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The European Portuguese version of the Oxford Cognitive Screening (OCS-Pt): a screening test for acute stroke patients

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Abstract

In Portugal, there is no gold standard test to assess acute stroke patients in the hospital context. However, cognitive deficits are common after a stroke episode and are followed by a negative impact on a patient's quality of life and rehabilitation. Here, we first aimed to adapt the Oxford Cognitive Screening to European Portuguese speakers (OCS-Pt), develop normative data cut-offs, and report the psychometric properties of the OCS-Pt. The second aim was to test the incidence of impairments in acute stroke patients. We tested 137 healthy participants aged between 25 and 92 years old, and we report normative cut-offs based on the 5th and 95th percentile, and on the patterns for age and education level. Our results are similar to other European OCS versions, and results using convergent and divergent validity show satisfactory values ranged between moderate to high. Additionally, 146 acute stroke patients, in the first week after the stroke episode, performed the OCS-Pt. Results show that this is an inclusive test and allows to discriminate between impaired and preserved functions. In conclusion, OCS-Pt is a promising cognitive screening tool to assess acute stroke survivors to be used in stroke care in Portugal.

Keywords Cognitive screen · Stroke · Normative data · European Portuguese

Background

Stroke is one of the main causes of death and disability in the developed countries. Portugal has a good system to prevent and detect stroke episodes [1], but there is still a lack of neuropsychology-based assessment tools for acute stroke episodes. The absence of suitable assessment tools for acute stroke patients adapted to the (European) Portuguese population results in discharging these patients without a targeted assessment of their cognitive abilities. This may have implications for rehabilitation efforts. In fact, studies have shown that early and accurate detection of cognitive impairments improves the patients' quality of life, their rehabilitation, and their chances to return to work and normal daily activities [2–4]. Here, we will adapt the Oxford Cognitive Screening (OCS) to European Portuguese (OCS-Pt) speakers, allowing the assessment of cognitive deficits in hospitalized acute stroke patients in Portugal.

Currently, there is no single instrument considered as the gold standard to detect cognitive deficits in Portuguese acute stroke units. Frequently, screening tools developed to detect dementia and cognitive decline, such as the Mini-Mental State Examination (MMSE) [5], the Addenbrooke's Cognitive Examination-Revised (ACE-R) [6], and the Montreal Cognitive Assessment (MoCA) [7], are applied to acute stroke patients. However, these tools were developed for dementia and do not assess important domains that can be impaired after a stroke, such as

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language processing, visual abilities, spatial and attentional processing, praxis, and/or reading [8–10]. Moreover, the use of these cognitive screening tools on acute stroke patients leads to frequent misclassification of dementia. Furthermore, to assess domains not included in these screening tests, clinicians often use subtests of larger batteries (e.g., Wechsler Memory Scale) that are very time-consuming and/or too difficult for acute stroke patients.

Importantly, these assessment tools, although widely used to assess hospitalized acute stroke patients, are not sufficiently sensitive to detect deficits after stroke. For instance, the MMSE, when used for this purpose, may inaccurately detect cognitive impairments in acute stroke cases [11, 12]. Additionally, MoCA does not include the assessment of key stroke-specific impairments that are highly prevalent in acute stroke patients [9, 13]. Moreover, to use MoCA as a screening tool on acute patients, one would need to set different cut-offs for the different stroke stages [14]. For all these reasons, a brief screening test capable of encompassing the typical cognitive deficits of an acute stroke population that can be used in the hospital context and that is adapted to European Portuguese speakers is urgently needed.

To the best of our knowledge, OCS [8] is the only brief screening assessment tool designed to assess cognitive deficits in acute stroke. Importantly, OCS provides cut-offs per cognitive domain allowing for a better understanding of the patients' deficits. Moreover, it is more inclusive and sensitive than MoCA [9, 15], for instance, patients with expressive aphasia cannot perform the Calculation or Orientation tasks of typical cognitive decline screening tools; thus, there is no way to assess calculus and orientation independently of the language. In contrast, OCS uses a method of multiple-choice and pointing that allows the assessment of these domains without spoken output. Recently, the new European guidelines recognized the advantages of stroke-specific and domain-specific cognitive screening for stroke, aligning with the OCS. This was called for in particular due to a higher inclusivity of stroke survivors with physical, language, and/or visuospatial impairments [16].

The OCS is an increasingly popular screening test around the world, and at the moment, there are normative data available for the original English version [8], as well as for the Cantonese [17], the Italian [15], the Spanish [18], the Brazilian Portuguese [19], the Russian [20], the Dutch [21], and the Danish versions [22]. Further cultural and language adaptations are underway. Our first goal was to adapt and develop normative data to the OCS European Portuguese version (OCS-Pt), as well as define patterns for different age and education levels. Secondly, we aimed to perform a preliminary analysis of the psychometric abilities of OCS by doing convergent and divergent validities. Finally, we aimed to test the capacity of OCS-Pt to detect impairments in an acute stroke population and show the ability of OCS to differentiate between preserved and impaired abilities.

