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FEATURE ARTICLE

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The Oxford Cognitive Screen for use with Australian people after stroke (OCS-AU): The adaptation process and determining cut scores for cognitive impairment using a cross-sectional normative study

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Abstract

Introduction: Two parallel versions (A and B) of the Oxford Cognitive Screen (OCS) were developed in the United Kingdom (UK) as a stroke-specific screen of five key cognitive domains commonly affected post-stroke. We aimed to develop the Australian versions A and B (OCS-AU), including Australian cut-scores indicative of impairment. We hypothesised there to be no difference in performance between the UK and Australian normative data cohorts.

Methods: Our multidisciplinary expert panel used the UK pre-defined process to develop the OCS-AU versions A and B. We then conducted a cross-sectional normative study. We purposively recruited community-dwelling, Australian-born, and educated adults; with no known cognitive impairment;

Colette Sanctuary and Luisa Hewitt contributed equally to this paper.

representative of age, sex, education level, and living location; at seven sites (four metropolitan, three regional) across four Australian states. Participants completed one or both OCS-AU versions in a randomised order. Australian cohorts were compared with the corresponding UK cohorts for demographics using Pearson's chi-squared test for sex and education, and Welch two-sample *t* test for age. For the cut-scores indicating cognitive impairment, the fifth (95th) percentiles and group mean performance score for each scored item were compared using Welch two-sample *t* tests. The pre-defined criteria for retaining OCS cut-scores had no statistically significant difference in either percentile or group mean scores for each scored item.

Results: Participants ($n = 83$) were recruited: fifty-eight completed version A [age (years) mean = 61,SD = 15; 62% female], 60 completed version B [age (years) mean = 62,SD = 13, 53% female], and 35 completed both [age (years) mean = 64,SD = 11, 54% female]. Education was different between the cohorts for version B (12 years, $p = 0.002$). Cut-scores for all 16 scored items for the OCS-AU version B and 15/16 for version A met our pre-defined criteria for retaining the OCS cut scores.

Conclusions: The OCS-AU provides clinicians with an Australian-specific, first-line cognitive screening tool for people after stroke. Early screening can guide treatment and management.

KEYWORDS
Australia, cognition, diagnosis, screening, Stroke

1 | INTRODUCTION

Cognitive impairment affects up to three quarters of stroke survivors and has early and long lasting impact on return to daily living including work, quality of life, and independence (Stolwyk et al., 2021). Cognitive impairment is associated with increased length of hospital stay and increased long-term rehabilitation needs (Valera-Gran et al., 2019). It also has an impact on the amount of support required from family members and carers (Mancuso et al., 2016). Identifying and managing cognitive deficits has been highlighted as a common unmet need for community-dwelling stroke survivors (Andrew et al., 2014).

To improve early detection of cognitive impairment, Australian stroke guidelines recommendations are that all stroke survivors should be screened by a trained person (e.g., neuropsychologist, occupational therapist, or speech pathologist) using a validated and reliable screening tool, ideally prior to discharge from hospital (Stroke Foundation, 2020). A full assessment of cognition should follow if deficits are identified on a cognitive screen. Tools widely used in Australia for screening post-stroke cognition are not stroke specific. For example, the Montreal Cognitive Assessment (MoCA) (Nasreddine et al., 2005) was originally developed for screening mild cognitive impairment and the Mini-Mental State Examination (MMSE) (Folstein et al., 1975) is used for dementia screening. These screens provide a single overall score that is often interpreted as a pass/fail result. They do not provide information about performance for single

Key Points for Occupational Therapy

- Early identification of spared and impaired cognition informs allied health, nurses, doctors, stroke survivors, and carers regarding rehabilitation and recovery.
- Screening cognition is a key role for Occupational Therapists, Speech Pathologists, and Neuropsychologists.
- The OCS-AU provides clinicians with a first-line, Australian, and stroke-specific screening tool.

cognitive domains (Robotham et al., 2020), which can limit their use in treatment planning and rehabilitation post-stroke. The MoCA and MMSE have low sensitivity for evaluating cognitive domains commonly affected after stroke, such as acalculia, apraxia, and hemispatial neglect (Demeyere et al., 2016). They also assume intact language and visuospatial function. Stroke survivors with aphasia or neglect may not be able to complete these screening tools, which may underestimate the prevalence of post-stroke cognitive impairment (Demeyere et al., 2016; Mancuso et al., 2018).

