version; MoCA, Montreal Cognitive Assessment; FAB, Frontal Assessment Battery; CDR, Clinical Dementia Rating; T-ADLQ, Technology-Activities of Daily Living Questionnaire; PFAQ, Pfeffer Functional Activities Questionnaire; IADL, Instrumental Activities of Daily Living; AD8-Ch, Alzheimer's Disease 8—Chilean version.
[a]Chi-square test applied. All other comparisons were carried out with a one-way analysis of variance test.
[b]Tukey post-hoc tests applied. All other measures were compared with Games–Howell tests.
*$p < 0.05$.

executive dysfunction, disease severity, functional capacity, and cognitive change.

Administration of the Test Your Memory—Spanish version

All participants completed the TYM-S with an average time of 11.29 ± 4.16 min (range: 5.27–20.25). The three groups differed significantly in completion time ($F_{(2,\ 73)} = 8.061$, $p < 0.01$) and the amount of help needed with the test ($F_{(2,\ 73)} = 8.061$, $p < 0.01$). The observed assistance level in the TYM-S reached 33.3% in controls, 90% in dementia, and 71.43% in MCI. Performance on the TYM-S is detailed in Table 3.

Influence of demographic variables on Test Your Memory—Spanish version performance

To determine the effects of demographic variables on TYM-S performance for all participants, a multiple regression analysis (Enter Method) was performed with TYM-S scores as dependent variables and participant-based variables (age, years of education, and sex) as independent variables. The resulting regression model excluded age and sex as important factors. Years of education had a positive effect (β coefficient = 0.31, $p < 0.001$) and explained 15% of the total variance in TYM-S scores ($r^2 = 0.150$, $F_{(2,\ 70)} = 4.12$, $p = 0.009$).

Convergent validity and reliability of the Test Your Memory—Spanish version

The TYM-S showed statistically significant associations with other measures of global cognitive impairment, executive dysfunction, dementia severity, functional capacity, and cognitive change (Table 4). Cronbach's α was 0.776, suggesting high internal consistency of the 11 items of the TYM-S.

Divergent validity, sensitivity, and specificity of the Test Your Memory—Spanish version

Table 3 summarizes the global and individual item TYM-S scores for the three groups. A one-way multivariate ANOVA revealed a significant multivariate main effect of diagnosis (Wilks's lambda = 0.273, $F_{(20,\ 124)} = 5.662$, $p < 0.001$, partial eta squared =

Table 3 Detailed scores on the TYM-S

	Descriptive statistics by group			Comparison		
Parameter	Control ($n = 30$)	Dementia ($n = 30$)	MCI ($n = 14$)	Dementia versus control	Dementia versus MCI	MCI versus control
TYM-S	43.93 ± 5.55	22.50 ± 11.29	36.50 ± 6.81	*	*	*
Orientation	9.67 ± 0.48	5.77 ± 2.71	8.57 ± 1.34	*	*	*
Copying	1.80 ± 0.55	1.20 ± 0.89	1.64 ± 0.74	*	*	*ns*
Semantic knowledge	2.90 ± 0.31	1.10 ± 1.09	2.36 ± 0.74	*	*	*
Calculation	3.40 ± 0.86	2.30 ± 1.44	2.93 ± 1.14	*	*ns*	*ns*
Verbal fluency	3.57 ± 0.77	2.10 ± 1.32	2.71 ± 0.99	*	*ns*	*
Abstraction	3.57 ± 0.77	1.97 ± 1.56	3.21 ± 0.89	*	*	*ns*
Naming	4.70 ± 0.95	2.63 ± 1.90	4.29 ± 1.07	*	*	*ns*
Visuospatial abilities	6.07 ± 1.34	2.53 ± 2.39	5.21 ± 1.53	*	*	*ns*
Letter W[a]	2.20 ± 1.13	0.70 ± 1.06	1.64 ± 1.22	*	*	*ns*
Clock drawing test	3.87 ± 0.43	1.83 ± 1.62	3.57 ± 0.76	*	*	*ns*
Anterograde memory	3.70 ± 2.09	0.30 ± 1.12	1.71 ± 1.82	*	*	*ns*
Executive function	4.57 ± 0.73	2.60 ± 1.25	3.86 ± 1.03	*	*	*
Need for assistance on the TYM-S						
No assistance	66.67%	10%	28.57%			
Trivial assistance	26.67%	10%	42.86%			
Minor assistance	3.33%	33.33%	14.29%			
Moderate assistance	3.33%	23.33%	14.29%			
Major assistance	0%	23.33%	0%			
Completion time	7.60 ± 2.02 (5.27–11.78)	14.27 ± 3.32 (6.97–20.25)	11.51 ± 3.58 (6.78–18.67)			