Methods

Materials

OCS consists of (1) a test booklet with the stimuli; (2) a manual with instructions for the assessment and scoring; (3) a scoring sheet, and (4) a test for the participant to complete. This cognitive screening test comprises 10 tasks and allows the assessment of five cognitive domains: Language, Memory, Number processing, Attention and Executive function, and Praxis. Importantly, OCS allows for measuring cognitive deficits while avoiding confound effects. For instance, OCS can be applied to aphasic patients: if there are spoken output difficulties, patients can respond by pointing to the correct multiple-choice answer. It can be applied to neglect patients: stimuli are presented centrally along the vertical midline of the stimulus booklet (except the Broken Hearts task that assesses neglect). Finally, it is an instrument that can be easily filled with one-hand, allowing for the assessment of patients with upper limb hemiparesis.

Furthermore, the OCS can be delivered bedside and takes around 15 min to complete. It is easy to administer and score and has a cut-off per task instead of a total score. This scoring method allows the assessment of patients who cannot complete one or more tasks. Additionally, the OCS provides a "visual snapshot" of the cognitive profile of the patient. After comparing the scores of the patient with the normative data, clinicians can fill and add comments, facilitating the interpretation by the multidisciplinary team that is responsible for the patients, without the need to refer to a technical and long report (see Fig. 1).

Procedure

Translation process

The Portuguese European version was translated by two independent Portuguese-English proficient speakers, and then it was backward translated by an independent third person. The back translation was assessed, discussed, and approved by the original author of the UK English version to ensure no discrepancies in meaning or terminology had occurred. This involved translation of the instructions and the test, with the guidance of a detailed concept elaboration document. The Sentence Reading task in particular needed cultural modification to have a similar complexity as the original version of OCS (including irregular words and high neighbourhood words to detect word-based neglect dyslexia). The sentence presents four irregular words (i.e.,

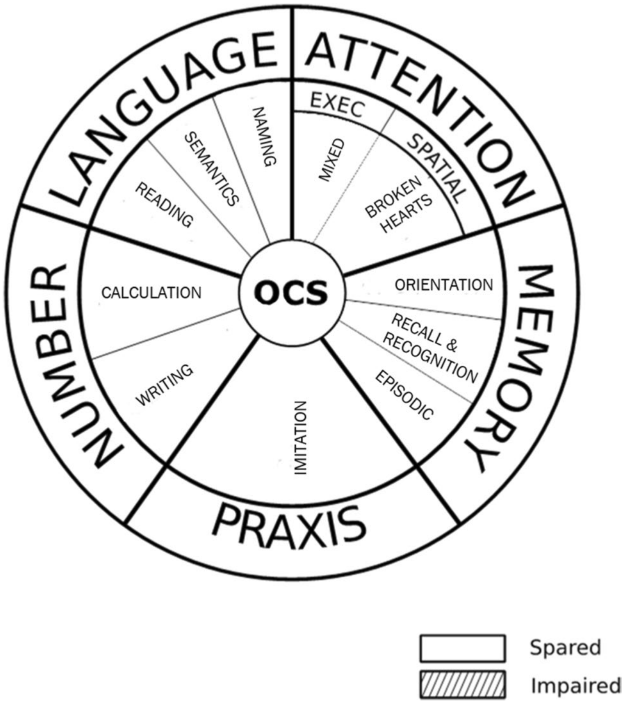


Fig. 1 An example of a "Visual Snapshot" with all domains and the associated tasks. Clinicians mark the impaired domains, and add comments to the pie chart (e.g., "patient presented an expressive aphasia with spared understanding")

"cinquenta," "táxis," "auxiliar," and "linguiça"; fifty, taxi, help staff, pork sausage, respectively) where errors could denote superficial dyslexia. Another four words present a high number of neighbours (i.e., "escola," "mais," "praças," and "comendo"; school, plus, squares/plazas, eating, respectively) where errors may suggest neglect dyslexia. The full translated and adapted sentence now reads "Haverá praças com mais de cinquenta táxis, pensou a auxiliar da escola comendo a linguiça" ("There might be squares with more than fifty taxis, wondered the staff member while eating pork sausage"). The verbal memory Recall and Recognition task was adapted to match the new sentence and following the principles of OCS multiple choice.

Participants

All participants of this study provided written and/or oral informed consent that included an explanation of the research goals, procedures, and the confidentiality of the information provided, in line with the approved protocols. The present research complied with the ethical guidelines for human experimentation stated in the Declaration of Helsinki. This study was approved by the Ethics and Deontological Research Committee by the Faculty of Psychology and Educational Sciences of the University of Coimbra.

Neurologically healthy participants

One-hundred thirty-seven native speakers of European Portuguese (91 women), without current history of neurological or psychological disorders, were assessed with OCS. We used a wide range of recruitment strategies to ensure that our sample was illustrative of the Portuguese population in age and education levels. Recruitment was carried out from advertising in aging support groups and senior universities; we also recruited the staff members in these elderly centres. We asked the caregivers and relatives of ambulatory patients at the memory appointment of a Portuguese central hospital to contribute to this study. Some participants, especially the youngest ones, were recruited using a word-of-mouth method.

The ages of the participants ranged from 25 to 92, with an average age of 59.74 (standard deviation (SD) = 17.75). The average duration of formal education was 9.64 years (SD = 4.77), with a range between 3 and 15 years of education. There were 6 left-handed healthy participants. The exclusion criteria included being illiterate and being a non-native European Portuguese speaker. We also excluded participants who were not functional independent in basic and instrumental activities in their daily lives using the Older Adults Functional assessment Inventory (IAFAI) [23], those participants that presented severe depression using the Geriatric Depression Scale – 30 items (GDS-30) [24, 25], and those participants that used medication with impact in cognition.

