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RESEARCH

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Adaptation of Oxford Cognitive Screen into Turkish (OCS-TR): Validity and reliability study in stroke survivors

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Abstract

Background The existing cognitive screening tests used to assess cognitive disorders after stroke in Türkiye face limitations in scope and user applicability. Therefore, this study aimed to address these limitations by adapting the stroke-specific cognitive screening test, the Oxford Cognitive Screen (OCS), into Turkish. Additionally, validity and reliability studies were conducted.

Methods A total of 114 stroke survivors and 92 healthy individuals participated in the study. Data were collected using the *"Participant Information Form," "Oxford Cognitive Screen Turkish Version (OCS-TR)," "Aphasia Language Assessment Test (ADD)," "Montreal Cognitive Assessment Test- Turkish (MOCA-TR)," "Barthel Activities of Daily Living Index (BGYAI)"* and *"Beck Depression Scale."* The team followed an established and detailed step by step process guided by the OCS Concept Elaboration document. Statistical analyses were conducted with IBM SPSS Statistics. Validity and reliability studies, including content validity, known-groups validity, convergent and divergent validity, concurrent validity, internal consistency reliability, test-retest reliability, inter-rater reliability, intra-rater reliability, and parallel forms reliability were conducted to assess the robustness of the measurement instruments.

Results The language and cultural adaptation process underwent content analysis, adhering to ISPOR and ISOQOL guidelines, resulting in minimal content changes post-pilot study. Notable differences in subtest scores between healthy and stroke participants in both A and B forms of OCS-TR demonstrate known-groups validity, emphasizing superior performance in healthy participants. Strong convergent validity was evidenced by significant correlations with MOCA-TR (r_s=0.18 to 0.81) and BGYAI (r_s=0.19 to 0.51), while divergent validity was supported by weak correlations with overall BGYAI scores. Noteworthy correlations between specific subtests of OCS-TR and ADD underscore concurrent validity, with high inter- and intra-rater reliability, internal consistency (α = 0.90 for stroke, α = 0.65 for healthy) and test-retest reliability (r_s=0.89 to 0.99). Parallel forms reliability was high in both healthy and stroke participants, though significant differences were observed on specific subtests.

Conclusion The results confirm that the OCS-TR scale can be considered a valid and reliable instrument for assessing cognitive functions in stroke survivors. This stroke-specific tool offers clinicians a comprehensive and inclusive brief cognitive screening tool tailored to the needs of stroke patients.

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Keywords Stroke, Cognition, Cognitive impairment, Screening

Introduction

Stroke, a prevalent and serious medical condition, poses life-threatening consequences affecting numerous individuals [1, 2]. Apart from physical and behavioural repercussions, cognitive difficulties commonly manifest after a stroke [1, 2]. Individuals struggling with impaired cognitive abilities often encounter challenges in maintaining independent living and resuming previous occupational and social engagements after stroke [2]. These cognitive impairments not only influence social participation [3], mood [4], and quality of life [5], but also compound the impact of physical impairments and functional limitations. A nuanced understanding of an individual's cognitive abilities, encompassing what has been lost, deteriorated, and what remains functional or least damaged, becomes crucial in formulating an effective rehabilitation plan [2–4].

The prevalence of cognitive impairment after stroke is substantial, although specific figures vary based on measurement criteria and participant characteristics [1, 6, 7]. While recovery trajectories exhibit variability, with some patients experiencing sustained cognitive impairment in the chronic stage post-stroke and others showing improvement [8], some may face a decline leading to post-stroke dementia [9, 10]. In predicting functional outcomes, Carota et al. [11] emphasizes the importance of considering all present and potential future disorders, highlighting the necessity to predict outcomes early for tailored rehabilitation programs with realistic goals. Existing studies consistently highlight the presence of cognitive impairment post-stroke and stress the importance of evaluating and managing cognitive deficits for effective rehabilitation with functional and realistic objectives. Commonly used instruments like Montreal Cognitive Assessment (MoCA) were designed to detect dementia symptoms with a focus on verbal memory. The requirements for verbal responses mean that outcomes are often confounded by language impairments [12]. In addition, MOCA was found to be less sensitive than Oxford Cognitive Screen (OCS) [12]. The lack of domain-specific cut-offs further fails to align with clinical guidelines for domain-specific cognitive screening [13]. Similar limitations also have been observed for Mini-Mental State Examination (MMSE) [14], which had previously been shown to be less sensitive than the MoCA [15] and studies emphasize the need for a more comprehensive assessment tool becomes apparent [15–17]. Delevaran et al. [16] discuss the effectiveness of MOCA and MMSE in evaluating cognitive abilities, while Bour et al. [17] indicate that a low MMSE score can signal long-term cognitive decline; however, it may not adequately predict changes in cognitive functioning over time, highlighting its limitations in later stages [17]. Challenges arising from accompanying conditions such as aphasia, visual loss, visuospatial neglect, apraxia, and literacy issues suggest that conventional cognitive tests may not accurately reflect performance [12].

Stroke stands out as a prominent contributor to both mortality and disability, not only within Türkiye but also worldwide [18, 19]. The rising incidence of stroke, a phenomenon anticipated in Europe and also in other countries, echoes a parallel trajectory within Türkiye. This upward trend is notably attributed to the increasing aging population, underscoring the shared demographic challenge faced by both regions. Recognizing the similarities in stroke incidence between Türkiye and Europe emphasizes the need for a unified approach in reducing the impact of this prevalent health concern. Comparable precautions and strategies should be adopted to address the shared challenges posed by stroke, working towards minimizing its effects on individuals in both Türkiye and Europe.

This highlights the demand for a test that is not limited to a very specific population and avoids attempting a domain free evaluation. Existing neuropsychological test batteries face limitations in widespread clinical use due to time-consuming administration, the need for professional training, and their unsuitability for early-stage stroke survivors with attention difficulties in Türkiye. The *"Oxford Cognitive Screen (OCS)"* [20], specifically designed for stroke assessment, serves as a solution. Licensed for no cost for publicly funded clinical and research use, the OCS has been culturally and linguistically adapted in 13 languages [e.g., 21, 22] and used in over 2000 settings. This study aims to adapt the OCS into Turkish and conduct validity and reliability studies to enhance the available tools for cognitive assessment in post-stroke individuals.

Method

Participants

Two distinct participant groups were enrolled for this study: a group of neurologically healthy adults and a group comprising individuals recovering from stroke.

The inclusion criteria for healthy participants encompassed the following aspects: (1) providing informed consent for study participation; (2) age exceeding 18 years; (3) a score above the cut-off for MCI on the Turkish version of MoCA (MOCA-TR > 21); (4) absence of significant difficulties in comprehending instructions and/or capacity to sustain attention for a minimum of 30 min; (5) no comorbidity with neurological or mental health conditions; (6) no substantial hearing and/or visual deficits; (7) no history of drug/substance/alcohol addiction, with a Beck Depression Scale score ≤ 16; (8) pre-existing right-handedness; and (9) proficiency in the Turkish language as a native speaker. If in doubt whether potential participants could stay attentive for sufficient time, consultations were held with both medical professionals and caregivers. In addition, engaging in conversations with participants during the consent procedure, allowed a clinical judgement on a sufficient level of confidence in understanding abilities. The healthy participants were meticulously matched with the stroke group in terms of gender, age, and educational background. Prior to the study, written informed consent was obtained from all participants.

Inclusion criteria for stroke participants mirrored those of the control sample with the exception of the MOCA-TR criteria. Additional criteria for the stroke group included: (1) the presence of brain lesions resulting from a confirmed stroke, as evidenced by CT or MRI; and (2) a minimum of 3 months post-onset from their most recent stroke.