Note. Results are expressed as $M \pm SD$. MCI, mild cognitive impairment; TYM-S, Test Your Memory—Spanish version.
[a]Tukey post-hoc tests applied. All other measures were compared with Games–Howell tests.
*$p < 0.05$.

Table 4 Convergent validity of the TYM-S

Assessment	Instrument	TYM-S
Global Cognitive Impairment	MMSE	0.902[a]
	ACE-R-Ch	0.922[a]
	MoCA	0.923[a]
Executive Dysfunction	FAB	0.862[a]
Dementia Severity	CDR scale	−0.757[a]
Functional Capacity	T-ADLQ	−0.864[a]
	PFAQ	−0.748[a]
	IADL scale	0.769[a]
Cognitive Change	AD8-Ch	−0.700[a]

Note. TYM-S, Test Your Memory—Spanish version; MMSE, Mini Mental State Examination; ACE-R-Ch, Addenbrooke's Cognitive Examination—Revised—Chilean version; MoCA, Montreal Cognitive Assessment; FAB, Frontal Assessment Battery; CDR, Clinical Dementia Rating; T-ADLQ, Technology-Activities of Daily Living Questionnaire; PFAQ, Pfeffer Functional Activities Questionnaire; IADL, Instrumental Activities of Daily Living; AD8-Ch, Alzheimer's Disease 8—Chilean version.
[a]Pearson correlation coefficient, $p < 0.001$.

0.477, with a power of 1.00 to detect the effect). The three groups differed significantly in average TYM-S scores ($F_{(2,\ 73)} = 47.963$, $p < 0.001$). Significant differences were found among controls, dementia patients, and participants with MCI for each TYM-S item (orientation: $F_{(2,\ 73)} = 34.477$; copying: $F_{(2,\ 73)} = 5.151$; semantic knowledge: $F_{(2,\ 73)} = 39.824$; calculation: $F_{(2,\ 73)} = 6.571$; verbal fluency: $F_{(2,\ 73)} = 14.225$; abstraction: $F_{(2,\ 73)} = 14.631$; naming: $F_{(2,\ 73)} = 16.621$; visuospatial abilities: $F_{(2,\ 73)} = 28.200$; anterograde memory: $F_{(2,\ 73)} = 30.121$; EF: $F_{(2,\ 73)} = 28.134$; all p's < 0.001). Details of the post-hoc analysis are presented in Table 3.

Results of the ROC curve analyses for the TYM-S and the other cognitive measures are displayed in Table 5 and Figure 1. It should be noted that the TYM-S distinguished between dementia patients and controls (AUC = 0.963) better than between MCI patients and controls (AUC = 0.826). A cut-off point of 39 was optimal for detecting dementia using the TYM-S with a sensitivity of 93.1% and a specificity of 82.2% [95% CI (0.922, 1.00)], indicating high overall diagnostic utility of the test to identify cases of dementia. A cut-off point of 44 discriminated MCI patients from controls and had a sensitivity of 85.7% and a specificity of 69% [95% CI (0.697, 0.956)]. No significant differences in AUC among the TYM-S, MMSE, ACE-R-Ch, MoCA, and FAB ($p > 0.05$) emerged between the dementia versus control groups, as well as between the MCI versus control groups (Hanley and McNeil, 1983).

The standardized mean difference (Cohen's d) for the TYM-S was 2.41 ($r = 0.77$) between dementia patients and controls, 1.50 ($r = 0.60$) between dementia and MCI patients, and 1.20 ($r = 0.51$) between MCI patients and controls.