Acute stroke patients

One-hundred forty-six stroke patients (65 women) were recruited from the Neurology Department of a Central Hospital in Portugal. All patients were in an acute stroke state (between 0 to 6 days post onset). OCS was applied at the bedside, and all patients were followed by an experienced neurologist. The patients were between 25 to 93 years old, with an average age of 65.94 (SD = 14.87). The average number of years in formal educational settings ranged from 1 to 15 years, with an average of 6.07 (SD = 3.84). Our sample includes three left-handed patients. Illiterate patients and non-native Portuguese speakers were excluded from this sample.

Procedure

We included all acute patients who could potentially complete the OCS test (as judged by the treating medical team). The majority of our acute stroke patients were too weak to perform a long assessment to add additional validation data. Therefore, we only administered an additional MMSE [26] in a subsample of 50 patients. For the healthy participants, 3 additional cognitive tests and a depression scale were administered where time allowed us to do so: MoCA [7] and a visuo-perceptual abilities test in d2 [27] and the Toulouse tests [28]. The depression scale administered was the GDS-30 [24, 25].

Data and statistical analysis

Statistical analyses were performed using IBM Statistical Package for the Social Sciences (SPSS) for Windows, version 22 (IBM Corp., Armonk, NY, USA, 2013). We established the normative data following the same approach as the original study [8], using task cut-offs based on the 5th percentile (or 95th percentile). We also provided task average scores for different age (inferior to 50 years old, between 50 and 69 years, and more than 69 years), and education levels (low education, less than 5 years of schooling, mid education, from 5 to 9 years of education; and higher education, more than 9 years of schooling). We compared the Portuguese healthy neurological sample in relation to age and education with other published versions of OCS, as well as with the cut-offs of other versions.

We additionally performed psychometric analysis using the additional test data available from healthy neurological participants and acute patients. We calculated a Pearson product-moment correlation (two-tailed) between the subtests of OCS and the other tests for convergent validation. We also calculated divergent validity by performing the same analysis with measures that do not assess the same domain. One hundred eleven healthy participants performed MOCA [29], 20 performed d2 [27] and 46 the Toulouse tests [28, 30], respectively. In addition, 83 participants completed the GDS-30 [24, 25].

We report the reasons why participants did not complete the whole test. We also describe the incidence of acute stroke impairments in our sample of 146 patients (i.e., an impairment is defined when the score is below the cut-off). Of those tasks impaired, we measured the severity level per task and the percentage of patients with severe, severe to moderate, moderate to mild, and mild deficits. The severity levels reflected the original scores when the task presented a maximum of 4; in the other tasks, we classified based on the proportion, following the system: 0 < 25%, 1–25 to 50%, 2–50 to 75%, and 3 > 75%. Additionally, we tested the ability of OCS to differentiate between syndromes. At last, we report the number of tasks impaired in the acute stroke sample.

Results

Normative data

We provide the normative cut-off scores for OCS-Pt set on the 5th percentile based on the full sample. Cut-off scores for the Executive, right object asymmetry, and space asymmetry tasks were calculated based on 95th percentile (see Table 1). As in the original study, the verbal recall measure (i.e., recall without recognition) has a normative cut-off of 0, and we followed the authors recommendation to highlight to the participants that they should remember the sentence. Table 2 shows average scores on the tests for the full sample, divided by the different age groups as well as different education levels.

We decided to add the cut-offs and average scores of the Circles and the Triangles tasks because it gives us valuable information about the patients' ability to comprehend complex instructions. We excluded 9 healthy participants from the Broken Hearts task because they showed difficulties to see the Broken Hearts (left or right independently) due to vision problems not corrected by glasses (e.g., cataracts). In general, our cut-offs are very similar to other published versions of OCS (see Table 4), with the Broken Hearts overall accuracy as an exception. However, most part of the healthy participants performed very well in this task (M = 43.87; SD = 4.86; median = 45.50; mode = 46; range from 29 to 50).

In Table 3, we compared the demographic characteristics of the Portuguese sample to the samples in the other international OCS versions. Importantly, the OCS-Pt sample size is similar to other versions including the original study, with the exception of the Italian version that has a larger sample. The age distribution is similar to other versions. However, due to the demographic characteristics, the Portuguese elderly sample (more than 69 years) has less years of schooling (M = 7.49; SD = 4.52; range from 3 to 17) when compared to English, Italian, Danish, and Russian samples (Table 4).

Convergent and divergent validities

Each subtest of OCS was matched with another published test that assesses the same domain in order to ascertain convergent validity. The results for the Pearson product-moment correlation (two-tailed) indicate that the different OCS-Pt subtests correlate with the expected cognitive subtests of other published assessment batteries. Convergent validity between OCS and other published tests are presented on Table 5. Our results show that OCS is significantly correlated with tasks of MMSE, MoCA, d2, and Toulouse that assess similar cognitive domains. For instance, the OCS Calculation presented a correlation of 0.688 with the MMSE calculation and 0.302 with MoCA calculation (for full comparisons see Table 5). Note, however, that only the neurologically healthy sample went through MoCA, d2, and Toulouse assessment tests.