Table 1 Demographic and clinical details of the study participants

	Participants with stroke (*n* = 114)		Healthy participants (*n* = 92)	
	n	%	n	%
Gender	42	6.84	37	40.21
Female	72	63.15	55	59.79
Male				
Age	4	3.50	2	2.17
18–35	19	16.66	11	11.95
36–46	30	26.31	33	35.86
47–57	33	28.94	34	36.95
58–68	28	24.56	12	13.04
69+	58.31		56.76	
Mean Age=				
Education level	79	69.29	68	73.90
Primary school level (1–8 years of	25	21.92	15	16.30
education)	10	8.77	9	9.78
High school level (12 years of				
education)				
Higher education level (+ 12 years of				
education)				
Brain lesion location	43	37.71	-	-
Right hemisphere	66	57.89	-	-
Left hemisphere	5	4.38	-	-
Bilateral hemisphere				
Time post onset of the most recent	27	23.68	-	-
stroke	23	20.17	-	-
3 months	19	16.66	-	-
4–6 months	20	17.54	-	-
7–12 months	19	16.66	-	-
13–24 months	3	2.63	-	-
24–72 months	3	2.63	-	-
73–120 months	21.22		-	-
+ 121 months				
Mean time=				

N/A= Not Available

n= Number

The participants in the study were recruited through hospitals, colleagues, and social networks. The data collection process took place between November 2020 and April 2021. Data from the stroke participant group were gathered at the Fatih Sultan Mehmet Training and Research Hospital, Gaziosmanpaşa Physical Therapy and Rehabilitation Hospital and private language clinics in İstanbul. Healthy participants were accessed through recommendations from individuals known to the researcher. The majority of participants were from Istanbul, with additional participants reached in different cities of Türkiye.

A comprehensive total of 206 participants were enrolled for this study, comprising 92 neurologically healthy individuals and 114 stroke patients sourced from diverse locations, including hospitals, clinics, and rehabilitation facilities. The post-stroke duration ranged from 3 months to 164 months (M = 21.22; SD = 29.69), encompassing 66 left-hemisphere (LH), 43 right-hemisphere (RH), and 5 bilateral (BL) stroke patients, as indicated in the MRI scan reports within clinical notes. As anticipated, some post-stroke participants received an aphasia diagnosis. Specifically, among the 66 LH stroke patients, 54 individuals were diagnosed with aphasia. Among them, 36 participants exhibited non-fluent aphasia (Broca $n = 25$; Transcortical Motor $n = 5$; Global $n = 6$), while 18 displayed fluent aphasia (Wernicke $n = 3$, Conduction $n = 4$, Transcortical Sensory $n = 1$, Anomic $n = 10$). A detailed summary of the demographic and clinical background information for all 206 participants is presented in Table 1 (refer to Table 1 for details).

Materials

The assessment battery for all participants included the Turkish version of the Montreal Cognitive Assessment (MoCA-TR) [23, 24], alongside the Oxford Cognitive Screen Turkish (OCS-TR). In addition to MoCA-TR, post-stroke participants underwent the Aphasia Language Assessment Test (ADD) [25], specifically designed for Turkish-speaking individuals with aphasia, and the Turkish version of the Barthel index (BGYAI) [26]. Meanwhile, healthy participants were subjected to the Turkish version of the Beck Depression Scale (BDI) [27]. The validity and reliability studies for all tests employed in this study were conducted in Turkish, and these tests have found extensive use in various research studies. The MoCA-TR exhibited an internal consistency, as measured by Cronbach's alpha, with a value of 0.664. Additionally, the test-retest reliability of the MoCA-TR was found to be 0.742. The cutoff score for the test was set at < 21 points [24]. In the test-retest reliability, a significant level of consistency was observed ($r = .88$, $p < .001$), and the inter-rater reliability of the test was also found to be high ($r = .97$, $p < .001$). In determining the structural validity of ADD, significant differences were found among subtest scores, total scores, and language scores of groups with healthy and aphasic participants ($p < .001$). The high correlation of ADD with similar measures' subtests supports its criterion validity (mean 0.76–0.98). Additionally, the internal consistency values for ADD (e.g., 0.94–0.98) indicate strong reliability [25]. BGYAI showed good internal consistency (0.93 for stroke, 0.88 for spinal cord injury) and substantial agreement between raters (Kappa > 0.5 for spinal cord injury, > 0.6 for stroke). Intra-class correlation coefficients were high (0.99 for stroke, 0.77 for spinal cord injury) [26]. The reliability of BDI was investigated through item analysis and split-half techniques, yielding correlation coefficients of $r = .80$ and $r = .74$, respectively. The Pearson correlation coefficient with a comparable scale was found to be $r = .50$ [27].

Convergent and concurrent validity were assessed using the MoCA-TR [24] and certain subtests of ADD [25]. Divergent validity was determined through the use of the BGYAI [26], specifically focusing on functional independence and activities of daily living. The BDI was administered to healthy participants with the aim of substantiating their health status (avoiding any potential confounds of low mood on cognition) [27], similarly, and MOCA-TR was administered to ensure control participants met the inclusion criteria [24].

Oxford cognitive screen

The Oxford Cognitive Screen (OCS), developed by Demeyere et al. in 2015, is a domain-specific cognitive screening test designed specifically for post-stroke patients. This comprehensive tool addresses five fundamental cognitive domains: attention, language, memory, number, and praxis. Notably, the OCS incorporates 10 subtasks that are specifically crafted to be aphasia- and neglect-friendly, ensuring a more accurate and inclusive assessment for individuals dealing with these challenges post-stroke. Scores are compared to normative data using a scoring template, where impairments are indicated by scores below or, in some cases, above the cut-off values (e.g., asymmetry values for neglect or executive function scores for switching difficulties). After scoring, a visual snapshot (or "wheel of cognition") chart is used to highlight areas of cognitive impairment, with each section representing a cognitive domain. This provides a quick, visual summary of the patient's cognitive profile, aiding clinical teams in identifying impairments. Clinical observations are also added to provide context for the results.

Adaptation of the Oxford Cognitive Screen (OCS) to Turkish: translation and cultural-linguistic modifications

The linguistic and cultural adaptation protocol was adhered to following the guidelines outlined in the *"Concept Elaboration Report & Translation and Linguistic Validation Process* [28]" as provided by Oxford University Innovations Clinical outcomes team. This process follows the recommended methodology by The Professional Society for Health Economics and Outcomes Research (ISPOR) and International Society for Quality-of-Life Research (ISOQOL) for Clinical Outcome Assessments. A proficient team of eight members, all holding or pursuing Ph.Ds in speech-language pathology, with diverse disciplinary backgrounds and no prior familiarity with the OCS, collaborated to establish linguistic equivalence for the Oxford Cognitive Screen Turkish version (OCS-TR). The team followed an established and detailed step by step process guided by the OCS Concept Elaboration document and associated linguistic validation tables. The guidance provided more detailed information on the required steps to ensure an acccurate adaptation of the OCS, including: Cultural adaptation of stimuli / tasks; Cultural adaptation reconciliation; Forward translation; Forward translation review; Back translation; Back translation review; Pilot testing; Pilot testing review; Proofreading; Normative data collection.

The translation team worked independently on the translations. For tasks and instructions that are considered language-neutral, a straightforward translation was considered appropriate—such as drawing lines in the Executive task, crossing hearts in the *"Broken Hearts"* subtask, or performing calculations in the *"Calculation"* subtask. Two parallel versions of the OCS were forward and back-translated into Turkish. However, *"Picture Naming*, *Semantics*, *Sentence Reading*, *Orientation"*, and *"Recall & Recognition"* subtests required modifications for both words and pictures to suit the specific cultural and language context. Word choices and drawing processes adhered to manual guidelines, incorporating frequency values from the British National Corpus, Subtlex-UK [29, 30], and Van Heuven et al.'s study [31]. To create the Turkish version, words sharing similar frequencies with those in the original edition were carefully selected within the same category. Utilizing the "*A Frequency Dictionary of Turkish*" [32] and the *"Turkish National Corpus"* established the frequency values of these words.