Discussion

This study provided evidence to support the use of the TYM-S as a valid and reliable instrument for assessing cognitive impairment in a Chilean Spanish-speaking older cohort. In addition to its good psychometric properties, the TYM-S showed an acceptable diagnostic utility for identifying cases of dementia.

Strong and statistically significant relationships found between the TYM-S and measures of global cognitive impairment (MMSE, ACE-R-Ch, and

Table 5 Receiver operating characteristic curves for the TYM-S and other cognitive screening tests

Comparison	Instrument	Area under Curve	Cut-off point	Sensitivity	Specificity	(CI 95%)
Dementia versus control	TYM-S	0.963	39	0.931	0.862	0.922; 1.00
	MMSE	0.974	28	0.931	0.828	0.934; 1.00
	ACE-R-Ch	0.984	79	0.931	0.966	0.960; 1.00
	MoCA	0.970	21	0.931	0.897	0.936; 1.00
	FAB	0.910	15	0.862	0.793	0.837; 0.983
MCI versus control	TYM-S	0.826	44	0.857	0.690	0.697; 0.956
	MMSE	0.867	29	0.857	0.655	0.754; 0.980
	ACE-R-Ch	0.901	86	0.857	0.793	0.813; 0.990
	MoCA	0.873	24	0.929	0.0690	0.768; 0.978
	FAB	0.729	17	0.857	0.552	0.576; 0.882

Note. MCI, mild cognitive impairment; TYM-S, Test Your Memory—Spanish version; MMSE, Mini Mental State Examination; ACE-R-Ch, Addenbrooke's Cognitive Examination—Revised—Chilean version; MoCA, Montreal Cognitive Assessment; FAB, Frontal Assessment Battery.

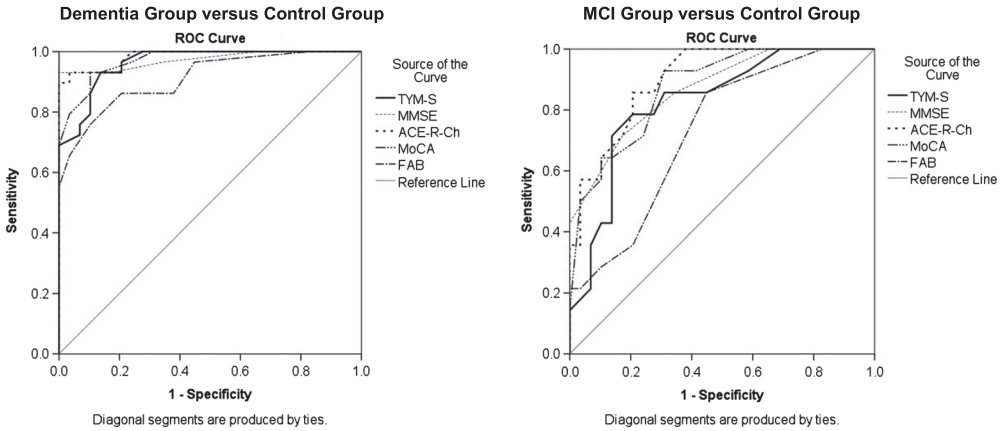

Figure 1 Receiver operating characteristic (ROC) curves for the TYM-S and other cognitive screening tests. TYM-S, Test Your Memory—Spanish version; MMSE, Mini Mental State Examination; ACE-R-Ch, Addenbrooke's Cognitive Examination—Revised—Chilean version; MoCA, Montreal Cognitive Assessment; FAB, Frontal Assessment Battery.