The strength of the correlations ranged from moderate (0.30 to 0.49) to strong (> 0.5; Cohen, 1988). This range of correlations was true for all subtests except for the Picture

Table 1 Normative data and cut-offs for impairment (scores on subtests lower than 5th percentile and above 95th percentile show an impairment)

Task name	Measure	Score range	Control sample N	Median score	Min task	Max task	5th percentile	95th percentile
Picture Naming	Overall accuracy	0 to 4	137	4	2	4	2	
Semantics	Overall accuracy	0 to 3	137	3	3	3	3	
Orientation	Overall accuracy	0 to 4	137	4	4	4	4	
Visual Field	Overall accuracy	0 to 4	136	4	2	4	4	
Sentence Reading	Overall accuracy	0 to 14	137	14	11	14	13	
Number Writing	Overall accuracy	0 to 3	137	3	1	3	3	
Calculation	Overall accuracy	0 to 4	137	4	2	4	2	
Broken Hearts	Overall accuracy	0 to 50	128	46	29	50	33	
	Space assimetry	Left inattention > 0; right < 0		-2	-9	3	-5	1
	Obj assimetry	Left inattention > 0; right < 0		0	-9	3	-8	2
Praxis	Overall accuracy	0 to 12	137	12	5	12	9	
Recall and Recognition	Verbal recall	0 to 4	137	3	0	4	0	
	Verbal memory recall and recognition	0 to 4	137	4	0	4	2	
	Episodic memory	0 to 4	137	4	2	4	3	
Executive Tasks	Circles task	0 to 6	135	6	2	6	3	
	Triangles task	0 to 6	135	6	1	6	3	
	Mixed task	0 to 13	128	13	1	13	7	
	Executive score (sum of the single tasks acc. minus Mixed task)	-3 to 10	128	-1	-3	10		5

Naming task, the Recall and Recognition task, the Episodic Memory tasks, and the Mixed task. The Picture Naming task presented a correlation of 0.280 with the object naming from the MMSE; the Recall and Recognition and Episodic Memory tasks presented a correlation of 0.258 and 0.275 with the delayed recall from the MoCA, respectively; in the Episodic Memory task, patients just have to recognize the picture that they previously saw. Overall, the correlations obtained in these three tasks were close to moderate; and the Mixed Task, the correlation between the scores in this task and those of the number of trails from the MoCA was of 0.105. Moreover, we calculated correlations from the same domain within OCS (see Table 6) and showed that tasks that assess the same domain correlate significantly with each other. For instance, Number Writing and Calculation presented a correlation of 0.596.

Importantly, the OCS-Pt showed strong divergent validity, as demonstrated by the lack of correlation between tasks that do not assess the same domain (Table 7). For example, the Calculation task presented a low correlation with MoCA verbal fluency ($r = 0.098$; $p = 0.305$) and even a lower correlation with OCS Visual Field task ($r = 0.005$; $p = 0.943$).

Incidence of impairments in acute stroke patients

As mentioned above, we assessed acute stroke patients in the first days post-episode, and a high number of patients were too weak to perform a long assessment. Thus, without surprise, we found a considerable number of patients who did not complete one or more tasks of the OCS (41.1%). Table 8 shows the reasons for not completing the tasks. Importantly, 22 patients did not perform the Sentence Reading and subsequent verbal memory Recall and Recognition tasks, because we made some changes in the sentence, and scores with the previous version were discarded. Note that because OCS allows for testing domains independently and still assessing patients that cannot complete the full test, we kept these patients in the sample for the analysis of the remaining domains.

We used the normative cut-offs per task to identify deficits in our acute sample. We described the percentage of

Table 2 Normative data, average score for different age groups and level of education

Task name	Measure	Overall ($n=137$)	< 50 ($n=34$)	50–69 ($n=52$)	> 69 ($n=51$)	Low educ ($n=40$)	Mid educ ($n=31$)	High educ ($n=66$)
Picture Naming	Overall accuracy	3.77	4	3.88	3.49	3.48	3.84	3.91
Semantics	Overall accuracy	3	3	3	3	3	3	3
Orientation	Overall accuracy	4	4	4	4	4	4	4
Visual Field	Overall accuracy	3.98	4	3.96	3.98	3.93	4	4
Sentence Reading	Overall accuracy	13.90	13.91	13.90	13.88	13.78	13.90	13.97
Number Writing	Overall accuracy	2.98	3	2.98	2.96	2.93	3	3
Calculation	Overall accuracy	3.67	3.82	3.67	3.57	3.43	3.68	3.82
Broken Hearts	Overall accuracy	43.87	45.3	44.41	42.26	43.64	42.93	44.45
	Space asyimmetry	−1.63	−1.62	−1.42	−1.87	−1.27	−2.10	−1.63
	Obj asymmetry	−0.93	−0.52	−1.20	−0.93	−1.50	−0.63	−0.74
Praxis	Overall accuracy	11.37	11.88	11.19	11.22	10.65	11.42	11.79
Recall and Recognition	Verbal recall	2.82	3.65	2.75	2.35	2.03	3.10	3.18
	Verbal memory recall and recognition	3.50	3.82	3.58	3.20	2.98	3.65	3.74
	Episodic memory	3.69	3.91	3.67	3.57	3.53	3.68	3.80
Executive Tasks	Circles task	5.72	5.82	5.64	5.73	5.53	5.65	5.86
	Triangles task	5.76	6	5.57	5.78	5.65	5.39	6
	Mixed task	11.69	12.55	11.42	11.36	11	10.93	12.41
	Executive score	−0.03	−0.70	−0.11	0.28	0.49	0.45	−0.53