A name agreement study involved 49 participants, evaluating the acceptability of drawings in the OCS-TR. Participants were presented with drawings and alternative versions, then asked to write down the name of the drawing they were shown. Based on this study, it was determined that modifications were necessary for some words and drawings in test forms A and B, as agreement in naming was lacking.

A collaborative effort involved three professionals—two linguists and one language speech therapist-linguist—in the forming of two sentences comprising 15 words each in Turkish. Two additional resources [31, 32], the *"A Frequency Dictionary of Turkish"* [32] and the website "https://kelimeler.net/, were employed. The diction ary was specifically used with caution to avoid forming sentences with frequently used words, considering the information that irregular target words in the sentence should not be commonly used. The website played a crucial role in identifying words with similar beginnings or endings within the sentences. Finding words with irregular orthography in Turkish, which has a transparent orthography unlike English, was quite challenging. Given the differing definitions of *"regularity"* in Turkish and English, various experts were consulted on identifying irregular words. Irregular words were selected as those that are borrowed or contain [ɣ], because they exhibit differences in their orthographic appearances [33, 34] and their placement within sentences was maintained consistently with the original.

Adapting linguistically and culturally appropriate distractions for multiple-choice questions posed another challenge. Distractors for the *"Delayed Recall & Recognition"* sub-test and the *"Verbal Memory: Recognition"* sub-task were chosen based on the target word. Various strategies, such as semantic or thematic relations, were employed in the selection of distractors to ensure their linguistic and cultural adaptation.

In the initial phase of the pilot study, OCS-TR A and B forms were administered to 15 participants in total; 5 participants identified with post-stroke aphasia and 10 healthy participants. These pilot participants actively contributed to the study by providing valuable insights into the recognition and naming of drawings, clarity of instructions, and additional comments on the tasks. Subsequently, based on their feedback, only minor adjustments were made, focusing on aspects such as font size, line and paragraph spacing, and the number of words per line.

To further validate the relevance of subtests and items in the OCS-TR concerning its intended purpose, language, and culture, interviews were conducted with experts representing various disciplines including "Neurology, Linguistics, Neuroscience", and *"Speech and Language Therapy"*. The insights gathered from these experts were instrumental in refining the final version of the OCS-TR, ensuring its alignment with the intended objectives and cultural context.

The below figure is further added for clarity (See Fig. 1).

Procedure

The study strictly adhered to the fundamental principles outlined in the Declaration of Helsinki. Comprehensive informed consent was obtained from all individual participants involved.

Throughout the data collection process, careful attention was given to ensure that the study room provided an environment characterized by quietness, ample brightness, and the absence of distracting factors. Each session generally involved only the participant and the researcher unless otherwise specified. The number of sessions, whether one, two, or three, was determined based on individual participant characteristics, study objectives, and considerations such as the absence of ADD score for stroke participants, their fatigue levels, and their expressed desire for breaks. Administering OCS-TR A and B forms took roughly 10–30 min for stroke participants and 6–25 min for healthy participants (per form).

The data collection process for stroke participants was systematically carried out over 2 or 3 sessions. The administrations of scales involved a careful sequence, including initial reevaluation with ADD in cases where the interval between OCS-TR administrations exceeded one month. For participants in ongoing therapy, therapists were consulted to administer ADD before initiating OCS-TR and MOCA-TR administrations. The sequential implementation of OCS-TR A or B forms (varied for equal data distribution), followed by MOCA-TR, and a subsequent re-administration of OCS-TR A or B forms ensured a comprehensive assessment. The ADD and the administration of other scales occurred on separate days or at different time periods (morning or afternoon).

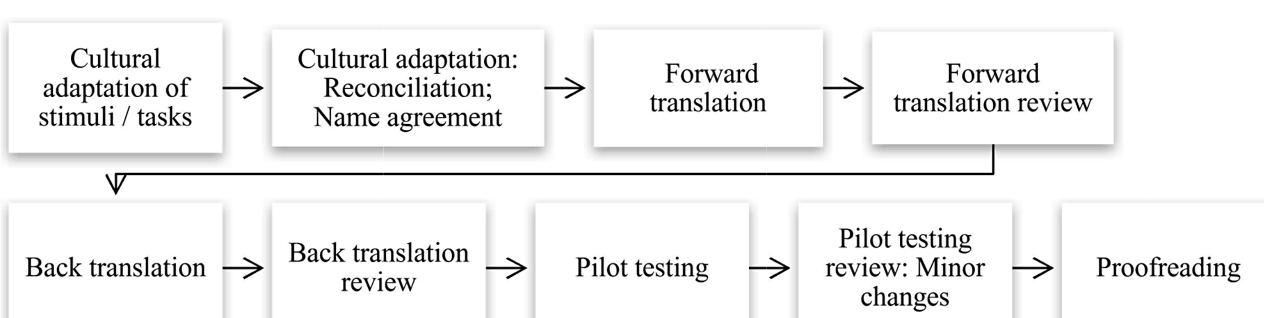

Fig. 1 The cultural and linguistic adaptation process [28]

Additionally, family members actively participated in completing specific forms, including the BGYAI.

Video recordings were obtained from 26 (22%) stroke patients by a smartphone, with explicit consent from either their family members or the participants themselves. These recordings served as crucial data for assessing inter- and intra-rater reliability.

Data Analysis

To ensure robust psychometric evaluation, we conducted comprehensive statistical analyses using IBM SPSS Statistics, version 20. Known-groups validity was assessed by comparing OCS-TR subtest scores between stroke and healthy participants, employing the Spearman's Rho correlation coefficient to ascertain consistency. The analytical toolkit included the Mann-Whitney U and Kruskal-Wallis tests for a thorough exploration of findings, aiming for correlations > 0.30 to delineate convergence. Furthermore, inter- and intra-rater reliability were scrutinized through video recordings obtained from 26 stroke patients, representing 22% of the participants with stroke, with assessments conducted independently by two raters and re-evaluated by the researcher for consistency. Test-retest reliability was evaluated with 31 stroke participants, utilizing intra-class correlation methods after a 15–20days interval. Internal consistency of OCS-TR scores was examined using Cronbach's alpha, and test-retest comparisons were subjected to the Wilcoxon Signed Ranks test with Bonferroni corrections for accuracy. This comprehensive methodology establishes a solid foundation for evaluating the reliability and validity of the OCS-TR.

We aim for correlations above 0.30 to signify convergent relationships between the measured attributes [35]. While interpreting the Intraclass Correlation Coefficient (ICC) value, it is aimed to obtain a value over 0.50 for moderate reliability [36]. All participants completed both forms of the OCS-TR scale. However, most of the analyses are based on data from Form A. Statistics for Form B can be obtained from the author upon request.

Results

Validity findings

Content validity

The language and cultural adaptation process underwent a thorough content analysis, benefiting from the collective expertise of researchers spanning linguistics, neuroscience, language, and speech therapy. The process followed recommended methodology by ISPOR and ISOQOL for Clinical Outcome Assessments. Following the pilot study, only minimal changes were needed in item content, underscoring the fidelity of the adapted instrument.

Known-groups validity

In both the A and B forms of the OCS-TR, a notable pattern emerged, revealing a statistically significant difference in every subtest score between healthy and stroke participants, except for the *"Broken Hearts Test: Space Asymmetry"*, *"Broken Hearts Test: Object Asymmetry"*, and "*Executive Task: Total Score*" sub-task scores. Across all subtests, healthy participants consistently demonstrated higher scores, underscoring their superior performance compared to stroke participants. Table 2 is provided for reference and further exploration of findings (See Table 2).