Considering this context, Demeyere et al. (2015) developed a stroke-specific screening tool, the Oxford Cognitive Screen (OCS), which consists of two parallel versions (A and B) for test–retest. The OCS examines five key cognitive domains commonly affected post-stroke: Language, attention and executive function, number processing, praxis, and memory (Demeyere et al., 2015). It includes 10 brief subtests, with 16 scored items. Each subtest component is scored separately, and there is no overall total score. The 16 scored items have a cut score derived from normative data that indicates potential cognitive impairment. The subtest components are designed to be inclusive for patients with aphasia and neglect and can be completed using one hand (Demeyere et al., 2015). The OCS has been demonstrated to be more sensitive than the MoCA in detecting post-stroke cognitive impairment (87% vs. 78% sensitivity) (Demeyere et al., 2016). In a study comparing the OCS and MMSE, of the 208 stroke survivors with a non-pathological MMSE performance (score of at least 22/30 for an Italian elderly population), 180 showed impaired performance in at least one domain of the OCS (Mancuso et al., 2018).

The OCS authors recommend that adaptations and translations of the OCS are only appropriate for administration in the country for which they were developed (Clinical Outcomes-Oxford University Innovation, 2018). For the OCS to be used in a new target country, the existing version of the OCS should be reviewed, and then linguistically and culturally validated for that country. Data should then be collected from a normative sample in a relevant (educational, age-matched) cohort to ensure country-specific cut scores for impairment are provide (Clinical Outcomes-Oxford University Innovation, 2018). To date, the UK OCS team have approved eight versions of the OCS that have been adapted, and cut scores determined for languages and cultural contexts other than "British English" (Hong et al., 2018; Huygelier et al., 2019; Kong et al., 2016; Mancuso et al., 2016; Ramos et al., 2018; Robotham et al., 2020; Shendyapina et al., 2019; Valera-Gran et al., 2019). There is currently no Australian version of the OCS, with established Australian cut scores.

In this study, we aimed to do the following:

1. develop versions A and B of the OCS that are culturally appropriate for Australia (OCS-AU), and
2. determine cut scores for the Australian population that indicate reduced cognition for each scored item for versions A and B of the newly developed OCS-AU. We hypothesised that the Australian cohort would perform similarly to the corresponding UK cohort.

2 | METHODS

2.1 | Study design

This research was conducted in two Phases (1 and 2) to address the two study aims. We adhered to the pre-defined Oxford Cognitive Screen Translation and Linguistic Validation Process (Clinical Outcomes-Oxford University Innovation, 2018). As the Australian version is in English, the five steps regarding language translation were not required. Two cohorts of participants were included: one in Phase 1 for pilot testing the newly developed OCS-AU, and one in Phase 2, a cross-sectional normative data study to determine Australian cut-scores for impairment. This study was approved by the Hunter New England Human Research Ethics Committee (2020/ETH02009).

2.2 | Phase 1: Adapting the OCS for Australia

2.2.1 | Developing the adaptation

Our Australian stroke expert team partnered with the UK OCS team (including author ND) to develop versions A and B of the OCS-AU. The Australian team consisted of four clinical neuropsychologists (including authors RS, KK, AS), an occupational therapist (author CS), a speech pathologist (author LH), a physiotherapist (author DM), a rehabilitation physician, a linguist and an Aboriginal person working in the health system.

Each member of the Australian team was provided with the OCS testing material and the OCS concept elaboration document, which were supplied by the UK team. The Australian team members, either individually or in pairs, used the elaboration document template to review each stimuli/task, and the accompanying instructions to identify if culturally relevant adaptations where required. To inform the process, a linguist was consulted to compare the British and Australian language used in the tasks.

The Australian team reviewed all suggested changes to reach a consensus, and the final alterations were

made in consultation with the UK OCS team. The UK team then produced drawings of the new stimuli in the same style as the original OCS (greyscale hand-drawn).

2.2.2 | Pilot testing the adaptation

The new OSC-AU was then pilot tested for readability and understanding.

Participants

Five Australian-born participants, aged 18 years or older, with no known or self-reported diagnosis of neurological condition or history of mental health issues, and who were able to provide consent were included (Clinical Outcomes-Oxford University Innovation, 2018). Participants were recruited through personal networks. They were selected to ensure a mix of sex, and a range of age and educational attainment level. Participant recruitment and data collection occurred from 01/10/2020 to 28/10/2020.

Data collection

Each participant attended a face-to-face interview with a member of the research team (authors CS and LH). At the interview participants:

- Completed versions A and B of the OCS-AU
- Provided feedback on the OCS-AU response options, including identifying any wording or instructions that were not clear, or were difficult to understand. If issues were identified participants were asked to suggest alternatives.
- Reviewed the four sentences of the reading task, Australian and UK options for versions A and B, then rank them from most preferred (score = 1) to least preferred (score = 4)

The researchers summarised the participants' responses in a pilot testing report.