Table 3 Sample size, education, and age for different versions of OCS

Version	Sample size	Education	Age
Portuguese	137	Less than 5: $n=40$ 5 to 9: $n=31$ More than 9: $n=66$ [range from 3 to 15]	Less than 50: $n=34$ Between 50 and 69: $n=54$ More than 69: $n=51$ [range 25 to 92]
English Original	140	M = 14; SD = 4	M = 65; SD = 12.3 [range from 36 to 88]
Spanish	54	Uneducated or primary: $n=28$ Secondary or higher: $n=26$	Mdn = 63 Less than 65: $n=33$ More than 65: $n=21$ [range from 58 to 71]
Italian	489	Less than 8: $n=134$ 9 to 13: $n=201$ More than 14: $n=163$	Less than 50: $n=196$ Between 50 and 70: $n=188$ More than 70: $n=174$ [range from 18 to 89]
Danish	91	Less than 12: $n=12$ 12 to 16: $n=32$ More than 16: $n=19$	Less than 65: $n=34$ Between 65 and 75: $n=3$ 8 More than 75: $n=19$ [range from 36 to 89]
Hong Kong	70	Primary school: $n=12$ Secondary school: $n=39$ Tertiary education: $n=19$	Less than 50: $n=22$ Between 50 and 59: $n=26$ More than 59: $n=22$
Russian	60	M = 15; SD = 2.7 [range from 7 to 21]	M = 61; SD = 19 [range from 20 to 91]

patients that were impaired at different levels (see Table 9). Interestingly, the incidence of impairments per task is very similar to other published OCS versions (see Table 1 of the supplementary materials for more information) [8].

Another way to compute divergency between tasks of OCS is using stroke patients with impairments in one domain, but preserved functions in another. We found dissociation patterns between different domains, across all

Table 4 Cut-offs compared with other published versions

Task Name	Score Range	Portuguese	English	Spanish	Italian	Danish	Russian	Hong Kong
Picture Naming	0–4	2	3*	2	3*	3*	3*	4*
Semantics	0–3	3	3	2 *	3	3	3	3
Orientation	0–4	4	4	3*	3.9 to 4	4	4	4
Visual Field	0–4	4	4	2*	4	4	4	4
Sentence Reading	0–14	13 (out of 14)	14 (out of 15)	14 (out of 15)	14.1 to 15	15 (out of 15)*	15 (out of 15)*	22 (out of 22)*
Number Writing	0–3	3	3	2*	2.8 to 3	3	3	3
Calculation	0–4	2	3*	3*	3.3 to 3.8*	3*	3*	4*
Broken Hearts	0–50	33	42*	43*	43.4 to 47.4*	39.5*	40*	40*
Imitation	0–12	9	8*	8 or 9	9	8*	8*	8*
Recall and Recognition	0–4	2	3*	3*	2.4 to 3.4	3.5*	4*	3*
Episodic Memory	0–4	3	3	3	3.4 to 3.8	3.5	3	3
Mixed task	0–13	7	7	__	10.5 to 11*	11*	4*	__
Executive Score	− 13 to 12	5	4*	0*	3*	1*	3*	6*

Note: In the Spanish version, the cut-offs were calculated based on the area under the curve (AUC); the other OCS versions are calculated based on the 5th and 95th percentiles. The * represents the cut-offs of international studies that differ from OCS-Pt

Table 5 Convergent validity: correlations between performance on OCS subtests and other published tests

Domain	OCS task name	Validation task	N	R	*p*
Language	Picture Naming	MoCA Picture Naming	112	0.382	< 0.0001
	Picture Naming	MMSE Naming	174	0.280	< 0.0001
	Sentence Reading	MMSE Sentence Writing	173	0.448	< 0.0001
Number	Calculation	MoCA Calculation	111	0.302	0.001
	Calculation	MMSE Calculation	174	0.688	< 0.0001
	Number Writing	MoCA Clock Total	112	0.367	< 0.0001
	Number Writing	MoCA Clock Numbers	112	0.332	< 0.0001
Memory	Orientation	MMSE Orientation	175	0.434	< 0.0001
	Verbal Memory Recall and Recognition	MoCA Delayed Recall	111	0.258	0.006
	Verbal Memory Recall and Recognition	MMSE Delayed Recall	175	0.487	< 0.0001
	Episodic Memory	MMSE Delayed Recall	174	0.404	< 0.0001
	Episodic Memory	MoCA Delayed Recall	110	0.275	0.004
Attention	Broken Hearts	Toulouse	46	0.361	0.014
	Broken Hearts	d2	18	0.537	0.021
Executive	Executive Score	d2 (accuracy)	20	-0.512	0.021
	Executive Score	Toulouse (accuracy)	45	-0.388	0.009
	Mixed Task	MoCA trails (0–7)	102	0.195	0.05

domains assessed. For instance, in our acute sample 13.01% of the patients showed impairments in both Picture Naming and Calculation, whereas 4.11% of the patients presented a deficit in Calculation with naming spared, and 27.4% of the patients presented deficits only in Picture Naming and not in Calculation. Another example of a dissociation is between Sentence Reading and Number Writing. Specifically, 8.13% of our patients presented impairments in both Sentence Reading and Number Writing, whereas 29.17% presented deficits that were exclusive for Number Writing and 19.51% presented problems exclusively for Sentence Reading with Number Writing spared.