Convergent validity and divergent validity

The study assessed both convergent and divergent validity using the MOCA-TR and BGYAI measures alongside the OCS-TR. Specifically, correlation values with the MOCA-TR ranged from r_s= 0.18 to 0.81 ($p < .001$- >0.05) (see Table 3), while correlations with the BGYAI ranged from r_s =0.19 to 0.51 ($p < .001$- 0.01) (see Table 4). These findings suggest strong convergent validity, indicating that the OCS-TR measures similar cognitive constructs as the other measures used. Conversely, divergent validity was demonstrated by weak or non-existent correlations between different cognitive domain tasks within the OCS-TR.

In Table 3, values for the correlated subtests are highlighted in bold. The data indicates both low (r_s= 0.23) and high (r_s= 0.75) levels of correlation between directly associated subtests (e.g., OCS-TR: Picture Naming vs. MOCA-TR Animal Naming, OCS-TR: Orientation vs. MOCA-TR: Orientation).

Concurrent validity

The study conducted a detailed examination of specific subtests from the ADD alongside carefully chosen counterparts from the A form of the OCS-TR. The OCS-TR subtest "Orientation" showed a significant correlation with ADD's *"Spontaneous Language and Speech (SLS)"* (r_s= 0.46). Similarly, the OCS-TR subtest *"Picture Naming"* demonstrated a high correlation with ADD's *"Picture Naming"* (r_s= 0.81). Additionally, the OCS-TR subtest *"Semantics"* exhibited a correlation with ADD's *"Auditory Understanding: Categories"* (r_s= 0.45), while the OCS-TR subtest *"Sentence Reading"* displayed a notably high correlation with ADD's "*Reading: Words*" (r_s= 0.87). For detailed results and other values regarding to all subtests of both tests, refer to Table 5.

Reliability findings

Internal consistency reliability Cronbach's alpha (α) coefficients for internal consistency were calculated for the OCS-TR A form, utilizing standardized items. In the stroke participant group, the internal consistency was

Table 2 Finding of known-groups validity of the OCS-TR: a Mann-Whitney U analysis of both forms

	Subtests ↓	**U**	**T**	***p***
OCS-TR Form A	Picture Naming	2360,500	-7,248	<,001*
	Semantics	3878,000	-4,755	<,001*
	Orientation	3497,000	-5,955	<,001*
	Visual Field Test	3680,000	-5,693	<,001*
	Sentence Reading	1294,000	-9,969	<,001*
	Number Writing	2466,500	-7,504	<,001*
	Calculations	2488,000	-6,967	<,001*
	Broken Hearts Test: Total Correct	1693,500	-8,381	<,001*
	Broken Hearts Test: Space Asymmetry	4604,500	-1,530	0.126
	Broken Hearts Test: Object Asymmetry	4488,000	-2,229	0.026
	Meaningless Gesture Imitation	2695,500	-6,116	<,001*
	Verbal Memory	2524,000	-6,634	<,001*
	Episodic Memory	1554,000	-9,219	<,001*
	Executive Task: Circles	1897,500	-8,669	<,001*
	Executive Task: Triangles	2300,000	-8,114	<,001*
	Executive Task: Mixed Trail connections	1770,500	-8,306	<,001*
	Executive Task: Total score	4725,000	-1,242	0.214
OCS-TR Form B	Picture Naming	2265,000	-7,543	<,001*
	Semantics	4149,000	-4,324	<,001*
	Orientation	3588,500	-5,759	<,001*
	Visual Field Test	3818,000	-5,394	<,001*
	Sentence Reading	1193,000	-10,060	<,001*
	Number Writing	2196,500	-8,209	<,001*
	Calculations	2529,000	-6,859	<,001*
	Broken Hearts Test: Total Correct	1642,500	-8,501	<,001*
	Broken Hearts Test: Space Asymmetry	5242,500	-,004	0.997
	Broken Hearts Test: Object Asymmetry	5027,500	-,607	0.544
	Meaningless Gesture Imitation	2254,000	-7,129	<,001*
	Verbal Memory	2453,500	-6,948	<,001*
	Episodic Memory	2022,500	-7,928	<,001*
	Executive Task: Circles	2211,000	-7,946	<,001*
	Executive Task: Triangles	2154,000	-8,248	<,001*
	Executive task: Mixed trail connections	1677,500	-8,517	<,001*
	Executive task: Total score	4348,500	-2,139	0.032

* Statistical significance

U: The Mann-Whitney U statistic, representing the number of times a value in one group is ranked higher than a value in the other group

T: The sum of ranks for one of the groups, used to calculate U

Participants with stroke (*n*=114); Healthy participants (*n*=92)

Bonferroni correction were conducted: *p*= .003

OCS-TR: Oxford Cognitive Screen Turkish

robust with α = 0.90, while the healthy participant group demonstrated a good level of internal consistency with α = 0.65. For the OCS-TR form B, the internal consistency coefficients for the stroke participant group were also noteworthy, with α = 0.87. However, in the healthy participant group, the internal consistency was slightly lower at α = 0.55.

Test-retest reliability Significant differences were observed in the test-retest scores for specific subtests of the OCS-TR A and B forms. Notably, the *"Broken Hearts Test: Total Hearts"* subtest exhibited a substantial difference in both the A form (Z= -3.345; *p* = .001) and B form (Z= -3.452; *p* = .001), while the *"Meaningless Gesture Imitation"* subtest in the A form showed a notable difference as well (Z= -2.970; *p* = .003[*Bonferroni correction p= ,003]). Higher scores were consistently obtained in the retest for these subtests. The overall test scores from the initial test and the retest data demonstrated a statistically significant agreement, with correlation coefficients ranging from r_s= 0.886 to 0.997, indicating high consistency. These findings were mirrored in the OCS-TR B form, further affirming

Table 3 Convergent validity findings between OCS-TR A subtests and MOCA-TR subtests