MoCA), executive dysfunction (FAB), dementia severity (CDR), and functional impairment (T-ADLQ, PFAQ, and IADL) supported its validity. These findings are consistent with previous validation studies of the instrument. For example, the original publication by Brown *et al.* (2009) demonstrated significant Pearson correlations between TYM scores and the MMSE (0.55, $p \leq 0.001$) and ACE-R (0.66, $p \leq 0.001$) in 540 controls and 139 patients with dementia or amnestic MCI, supporting good convergent validity. The TYM—Japanese version (TYM-J) (Hanyu *et al.*, 2011) showed good convergent validity with the MMSE ($r = 0.68$), Wechsler Memory Scale—Revised (WMS-R) Logical Memory I ($r = 0.71$), AD Assessment Scale—Cognitive Subscale—Japanese version (ADAS-Jcog; $r = 0.74$), and FAB ($r = 0.66$); all p's < 0.0001. Furthermore, English and Afrikaans versions of the TYM have shown good associations with the MMSE ($r = 0.455$ for English speakers, $r = 0.747$ for Afrikaans speakers; $p < 0.001$) (van Schalkwyk *et al.*, 2012). Chinese (Hou and Lee, 2011) and Polish (Szczesniak *et al.*, 2013) validation studies have also reported acceptable correlations between the TYM and other cognitive measures.

The important association between the TYM-S and measures of both global cognitive impairment and executive dysfunction suggests that the TYM is sensitive to executive disorders. This is crucial for a screening instrument because executive dysfunction is often the earliest and most prominent sign of certain dementias, including syndromes such as FTD (the behavioral variant) (Torralva *et al.*, 2008) and VD (Graham *et al.*, 2004; Merino and Hachinski, 2008). Assessment of EF contributes to early diagnosis; therefore, such tasks should be included in cognitive tools. Indeed, a main limitation of the MMSE as a screening instrument is its poor sensitivity in detecting executive dysfunction (Dubois *et al.*, 2000).

To the best of our knowledge, this is the first study reporting a correlation between performance on the TYM and MoCA, which has shown an excellent ability to detect dementia or MCI by assessing multiple cognitive domains (Nasreddine *et al.*, 2005).

Similar to the aforementioned Chinese study, the TYM-S was also associated with the CDR, a measure of dementia severity. Moreover, the present study provides additional evidence for the validity of the TYM by showing its correlation with measures of executive dysfunction (FAB), functional impairment (T-ADLQ, PFAQ, and IADL scale), and an informant-based assessment of cognitive change (AD8-Ch). The strong correlation between the TYM-S and functional ability is remarkable for a cognitive screening test given that functional impairment or disability is an essential aspect of identifying dementia (Royall *et al.*, 2007).

Our study found the TYM-S had high internal consistency, supporting its reliability. Acceptable reliability data have also been identified in other studies of the TYM (Brown *et al.*, 2009; Hou and Lee, 2011; van Schalkwyk *et al.*, 2012; Szczesniak *et al.*, 2013).

The diagnostic utility of the TYM-S to distinguish cases of dementia from controls is supported by its AUC and its acceptable sensitivity, specificity, and Cohen's *d* values. The small sample size of MCI patients may have interfered on the results obtained to discriminate these individuals from controls. In their original study, Brown *et al.* (2009) reported that a TYM cut-off score of ≤42 showed 93% sensitivity and 86% specificity for AD diagnosis. Another study of memory clinic patients proposed adjusting the cut-off to 30, which maintained acceptable sensitivity

(73%) and specificity (88%) (Hancock and Larner, 2011). Hanyu *et al.* (2011) proposed two cut-off points for the TYM-J: one at 42 or 43 with 96% sensitivity and 91% specificity to distinguish AD patients from controls and another at 44 or 45 with 76% sensitivity and 74% specificity to differentiate MCI patients from healthy controls. In that study, the AUC was significantly better for the TYM-J than for the MMSE, WMS-R Logical Memory I, and ADAS-Jcog. The South African study of 100 participants showed that both English and Afrikaans versions performed very well in detecting cognitive impairment (van Schalkwyk *et al.*, 2012). Although the TYM-S had excellent psychometric properties and diagnostic utility for identifying cognitive impairment, the ROC curve analysis suggested that it did not discriminate between dementia or MCI patients and controls significantly better than the MMSE, ACE-R-Ch, MoCA, or FAB. Nevertheless, the TYM-S has advantages as a quick assessment of several cognitive functions, making it a promising alternative to cognitive tools that are not self-administered.