Furthermore, OCS-Pt is able to disentangle attention and memory problems: 7% of our patients presented attentional (Broken Hearts) and verbal memory (Recall and Recognition) deficits, but 19% of our patients presented with deficits exclusively for Broken Hearts, whereas 24.59% of our patients specifically demonstrated memory deficit. Similarly, 4% of the patients presented deficits in both Praxis and Broken Hearts tasks, whereas 15.28% of the patients showed

Table 6 Convergent validity within OCS

Domain	OCS task name	Validation task	N	R	p
Language	Picture Naming	Reading	262	0.525	< 0.0001
		Semantics	283	0.350	< 0.0001
	Semantics	Reading	262	0.178	0.004
Number	Calculation	Number Writing	283	0.596	< 0.0001
Memory	Verbal Memory Recall and Recognition	Episodic Memory	261	0.687	< 0.0001
		Orientation Free or MQC	264	0.408	< 0.0001
	Episodic Memory	Orientation Free or MQC	277	0.431	< 0.0001
Attention	Broken Hearts	Visual Field	234	0.143	0.029
	Broken Hearts	Mixed Task	213	0.278	< 0.0001
	Executive Score	Mixed Task	220	− 0.727	< 0.0001

Table 7 Divergent validity

Domain	OCS task name	Validation task	N	R	p
Language	Picture Naming	GDS-30	83	− 0.054	0.630
		MoCA Clock Total	112	0.129	0.179
	Semantics	OCS Executive Score	220	− 0.025	0.717
	Semantics	MMSE sentence repetition	175	− 0.012	0.879
	Reading	GDS-30	83	− 0.028	0.804
Number	Calculation	MoCA Verbal Fluency	111	0.098	0.305
	Calculation	OCS Visual Field	174	0.005	0.943
	Number Writing	GDS-30	83	0.029	0.794
Memory	Verbal Memory Recall and Recognition	MMSE naming	175	0.110	0.148
	Episodic Memory	MoCA Verbal Fluency	110	0.144	0.134
Attention	Broken Hearts	MMSE naming	158	0.074	0.353
	Broken Hearts	MMSE order	158	0.046	0.566
	Mixed Task	MMSE order	156	0.081	0.313
Praxis	Imitation	MoCA Clock Total	112	0.116	0.225

Table 8 Reasons for acute stroke patients not complete all tasks of the OCS

OCS task	Total	N Completed	Visual	Motor	Comprehension	Time Restriction	Fatigue	Test alterations	Others
Picture Naming	146	146							
Semantics	146	146							
Orientation	146	146							
Visual Field	146	143			3				
Sentence Reading	146	123	1					22	
Number Writing	146	144		2					
Calculation	146	146							
Broken Hearts	146	100	13	16	7	2	7		1
Praxis	146	144	1	1					
Recall and Recognition	146	122			1		1	22	
Episodic Memory	146	142	1	1	1		1		
Circles task	146	105	5	16	15		5		
Triangles task	146	98	5	16	19		8		
Mixed task	146	86	5	16	30		9		

Table 9 Number of impaired stroke patients and severity levels based on the normative cut-offs

Task name	Measure	Patients sample *N*	Impaired	0 (severe)	1 (sev-mod)	2 (mod-mild)	3 (mild)
Picture Naming	Overall accuracy	146	59	1.4%	19.2%	19.9%	
Semantics	Overall accuracy	146	11	0%	2.1%	5.5%	
Orientation	Overall accuracy	146	30	0%	4.8%	5.5%	10.3%
Visual Field	Overall accuracy	143	19	8.1%	0.7%	1.4%	4.2%
Sentence Reading	Overall accuracy	123	34	9.8%	0.81%	8.9%	8.1%
Number Writing	Overall accuracy	144	50	13.9%	8.3%	12.5%	
Calculation	Overall accuracy	146	25	7.5%	9.6%		
Broken Hearts	Overall accuracy	100	43	10%	13%	10%	10%
	Space asymmetry	100	36	—	—	—	—
		Left neglect	16	4%	6%	4%	2%
		Right neglect	20	2%	8%	5%	5%
	Obj asymmetry	100	8	—	—	—	—
		Left neglect	4	1%	1%	2%	
		Right neglect	4	1%	1%	1%	1%
Praxis	Overall accuracy	144	34	4.2%	2.8%	7.6%	9%
Recall and Recognition	Overall accuracy	122	37	13.9%	16.4%		
Episodic Memory	Overall accuracy	142	52	11.27%	9.2%	16.2%	
Executive Tasks	Circles task	105	16	10.48%	0.95%	3.81%	
	Triangles task	98	14	11.22%	1.02%	2.04%	
	Mixed task	86	22	10.47%	3.49%	9.30%	2.33%
	Executive score	86	11	2.33%	3.49%	6.98%	

**Note:* We considered as a deficit when the patient score was below the normative cut-offs. When the task presented a maximum of 4, the severity levels reflect the original scores. Other scores were classified based on the proportion, following the system: 0 < 25%, 1–25 to 50%, 2–50 to 75%, and 3 > 75%

problems that were specific to praxis and 22% of the patients presented exclusively with an attention deficit. These dissociations show that OCS-Pt has the ability to discriminate between different cognitive domains (detailed information is provided in Table 2 of the supplementary materials).