MOCA-TR Subtests ◊		Alternating Trail Making		Cube Copy		Clock Drawing		Animal Naming		Digit Span		Target Tapping		Serial Subtraction		Repetition		Verbal Fluency		Abstraction		Memory		Orientation		Total	
		r	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*
OCS-TR Form A	Picture Naming	0.411*	< 0.001	0.378*	< 0.001	0.505*	< 0.001	**0.757***	< 0.001	0.643*	< 0.001	0.526*	< 0.001	0.596*	< 0.001	0.527*	< 0.001	0.336*	< 0.001	0.559*	< 0.001	0.421*	< 0.001	0.724*	< 0.001	0.808*	< 0.001
	Semantics	0.253*	0.007	0.322*	< 0.001	0.461*	< 0.001	**0.447***	< 0.001	0.337*	< 0.001	0.359*	< 0.001	0.373*	< 0.001	0.258*	0.006	0.112	0.234	0.334*	< 0.001	0.257*	0.006	0.484*	< 0.001	0.553*	< 0.001
	Orientation	0.324*	< 0.001	0.280*	0.003	0.368*	< 0.001	0.487*	< 0.001	0.342*	< 0.001	0.290*	0.002	0.313*	0.001	0.194*	0.039	0.206*	0.028	0.290*	0.002	0.250*	0.007	**0.553***	< 0.001	0.519*	< 0.001
	Visual Field	0.243*	0.009	0.063	0.505	**0.358***	< 0.001	0.276*	0.003	0.114	0.229	0.265*	0.004	0.206*	0.028	0.151	0.109	−0.007	0.943	0.123	0.192	0.233*	0.013	0.336*	< 0.001	0.337*	< 0.001
	Sentence Reading	0.305*	0.001	0.170	0.070	0.409*	< 0.001	0.721*	< 0.001	0.583*	< 0.001	0.559*	< 0.001	0.623*	< 0.001	**0.493***	< 0.001	0.292*	0.002	0.490*	< 0.001	0.419*	< 0.001	0.786*	< 0.001	0.772*	< 0.001
	Number Writing	0.352*	< 0.001	0.288*	0.002	0.377*	< 0.001	0.644*	< 0.001	0.668*	< 0.001	0.658*	< 0.001	**0.718***	< 0.001	0.525*	< 0.001	0.311*	0.001	0.518*	< 0.001	0.392*	< 0.001	0.743*	< 0.001	0.780*	< 0.001
	Calculation	0.369*	< 0.001	0.220*	0.018	0.550*	< 0.001	0.520*	< 0.001	0.518*	< 0.001	0.483*	< 0.001	**0.546***	< 0.001	0.388*	< 0.001	0.394*	< 0.001	0.458*	< 0.001	0.331*	< 0.001	0.589*	< 0.001	0.684*	< 0.001
	Total Hearts	0.382*	< 0.001	0.257*	0.006	0.533*	< 0.001	0.272*	0.003	0.133	0.158	0.268*	0.004	0.115	0.225	−0.017	0.853	0.113	0.230	0.213*	0.023	0.352*	< 0.001	0.323*	< 0.001	0.354*	< 0.001
	Space Asymmetry	0.025	0.795	−0.005	0.958	0.115	0.222	0.316*	0.001	0.368*	< 0.001	0.194*	0.038	0.266*	0.004	0.370*	< 0.001	0.192*	0.040	0.341*	< 0.001	0.008	0.930	0.272*	0.003	0.335*	< 0.001
	Object Asymmetry	−0.159	0.092	−0.014	0.886	−0.180	0.055	−0.080	0.399	0.075	0.429	−0.044	0.645	0.005	0.956	0.212*	0.023	−0.028	0.764	0.058	0.539	−0.046	0.629	−0.028	0.771	−0.020	0.836
	Meaningless Gesture Imitation	0.380*	< 0.001	0.370*	< 0.001	0.590*	< 0.001	0.448*	< 0.001	0.387*	< 0.001	0.370*	< 0.001	0.348*	< 0.001	0.260*	0.005	0.272*	0.003	0.444*	< 0.001	0.307*	0.001	0.451*	< 0.001	0.561*	< 0.001
	Verbal Memory	0.243*	0.009	0.320*	0.001	0.424*	< 0.001	0.590*	< 0.001	0.507*	< 0.001	0.404*	< 0.001	0.465*	< 0.001	0.480*	< 0.001	0.339*	< 0.001	0.558*	< 0.001	**0.235***	0.012	0.630*	< 0.001	0.672*	< 0.001
	Episodic Memory	0.399*	< 0.001	0.320*	0.001	0.489*	< 0.001	0.501*	< 0.001	0.476*	< 0.001	0.462*	< 0.001	0.423*	< 0.001	0.395*	< 0.001	0.238*	0.011	0.458*	< 0.001	**0.312***	0.001	0.554*	< 0.001	0.636*	< 0.001
	Executive Task: Circles	**0.483***	< 0.001	0.272*	0.003	0.593*	< 0.001	0.381*	< 0.001	0.421*	< 0.001	0.386*	< 0.001	0.330*	< 0.001	0.128	0.173	0.153	0.105	0.399*	< 0.001	0.393*	< 0.001	0.404*	< 0.001	0.538*	< 0.001
	Executive Task: Triangles	**0.473***	< 0.001	0.294*	0.002	0.674*	< 0.001	0.317*	0.001	410*	< 0.001	0.406*	< 0.001	0.318*	0.001	0.172	0.067	0.195*	0.038	0.386*	< 0.001	0.427*	< 0.001	0.354*	< 0.001	0.529*	< 0.001
	Executive Task: Mixed trail Connections	**0.515***	< 0.001	0.333*	< 0.001	0.587*	< 0.001	0.377*	< 0.001	0.362*	< 0.001	0.422*	< 0.001	0.259*	0.005	0.064	0.500	0.183	0.051	0.293*	0.002	0.363*	< 0.001	0.340*	< 0.001	0.485*	< 0.001
	Executive Task: Total score	−0.072	0.449	−0.010	0.914	0.238*	0.011	0.028	0.770	0.125	0.186	0.005	0.958	0.188*	0.045	0.180	0.055	0.009	0.924	0.271*	0.004	0.145	0.124	0.122	0.197	0.184	0.050

* Statistical correlation (Spearman's correlation)

Findings of participants with stroke (n=114)

OCS-TR: Oxford Cognitive Screen Turkish Version

MOCA-TR: Montreal Cognitive Assessment Test- Turkish

Table 4 Divergent validity findings between OCS-TR A subtests and BGYAI total score

	Subtests ↓	*r*	*p*
OCS-TR Form A	Picture Naming	0.129	0.171
	Semantics	0.191*	0.042
	Orientation	0.358*	< 0.001
	Visual Field Test	0.258*	0.006
	Sentence Reading	0.284*	0.002
	Number Writing	0.177	0.060
	Calculation	0.270*	0.004
	Broken Hearts Test: Total Hearts	0.509*	< 0.001
	Broken Hearts Test: Space Asymmetry	−0.155	0.099
	Broken Hearts Test: Object Asymmetry	−0.304*	0.001
	Meaningless Gesture Imitation	0.453*	< 0.001
	Verbal Memory	0.304*	0.001
	Episodic Memory	0.346*	< 0.001
	Executive Task: Circles	0.408*	< 0.001
	Executive Task: Triangles	0.469*	< 0.001
	Executive Task: Mixed Trail Connections	0.455*	< 0.001
	Executive Task: Total Ccore	0.028	0.768

* Statistical correlation (Spearman's correlation)

Findings of participants with stroke (*n*=114)

OCS-TR: Oxford Cognitive Screen Turkish Version

BGYAI: Barthel Activities of Daily Living Index

Table 5 Concurrent validity findings between OCS-TR A subtests and ADD subtests

ADD Subtests →		Spontaneous Language and Speech		Auditory Understanding: Categories		Picture Naming		Reading: Words	
	Subtests ↓	*r*	*p*	*r*	*p*	*r*	*p*	*r*	*p*
OCS-TR Form A	**Picture Naming**	0.661*	< 0.001	0.604*	< 0.001	**0.814***	**< 0.001**	0.719*	< 0.001
	Semantics	0.491*	< 0.001	**0.456***	**< 0.001**	0.520*	< 0.001	0.447*	< 0.001
	Orientation	**0.467***	**< 0.001**	0.397*	< 0.001	0.393*	< 0.001	0.385*	< 0.001
	Sentence Reading	0.716*	< 0.001	0.601*	< 0.001	0.719*	< 0.001	**0.873***	**< 0.001**

* Statistical correlation (Spearman's correlation)

Findings of participants with stroke (*n*=114)

OCS-TR: Oxford Cognitive Screen Turkish Version

ADD: Aphasia Language Assessment Test

the reliability of both A and B forms in terms of test-retest reliability. For a detailed overview, refer to Table 6.

Inter-rater reliability and intra-rater reliability The comprehensive assessment of both inter- and intra-rater reliability is thoroughly presented in Table 7. This detailed analysis encompassed 26 stroke participants, representing roughly 22% of the participants with stroke. Upon closer review of the reliability metrics, it is clear that the obtained values for both inter- and intra-rater reliability are not just satisfactory but remarkably high.

Parallel forms reliability Significant differences between the two parallel forms of the OCS-TR were observed in specific subtests among both healthy and stroke participants. Within the healthy participants, a notable disparity was found exclusively in the *"Verbal Memory"* subtest (Z= -2.927, $p = .003^{\text{*Bonferroni correction } p= .003}$) indicating a significant variation between the forms. Conversely, among stroke participants, the *"Meaningless Gesture Imitation"* subtest showed a significant difference (Z = 4.243, $p < .001$) between the forms. However, no significant differences were detected in other subtests for both healthy and stroke participants. This suggests that while certain subtests exhibited variability between forms, the majority of subtests remained consistent across the parallel forms of the OCS-TR.