The current research reported longer completion times (range: 5.27–20.25) for the TYM-S than previous studies, which might be deemed too lengthy in many clinical settings (Tangalos *et al.*, 1996). Considering that TYM-S administration does not require the presence of a professional but only supervision by a non-professional in a separate waiting room, this duration is probably not a limitation. In any case, it should be acknowledged that the self-report format of the TYM solves the paradox of achieving thorough testing in minimal time (Brown *et al.*, 2009). This feature should be especially useful in primary care where clinicians lack sufficient time to administer a detailed diagnostic interview or cognitive assessment.

Another important point is the number of cognitively impaired participants who required some level of assistance with the TYM-S, which may suggest that the test is more suitable for controls or individuals with minimal cognitive impairment rather than moderate-to-severe dementias. This limitation could restrict the TYM-S as a self-administered tool; however, the test does assess the level of help given by an examiner, which factors into the overall result. Despite the possibility that the considerable amount of assistance observed may reduce the overall utility of the TYM-S, its ability to quickly assess several cognitive domains supports its widespread use in different clinical settings.

Our study found that TYM-S performance was not correlated with age, which may reflect the fact that the sample was older than 65 years. As expected, TYM-S performance was influenced by years of education, supporting the established notion that education affects cognitive outcomes (Lezak, 2012). This suggests the need for normative data on the TYM-S that considers educational level or a normative study to determine a better cut-off according to educational level.

The main limitation of this study is the use of a small convenience sample that could preclude a generalization of the results obtained to an unselected population. Indeed, Hancock and Larner (2011) have pointed out that index studies of new test instruments are conducted in ideal diagnostic circumstances and/or with ideal patients, which is not representative of day-to-day clinical practice.

To conclude, this study found that the TYM-S is a valid and reliable instrument to identify cases of dementia with acceptable diagnostic utility. Future research should be conducted with larger samples and examine the utility of the TYM-S when studying participants with MCI alone. Evaluating the utility of the tool in the psychiatric population may also be of interest. Studies must be conducted in an unselected population of cognitive clinic patients or those in primary care to determine the best cut-off point of the TYM-S in general practice.

Conflict of interest

None declared.

Key points

- The TYM-S is a valid and reliable cognitive screening tool that quickly assesses several cognitive domains.
- The TYM-S has an acceptable diagnostic utility for distinguishing cases of dementia from controls in a sample of Spanish-speaking older people.
- The TYM-S correlates significantly with other measures of global cognitive impairment, executive dysfunction, dementia severity, functional capacity in activities of daily living, and cognitive change.
- The TYM-S may be a convenient option for assessing cognitive complaints in different Spanish-speaking clinical settings instead of other widely popular measures such as the MMSE and ACE-R.