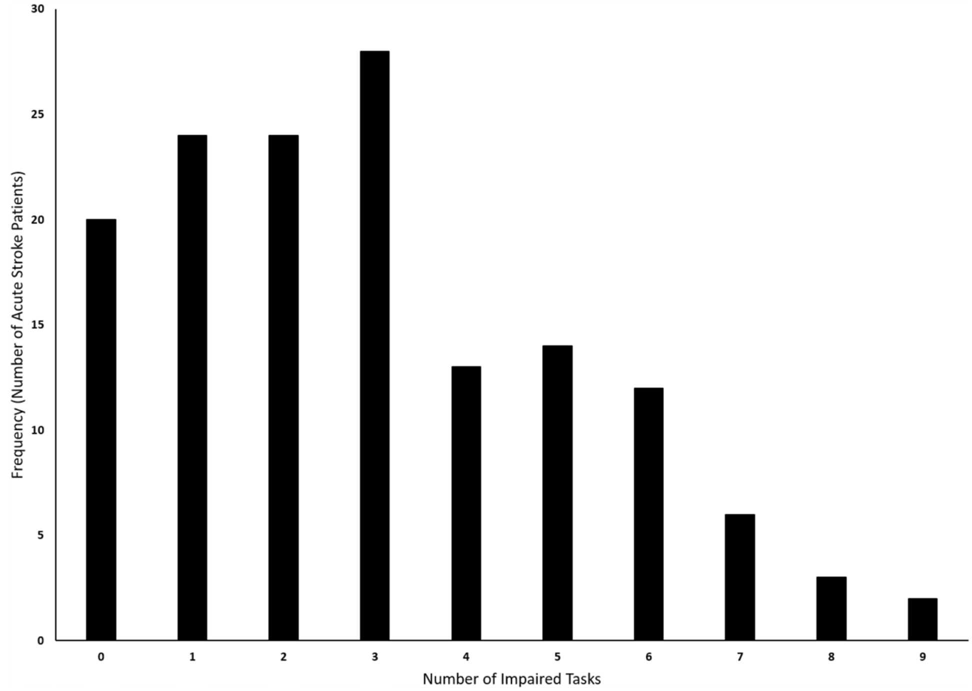
As mentioned above, OCS has the advantage of having a cut-off per task instead of a total score. However, similar to the original study, a possible way to measure an overall performance is using the number of impaired tasks. Thus, we calculated the number of patients who failed in the different number of tasks of OCS-Pt based on the cut-off (see Fig. 2). We found that 20 patients did not fail in any task, 24 were impaired in one single task, and 24 were impaired in two tasks. By contrast, in the healthy participants, 104 did not fail in any task, 24 failed one task, and 8 failed two tasks.

Discussion

Stroke is one of the most pervasive causes of death and disability. Adequate cognitive assessment within the acute stages of a stroke may be one of the strongest predictors to disease prognosis. Nevertheless, in Portugal, we lack neuropsychological assessment tools for acute stroke episodes. Here, we developed and assessed an European Portuguese translation of the Oxford Cognitive Screening (OCS-Pt), and we present cut-off values for the different subtasks. Importantly, we also provide detailed performance patterns for the different age and education levels. Additionally, we showed that the OCS-Pt presents good values of convergent validity with other published tests and within OCS, and good divergent validity, as shown by the lack of correlation between tasks that assess different domains. Finally, our data show that it is possible to dissociate between different domains with the OCS-Pt. The current study is an important step for the future use of a screening tool to Portuguese acute strokes units.

The normative OCS-Pt scores are similar to those in the original version of the OCS, except for the Broken Hearts task. One possible explanation for this difference may be related to some demographic differences between the two samples, namely, in our elderly sample, the low education group presents with very low levels of formal education (below 5 years of schooling), whereas in the sample of the original study, the lower education group is below 10 years of formal education. Plus, in the Italian version, where a larger sample was collected, the Broken Hearts task presented different cut-offs for age and education level. Another plausible explanation is that some participants did not have

Fig. 2 The number of tasks impaired in our acute sample based on the normative cut-offs



the right prescription glasses, or they presented non-corrected vision problems that they did not mention to us. However, in this task, the incidence of attentional problems in our stroke patients is similar to the other published versions (see Table 1 of the supplementary materials).

Importantly, we chose MMSE and MoCA as the main validation tests because those are the most popular brief screenings and are extensively used in Portuguese hospitals. Moreover, MoCA was used in other OCS validation studies. We found good values of convergent validity, ranging from moderate to strong. In contrast, we found low correlations in the language, memory, and mixed tasks. Some of these low correlations could probably be explained by slight differences in the nature and complexity of the validation tasks. For instance, OCS-Pt and MoCA have a comparable verbal memory task, but a different scoring system. In OCS-Pt, patients have two opportunities to score: free recall or multiple choice with word recognition, whereas in MoCA, patients just score when they accurately recall the item in the free recall task. Moreover, for the picture naming task, the naming task used for calculating convergent validity (the MMSE naming task) is easier than the OCS-Pt task: in the MMSE, participants have to name two very familiar real objects (a clock and a pencil), whereas, in the OCS Picture Naming task, patients have to name four pictures with different familiarity values (e.g., a hippo and a pear). Finally, regarding the Mixed Task, where the correlations with the number of trails task from the MoCA was relatively low, this result is in line with the original version, where this task was also the one with the lowest convergent validity.