Table 6 Spearman correlation coefficients of OCS-TR A form test-retest reliability

Cognition Domain	OCS-TR subtests	Test-retest
		r
Language	Picture Naming	0.978*
	Semantics	0.997*
	Sentence Reading	0.993*
Memory	Orientation	0.886*
	Verbal Memory	0.975*
	Episodic Memory	0.954*
Attention	Visual Field Test	0.943*
	Broken Hearts Test: Total Hearts	0.988*
	Broken Hearts Test: Space Asymmetry	0.941*
	Broken Hearts Test: Object Asymmetry	0.932*
	Executive Score	0.969*
Number	Number Writing	0.997*
	Calculation	0.984*
Praxis	Meaningless Gesture Imitation	0.953*
Executive Functions	Executive Task: Circles	0.914*
	Executive Task: Triangles	0.945*
	Executive Task: Mixed Trail Connections	0.983*
	Executive Task: Total Score	0.969*

* Statistical correlation (Spearman's correlation)

Findings of participants with stroke (*n*=114)

OCS-TR: Oxford Cognitive Screen Turkish Version

Discussion

Validity

The language and cultural adaptation process underwent a rigorous content analysis, drawing on the expertise of researchers across various disciplines, including linguistics, neuroscience, language, and speech therapy. This meticulous approach, guided by the adaptation guide from Oxford University Innovation (2013), involved thoughtful modifications during the translation phase, aligning with similar adjustments found in other studies [37, 38, 39, 40, 41]. Subsequent to the pilot study, minimal changes were made to item content, preserving the integrity of the adapted instrument. The language and cultural adaptation adhered closely to established guidelines and similar studies in the literature [14, 20, 37–44]. In the pilot study phase, OCS-P [37] exhibited stability, requiring no significant alterations after the adaptation study. Conversely, following the pilot study of OCS-Dansk [39], adjustments were necessary in sentence structures.

Healthy participants outperformed stroke patients across all OCS-TR A and B subtests and OCS-TR subtest correlations revealed expected links among cognitive areas, supporting the scale's known-groups validity. Our findings that OCS distinguishes patients from controls echo the same pattern observed in previous translations of the OCS, providing strong evidence for the test's validity in the context of stroke assessment [12, 14, 17, 20, 38, 43]. Kong et al. (2016) [41] aimedt to adapt the OCS to another language, finding that healthy participants consistently had better scores than those with strokes. Recent studies in Spanish [44] and Putonghua Chinese [37] showed similar patterns, with healthy participants scoring higher than stroke individuals. Shendyapina et al. (2018) noted significant differences in all subtests between healthy and stroke participants in the Russian adaptation study [21]. These findings, consistent with other adaptations, support the validity of the Turkish OCS. Nevertheless, a nuanced analysis reveals that few controls performed below certain patients. This is not unexpected given not all stroke survivors will show cognitive changes in all domains.It is known that stroke survivors are at risk for cognitive impairment, particularly in executive function and visual perception [5, 45, 46]. Cognitive impairments are prevalent after a stroke, impacting attention, memory, and executive function [46]. Nakling et al. (2017) found executive functions most affected in 60% of stroke participants [47] while Delavaran et al. (2016) confirmed cognitive impairment based on MMSE and MOCA results [16]. In this study as well, stroke survivors tended to achieve lower scores overall, reflecting the challenges they face in comparison to other groups.

We conducted a systematic evaluation of validity by employing established Turkish tests to thoroughly assess convergent, divergent, and concurrent validity. Correlation analyses between MOCA-TR and OCS-TR subtests unveiled varying degrees of significance, with most OCS-TR subtests surpassing the recommended threshold of $r = .30$ for convergent validity [48]. Instances of non-correlation were carefully examined, suggesting that subtests not correlated or weakly correlated may assess distinct cognitive domains. Cross-referencing our results with existing OCS adaptations (e.g., Rus-OCS [21], OCS-P [37], S-OCS [44]) revealed consistently similar or close correlation values [eg. S-OCS [44]; OCS-TR: Picture Naming: 0.62; 0.75 Orientation: 0.58; 0.55, Verbal Memory: 0.46; 0.23, Episodic Memory: 0.40; 0.31, Executive Task: −0.19; −0.07, Calculation: 0.79; 0.51]. Furthermore, extending our investigation to include ADD and OCS-TR-related subtests demonstrated significant correlations, further supporting the concurrent validity of the OCS-TR. The obtained correlation values between all OCS subtests and the specified ADD subtests indicate low to moderate levels of relationship. It is important to note that this lack of convergence signifies that OCS does not demonstrate convergence with specific ADD measures. The absence of a significant correlation e.g. between the MOCA-TR *"Naming"* subtest and the *"Broken Hearts Test: Object Asymmetry"* confirms also the divergent validity, with subtests attributed to the assessment of distinct cognitive domains. Additionally, the determination of correlation between the OCS-TR and MOCA-TR was integral to both validity and reliability analyses. The values obtained in our study align

Table 7 Inter-rater reliability findings of OCS-TR A and B form subtests in stroke participants

Subtests ↓	Reliability Analyses							
	Inter-rater reliability				Intra-rater reliability			
	Form A		Form B		Form A		Form B	
	ICC [95% CI]	r	ICC [95% CI]	r	ICC [95% CI]	r	ICC [95% CI]	r
Picture Naming	0.860 [0.688–0.937]	0.738*	0.855 [0.669–0.879]	0.755*	1.000	1.000*	1.000	1.000*
Semantics	0.737 [0.426–0.881]	0.675*	0.933 [0.571–0.970]	0.798*	1.000	1.000*	1.000	1.000*
Orientation	0.700 [0.321–0.866]	0.682*	0.950 [0.890–0.978]	0.823*	1.000	1.000*	0.989 [0.976–0.995]	1.000*
Visual Field Test	0.819 [0.595–0.920]	0.714*	0.977 [0.949–0.990]	0.995*	0.989 [0.976–0.995]	0.903*	1.000	1.000*
Sentence Reading	0.826 [0.609–0.922]	0.727*	0.873 [0.719–0.943]	0.786*	1.000	1.000*	1.000	1.000*
Number Writing	0.767 [0.487–0.895]	0.612*	0.926 [0.835–0.967]	0.861*	1.000	1.000*	1.000	0.989*
Calculation	0.891 [0.759–0.951]	0.834*	0.968 [0.930–0.986]	0.915*	1.000	1.000*	1.000	1.000*
Broken Hearts Test: Total Hearts	1.000	1.000*	1.000	1.000*	1.000	0.999*	1.000	1.000*
Broken Hearts Test: Space Asymmetry	1.000	1.000*	1.000	1.000*	1.000	1.000*	1.000	1.000*
Broken Hearts Test: Object Asymmetry	1.000	1.000*	1.000	1.000*	1.000	1.000*	1.000	1.000*
Meaningless Gesture Imitation	0.929 [0.840–0.968]	0.836*	0.893 [0.761–0.952]	0.843*	0.998 [0.996–0.999]	0.998*	0.998 [0.996–0.999]	0.999*
Verbal Memory	0.816 [0.595–0.917]	0.731*	0.963 [0.917–0.983]	0.886*	1.000	1.000*	1.000	1.000*
Episodic Memory	0.852 [0.669–0.933]	0.769*	0.900 [0.778–0.955]	0.786*	0.994 [0.987–0.997]	0.983*	0.994 [0.987–0.997]	1.000*
Executive Task: Circles	1.000	1.000*	0.979 [0.953–0.990]	0.955*	1.000	1.000*	1.000	1.000*
Executive Task: Triangles	1.000	1.000*	0.964 [0.920.984]	0.943*	1.000	1.000*	1.000	1.000*
Executive Task: Mixed Trail Connections	1.000	1.000*	1.000	1.000*	1.000	1.000*	1.000	1.000*
Executive Task: Total Score	1.000	1.000*	1.000	1.000*	1.000	1.000*	1.000	0.992*

* Statistical correlation

ICC= Intraclass Correlation Coefficient

Findings of participants with stroke (*n*=114)

OCS–TR: Oxford Cognitive Screen Turkish Version

closely with those reported in comparable studies assessing convergent validity in the context of cultural and linguistic adaptations of the OCS.