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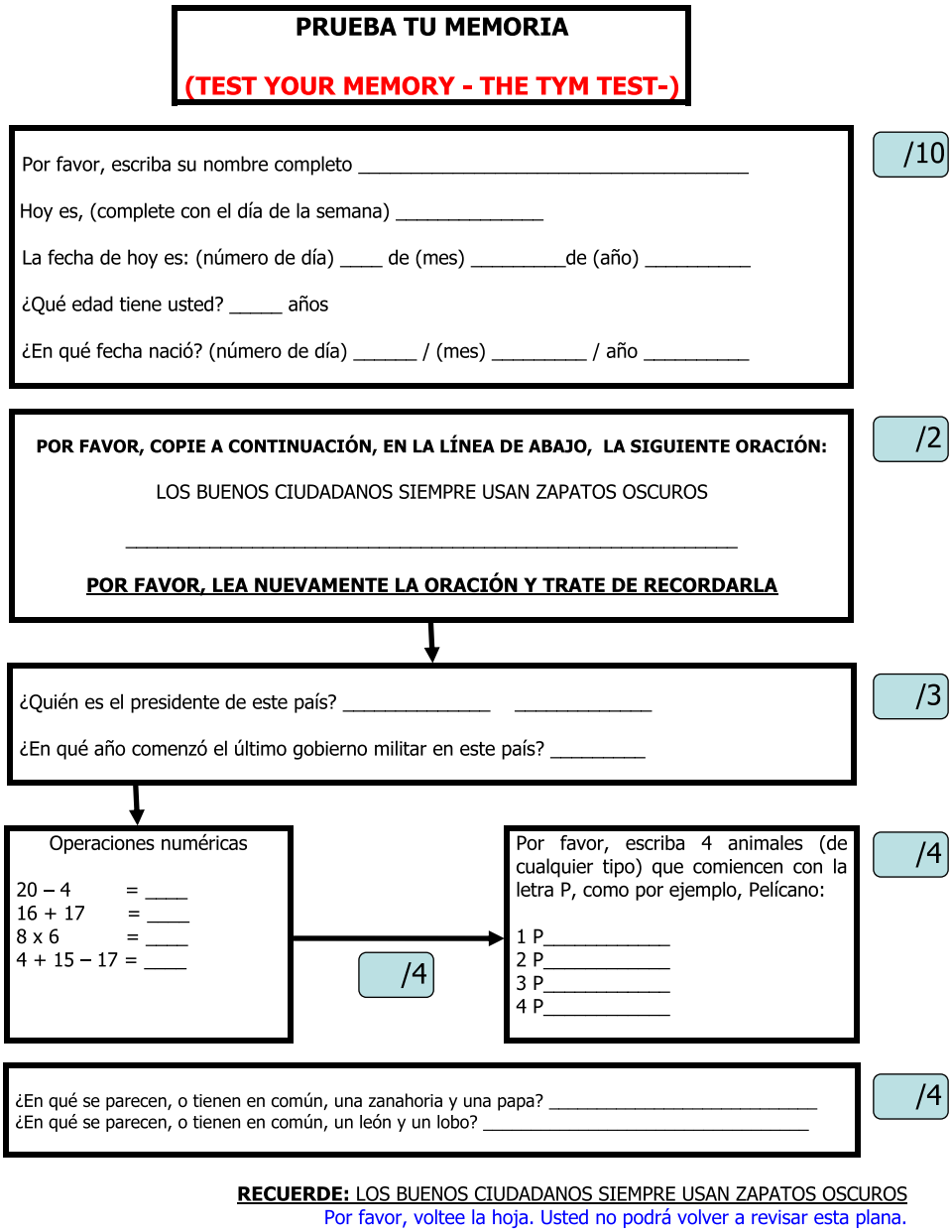
Appendix A



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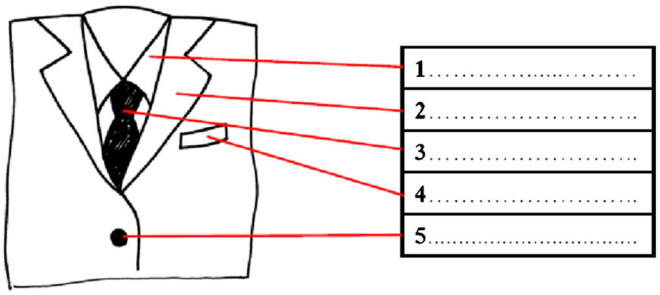

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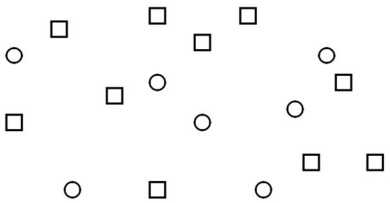

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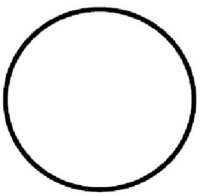

SIN VOLTEAR LA HOJA, POR FAVOR ESCRIBA A CONTINUACIÓN LA ORACIÓN QUE USTED COPIÓ AL COMIENZO DE ESTA PRUEBA. ESCRIBA TODO LO QUE RECUERDE: /6

Completado por el evaluador: /5
AYUDA ENTREGADA: NINGUNA/DISCRETA-TRIVIAL/LEVE/MODERADA/MUCHA
¿LAS RESPUESTAS FUERON ESCRITAS POR EL PACIENTE? SÍ __ NO __

TOTAL /50