As a limitation, when we computed convergent validity, we did not use another published subtest to compare the OCS performance on the Semantics and Praxis tasks. However, we asked our acute patients to perform transitive and intransitive gestures, and we found that patients that had more difficulties performing those gestures also presented a lower score in the OCS praxis task.

OCS-Pt also presents good convergent validity within OCS tasks, showing that tasks that assess the same domain are significantly correlated. For instance, the three tasks of the language domain are all significantly correlated demonstrating that all assess similar cognitive abilities. In contrast, there is good divergent validity shown by the lack of correlation between tasks that assess different domains.

Patients stay, on average, between 3 and 6 days in the hospital ward after the stroke episode, and during this period, we assessed 146 acute stroke patients with OCS-Pt. Surprisingly, 58.9% of acute stroke patients, in the first days' post onset, performed the entire OCS-Pt demonstrating how inclusive the OCS-Pt is. As expected, having mild or moderate aphasia did not interfere with the completion of OCS tasks, due to multiple choices and finger-pointing methods (we did not assess patients with severe expressive or global aphasia). Although 41.1% of patients did not complete one or more tasks of the test, this is not problematic because OCS-Pt has a cut-off per task that allows interpreting the cognitive performance of the patients even when the entire test is not completed. However, in many studies, patients who cannot complete the entire test are excluded from the analysis, making the acute sample not representative of the reality in neurology wards, for instance, by just including the patients with minor strokes or with pre-stroke disabilities [32]. In our sample, the most observed reasons to not complete the OCS-Pt were motor deficits that did not allow patients to write (e.g., hemiparesis), visual problems, comprehension aphasia, extreme fatigue or dizziness, and other practical problems (e.g., patients went to the hospital without bringing their prescription glasses, or interruptions from medical staff or families, timing issues, etc.). Importantly, more patients completed the first tasks than the last ones, mainly because the first tasks have easier instructions, they do not need a motor response, and patients were less tired. In fact, we did not calculate sensitivity and specificity for OCS-Pt, because our patients were not assessed with the same neuropsychology tests as our healthy subjects, as they were too weak to be involved in a long neuropsychology assessment.

Recently, the OCS-NL study showed that age has a considerable effect on test performance, but the level of education has a small effect. They found that healthy participants with 6 years of formal education are highly accurate in the OCS test [21]. However, in Portugal, there is a high rate of population with less than 5 years of education, especially among older people. These differences between Portugal and other European versions of OCS might explain smaller cut-offs in the OCS test (especially in Broken Hearts). We recognized that would be good to obtain cut-offs for the different levels of age and education, but similarly to the original study, our current sample does not allow for this stratification. In addition, OCS was designed to be a first-line screening test, complicated cut-off score tables would make for a more complex process in determining impairment on a busy stroke ward. Instead, we chose to keep overall group-based norms to detect these first impairments and balance specificity with sensitivity. At the same time, we recognize the potential cost of sensitivity for higher educated participants where the cut-off may be too low. Thus, we recommend a more detailed assessment to follow on from this initial cognitive screen.

Our data show that OCS-Pt can differentiate between disorders in different domains and for discriminating between impaired and preserved functions. We calculated the efficiency of OCS-Pt by calculating the incidence of deficits in our acute stroke patients. In fact, we found that 23.6% of patients presented apraxia, 43% presented attentional deficits, and 34.7% presented number writing problems — none of these abilities are assessed by other brief screening tests developed for dementia. Furthermore, we measured the number of tasks impaired in our acute sample. This analysis showed that the OCS allows for the detection of acute deficits in one or two tasks, in the context of other spared functions. Notably, we found dissociations in many tasks of our acute sample, showing that tasks that assess different domains were differently impaired in the same patients. For instance, patients with spoken output problems presented difficulties in Picture Naming, but they were still above the cut-off in the Calculation task — OCS-Pt was able to assess the number domain (i.e., calculus and writing) in patients with language problems (e.g., 27.4% presented problems naming pictures but were able to calculate). Overall, these findings show that OCS-Pt is aphasia friendly and allows for the assessment of other cognitive domains independently of spoken output problems.

To sum up, we suggest that OCS should be applied to all acute stroke patients to assess cognitive deficits, because it is very inclusive and minimizes the confounds (as aphasia and neglect). This is also in line with recent European Stroke guidelines, which called for domain-specific cognitive screening [33]. Moreover, patients can be assessed immediately after a stroke episode and just before being discharged in order to document any improvement or worsening in any of the cognitive domains. Knowing these cognitive impairments earlier on contributes to improving the rehabilitation success on the specific affected domains. Finally, the OCS detects cognitive deficits frequently associated with stroke that are not measured by other screening tools such as the MMSE and MoCA.

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Declarations

Ethical approval The study was approved by the Ethics and Deontological Research Committee by the Faculty of Psychology and Educational Sciences of the University of Coimbra.

Competing interests The authors declare no competing interests.

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