The analysis of the correlation between BGYAI scores and OCS-TR subtests highlights a weak to moderate correlation between the BGYAI total score and certain OCS-TR subtest scores. This finding aligns with observations made by Valera-Gran et al. [44], who similarly reported a weak but statistically insignificant correlation between BGYAI scores and S-OCS scores. Notably, in both our study and that of Valera-Gran et al., the *"Broken Hearts Test: Total Hearts"* and *"Meaningless Gesture Imitation"* subtests of the S-OCS exhibited a significant and moderate correlation, mirroring the remarkably similar correlation coefficients obtained in these subtests within the OCS-TR. In parallel, the HK-OCS study [41] also identified weak-moderate and high-level correlations between the BGYAI total score and certain subtests of the HK-OCS. Strikingly, our study replicated these results, demonstrating consistent correlation values ranging from r_s= 0.31 to 0.68 (HK-OCS [41]). These correlation values, meeting the criteria for divergent validity, also show the robustness of the OCS-TR in reliably assessing and predicting functional outcomes in stroke survivors. The demonstrated consistency in correlation patterns across studies reinforces the validity of the OCS-TR. The ability of the OCS-TR to reliably predict functional outcomes in stroke survivors is further emphasized by these results, positioning the assessment tool as a valuable and consistent predictor in clinical contexts.

In conjunction with the examination of MOCA-TR, our study thoroughly investigated the concurrent correlations between specific ADD and OCS-TR-related subtests. The decision to include an additional scale in our research was prompted by insights gleaned from prior adaptation studies, which emphasized the importance of incorporating language assessment scales specific to the language alongside the well-established MOCA scale. As we explored the language subtests of the OCS-TR and their counterparts in ADD, a noteworthy discovery unfolded – a significant correlation between the two sets of subtests (ADD *"Spontaneous Language and Speech (SLS)"* [r_s= 0.467], OCS-TR *"Picture Naming"* demonstrating a strong correlation with ADD *"Picture Naming"* [r_s= 0.814], OCS-TR *"Semantics"* showing a correlation with ADD *"Auditory Understanding: Categories"* [r_s= 0.456], and OCS-TR *"Sentence Reading"* displaying a notably high correlation with ADD *"Reading: Words"*

[r_s= 0.873]). The OCS test, evaluated for language skills in the original English version [20], demonstrated moderate to high correlations with subtests of other language assessment scales ([OCS Semantic-PALPA: 0.44]; [OCS Sentence Reading- Boston Diagnostic Aphasia Examination [BDAE]: 0.67]). Similarly, the HK-OCS [41] showed strong correlations with the Western Aphasia Battery Cantonese version (CAB), including CAB Naming and HK-OCS Picture Naming (r = .73), CAB Auditory Comprehension and HK-OCS Semantic (r = .69), and CAB Reading and HK-OCS Sentence Reading (r = .78). This consistency across studies demonstrates the robustness and generalizability of the observed correlation patterns. These correlation values not only demonstrated a moderate to very high level of association but also highlighted the interconnectedness of language assessments in this context. Furthermore, our findings revealed a moderate-high correlation between the subtests designed to assess language skills and corresponding subtests in language assessment scales utilized in both OCS [20] and the HK-OCS study [41]. This strong correlation underscores the consistency and reliability of the language assessment component within the OCS-TR, aligning with established measures and contributing to the overall strength of the assessment tool in evaluating language-related cognitive domains.

Through a detailed examination of convergent, divergent, and concurrent validity using established Turkish tests, this study sheds light on the cognitive assessment field for Turkish stroke survivors. These findings, echoing similar studies, support the validity claims of the OCS-TR and reinforce its significance in accurately assessing cognitive function post-stroke. Further exploration of comparable studies could provide additional validation for the OCS-TR and enrich our understanding of cognitive assessment tools in stroke rehabilitation.

Reliability

The assessment of reliability in the OCS-TR encompassed internal consistency, stability, and equivalence measures, providing a comprehensive understanding of its robustness. The Coefficient Alpha (CA) value obtained for the OCS-TR was regarded acceptable across all relevant aspects within the field [49, 50]. Analysis of data from stroke participants confirmed the scale's exceptional reliability, while data from healthy participants indicated a moderately reliable performance. It's noteworthy that the diverse motivational factors driving healthy participants might contribute to variability in internal consistency values between groups. Despite these variations, the internal consistency level of the OCS-TR remained notably sufficient, especially within the context of its primary development for stroke patients. The reliability of a scale, as indicated by the Coefficient Alpha (CA) value, is categorized as follows: a CA between 0.40 and 0.60 suggests low reliability, 0.60 to 0.80 indicates moderate reliability, and a range from 0.80 to 1.00 reflects high reliability for the scale [50]. This observation aligns with the insights provided by Özdamar [49] and Terzi [50] and, supporting the overall confidence in the internal consistency of the OCS-TR. Comparative analysis revealed that the OCS-TR's internal consistency coefficient closely paralleled the high consistency value observed in the other adaptations such as Rus-OCS [21] (0.77), HK-OCS [41] (0.72), and S-OCS [44] (0.90). This consistency across internal consistency coefficients strengthens the reliability claims of the OCS-TR, signifying its robust and consistent performance across different samples. The significance of the OCS-TR CA coefficient, especially in the stroke sample, stands out as a significant contribution to both the validity and reliability of the test. This demonstrates the instrument's capability to reliably measure cognitive functions in stroke survivors, further reinforcing its utility as a valid tool in clinical assessments.

A test-retest procedure involving 31 participants was conducted to assess stability over a period of 15–20 days. The test-retest correlation values for the OCS-TR A form were high, ranging from r_s= 0.88 to 0.99, indicating strong stability over time. In a test-retest procedure involving 15 participants, OCS [20] (OCS: 0.33–0.77) and Kong et al. (2016) [41] reported also notably high correlations ranging from 0.57 to 0.98, mirroring the current study's outcomes Similarly, the test-retest data from the Russian adaptation, Rus-OCS [21], demonstrated a substantial level of consistency between the first and second data collection process, supporting our findings (OCS-Rus: 0.48–0.10).

Intra-rater reliability was examined to complete the reliability analysis. The intraclass correlation coefficient (ICC) estimate for inter-rater reliability across both OCS-TR A and B forms demonstrated consistently high levels. All subtests exhibited similarly high intra-rater reliability coefficients for both A and B forms, with the exception of the *"Meaningless Gesture Imitation"* subtest. Comparisons with the OCS-P [37] revealed very high inter-rater reliability data for most subtests. Reviewing inter-rater and intra-rater reliability, our findings align with studies on S-OCS [44] and HK-OCS [41]. Specifically, Valera-Gran et al. reported excellent inter-rater reliability and good intra-rater reliability for the S-OCS [44]. Similarly, data on HK-OCS [41] highlighted very high levels of both inter-rater and intra-rater reliability. In the OCS-P study, reliability was assessed through a meticulous test-retest procedure, emphasizing stability [37]. Valera-Gran et al. (2019), in their adaptation studies, reported the S-OCS to exhibit outstanding interrater reliability (≥ 0.90) and commendable intrarater reliability (≥ 0.70) [44]. Likewise, reliability analyses for HK-OCS [41] indicated its remarkably high reliability, both in interrater (from 0.95 to 1.000) and intrarater (from 0.89 to 1.000) aspects. The outcomes of these studies resonate with the current research. In line with similar investigations, no significant disparities emerged in interrater and intrarater reliability data among OCS-TR subtest scores. This clearly demonstrates the reliability of the OCS-TR scale [35, 36].

In the analysis of data obtained through the parallel forms method for equivalence, only the scores of two subtests exhibited a statistically significant difference between the two forms of the OCS-TR. Notably, in the OCS-TR B form, the scores for these two subtests were higher. Conversely, the remaining subtests demonstrated a moderate to extremely high correlation, emphasizing the overall equivalence between the parallel forms. This observation aligns with findings from OCS-NL [38], where minor differences between parallel forms were also noted during equivalency analyses. The high correlation coefficients observed in our study, similar to the results in OCS-NL [38], underscore the equality and consistency of the two forms. According to established principles, high correlation coefficients support to the assertion that the two tests used are indeed equivalent and consistent, thereby enhancing their reliability [12]. The significant difference in scores for two subtests between the OCS-TR A and B forms in the parallel forms equivalence analysis may be attributed to various factors. One possibility is that these particular subtests might have a higher level of sensitivity to subtle variations in the testing conditions or format, leading to differences in scores between the two forms. It could also be influenced by specific nuances in how participants interpret or respond to the content of these subtests. The variation in scores might be indicative of specific cognitive processes or skills assessed by these subtests that are more prone to fluctuations or individual differences or the environmental factors. Despite these disparities, the moderate to extremely high correlation observed in the remaining subtests suggests a general equivalence and consistency between the parallel forms of the OCS-TR. The alignment with findings from the OCS-NL study [38], which also noted minor differences, align with our results and support the idea that such discrepancies may be inherent to the nature of these assessments. These differences do not undermine the overall reliability and consistency of the instrument. The high correlation coefficients, in accordance with established principles [35, 36, 49, 50], provide assurance that the two forms are indeed equivalent and consistent, reinforcing the reliability of the OCS-TR as a robust cognitive assessment tool.

The reliability assessment of the OCS-TR not only establishes its stability in measuring cognitive functions but also implies its utility as a reliable tool for assessing cognitive impairment in Turkish stroke survivors. The moderately reliable performance observed in healthy participants highlights the importance of considering motivational factors in cognitive assessments. Moreover, the strong stability over time suggests that the OCS-TR can provide consistent and reliable measurements of cognitive function longitudinally, which is crucial for tracking changes in cognitive status during recovery or intervention. These findings have significant implications for clinical practice, as they support the use of the OCS-TR as a reliable tool for evaluating cognitive function in stroke survivors and monitoring their progress over time. Additionally, the high correlation coefficients observed in the parallel forms equivalence analysis imply that the OCS-TR forms are interchangeable, providing flexibility in administration without compromising reliability. This enhances the feasibility of incorporating the OCS-TR into routine clinical assessments, facilitating early detection and intervention for cognitive impairments in stroke survivors.

Professionals can leverage the OCS-TR to precisely determine whether crucial cognitive domains affected by a stroke remain intact or impaired. This understanding of cognitive capabilities facilitates a more comprehensive approach to patient care. Professionals can initiate an effective treatment process that addresses the patient's needs holistically by integrating cognitive skills into the treatment plan. The OCS-TR, with its demonstrated validity and reliability, is anticipated to fulfill this crucial clinical need. Not only does this enhance diagnostic accuracy, but it also lays the groundwork for tailored interventions, contributing to more targeted and effective rehabilitation strategies for stroke survivors. The cohesive integration of cognitive assessment into clinical practice, facilitated by the OCS-TR, has the potential to significantly improve patient outcomes and enhance our understanding of cognitive functioning in stroke recovery.

Conclusion

This study presents significant implications for both clinical practice and future research. The OCS-TR has emerged as a validated and reliable assessment tool, providing valuable insights into the cognitive profiles of Turkish-speaking stroke participants. The robust psychometric properties of the OCS-TR reflect its potential to improve clinical decision-making, supporting accurate diagnoses and personalized intervention plans for stroke survivors. Moreover, the thorough assessment of validity and reliability in this study provides a solid foundation for future research focused on understanding the cognitive effects of stroke and improving assessment tools to meet the needs of various populations. Consequently, the OCS-TR is positioned to make substantial contributions to the field of stroke rehabilitation and cognitive neuroscience, fostering advancements that can lead to enhanced outcomes and improved quality of life for individuals impacted by stroke.

Limitations
The assessment of cognitive impairment in stroke participants exclusively utilized the materials outlined in the research methodology. It is essential to acknowledge that the potential influence of therapy on the scales could not be evaluated due to the unavailability of information regarding participants' therapy status. Additionally, it is worth noting that the distribution of groups based on specific variables, such as education levels (e.g., participants with primary school education versus those with higher education), could not be balanced. We also acknowledge that our pragmatically and clinically guided inclusion approach, which involved consulting with medical professionals and caregivers when in doubt about the potential participants' ability to maintain sufficient attention, as well as assessing their understanding abilities during the consent procedure is not an objective criterion. Finally, no a priori sample size was set. Instead, sample sizes from similar published articles were referenced, and effect sizes were reported.

Suggestions
Collaborating with a neurologist to conduct and assess cognitive evaluations can offer a more comprehensive understanding of an individual's performance. A study encompassing participants in various stages of stroke—acute, subacute, and chronic—would be particularly intriguing. Such research could enhance our comprehension of the intricate relationship between the time after a stroke and cognitive skills. Additionally, it could provide insight into the distinct trajectories of recovery or deterioration across different cognitive domains.

Abbreviations
ADD	Aphasia Language Assessment Test
BDAE	Boston Diagnostic Aphasia Examination
BDI	Beck Depression Inventory
BGYAI	Barthel Activities of Daily Living Index
CA	Coefficient Alpha
CAB	Cantonese version of the Western Aphasia Battery
ICC	Intraclass Correlation Coefficient
ISOQOL	International Society for Quality-of-Life Research
ISPOR	International Society for Pharmacoeconomics and Outcomes Research
LH	Left Hemisphere
MCI	Mild Cognitive Impairment
MMSE	Mini-Mental State Examination
MOCA	Montreal Cognitive Assessment
MOCA-TR	Montreal Cognitive Assessment - Turkish Version
MRI	Magnetic Resonance Imaging
OCS	Oxford Cognitive Screen
HK-OCS	Oxford Cognitive Screen, Hong Kong version
OCS-Dansk	Oxford Cognitive Screen, Danish version
OCS-NL	Oxford Cognitive Screen, Dutch version
OCS-P	Oxford Cognitive Screen, Portuguese version
OCS-TR	Oxford Cognitive Screen, Turkish version
Rus-OCS	Oxford Cognitive Screen, Russian version
S-OCS	Oxford Cognitive Screen, Spanish version
PALPA	Psycholinguistic Assessments of Language Processing in Aphasia
RH	Right Hemisphere
r_s	Spearman's rank correlation coefficient
SLS	Spontaneous Language and Speech (ADD subtest)
SPSS	Statistical Package for Social Sciences

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Author contributions
Ö.O. Conceive and design the analysis; Collect the data; Contribute data or analysis tools; Perform the analysis; Write the paper; Review and Edit. B.T. Review and edit. N.D. Review and edit.

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Data availability
The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request. Additionally, statistics for Form B can be accessed on the official website: https://tez.yok.gov.tr/UlusalTezMerkezi/ using the dissertation number [703975]. The tables are included in the appendix. Please note that the thesis is in Turkish.

Declarations

Ethics approval and consent to participate
Informed consent was obtained from all individual participants included in the study. All experimental procedures including informed consent for participation in the protocol were approved by the Human Ethics Committee of Anadolu University (No: 68215917-050.99-E.66402). The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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