2.2.3 | Finalising the adaptation

The Australian and UK OCS teams reviewed the pilot testing report, including the scores for the alternative sentences for the reading task, and then finalised the adaptation. The formatted adaptation then underwent two sets of proofreading by a member from each of the Australian and UK teams. The final version of the OCS-AU was then approved and licence agreements completed with Oxford University Innovations.

2.3 | Phase 2: Cross-sectional normative data study

In this phase, we derived Australian normative data to determine the cut scores for the OCS-AU that indicate reduced cognition for each scored item.

2.3.1 | Setting

Data were collected at health service settings and in participants' homes.

2.3.2 | Participants

We recruited people living in four metropolitan settings (Newcastle and Sydney [New South Wales], Adelaide [South Australia], and Melbourne [Victoria]) and three regional settings (Tamworth [New South Wales], Bunbury [Western Australia], and Shepparton [Victoria]). We included community-dwelling people aged 18 years or older, born and educated in Australia, with no current or previous history of neurological disease (e.g., stroke and brain injury) or mental health illnesses likely to impact on cognitive function (e.g., major depressive illness and schizophrenia), and who were able to provide informed consent. We excluded people with significant or severe hearing and/or visual impairment (uncorrected by hearing aids/glasses, or use of a sign language interpreter), as participants were required to follow instructions from the assessor. Any potential participants scoring less than 22 on the Standardised MMSE (Molloy & Clamette, 1999) were excluded, as the score would indicate likely cognitive impairment.

2.3.3 | Sampling strategy

Participants were recruited via purposive sampling for representation across three age categories: <65 years, 65–75 years, and >75 years. For each age category, we aimed for representation across sex, educational attainment level (low [year 10 completion or less]/mid [year 11 or 12 completion, no university education]/high [completion of university education]), and living location (metropolitan/regional).

2.3.4 | Sample size

We aimed to have 60 participants complete each version of our adapted OCS tool (OCS-AU), as recommended in

the Translation and Linguistic Validation Process (Clinical Outcomes-Oxford University Innovation, 2018). To achieve these samples, we aimed to recruit 90 participants, anticipating that a proportion of the participants would volunteer to do both versions.

2.3.5 | Recruitment

Participant recruitment and data collection occurred from December 2020 to July 2021. Participants were recruited via clinical networks and by displaying posters at participating hospitals in locations that could readily be observed by staff and visitors.

Where incidental recruitment of people who identified as Aboriginal or Torres Strait Islander occurred, we used social yarning (Bessarab & Ng'andu, 2010) prior to introducing information about the study. Yarning is a cultural form of conversation used by Aboriginal or Torres Strait Islander people. Social yarning about topics of interest, including news, gossip, and using humour can build relationships and trust between the researchers and potential participants (Bessarab & Ng'andu, 2010). We encouraged site clinicians who approached these potential participants about the study to introduce them to a member of the research team in person before the project was discussed. Aboriginal and Torres Strait Islander people were invited to have a support person of their choice with them for all conversations and appointments with the research team.

2.3.6 | Procedure

Assessments were conducted by experienced stroke clinicians who had been trained in administering the OCS-AU according to the standardised instructions in the Australian version of the OCS User Manual (Demeyere & Clinical Outcomes Team, 2015). Participants had the choice of completing one or two versions of the OCS-AU. At the first assessment, we collected demographic information. Participants completed the Standardised MMSE (Molloy & Clamette, 1999) to identify any undetected cognitive impairments and then completed the OCS-AU. The alternate OCS-AU version was administered at the second appointment for participants who consented to complete both tests. The second appointment was at least 2 weeks after the first, to allow for a testing washout period, as recommended for test–retest in the OCS User Manual (Demeyere & Clinical Outcomes Team, 2015). The version of the OCS-AU completed first by each participant at each site was determined using a site-specific, 2-block randomisation schedule, stratified by the three age categories. The schedule for each site was generated by a member of the research team not involved in recruitment or data collection, using a freely available online tool (Sealed Envelope Ltd. 2020 https://www.sealedenvelope.com/simple-randomiser/v1/lists).

2.3.7 | Outcome measures

Demographic data

Participants' age, sex, level of education, place of residence (metropolitan/regional), whether the participant identified as Aboriginal or Torres Strait Islander, and Standardised MMSE results were collected.

OCS-AU cut score data

The 10 subtests, with 16 scored items, were scored as per the OCS-AU version of the User Manual (Demeyere & Clinical Outcomes Team, 2015). The 10 subtests are picture naming, semantics, orientation, visual field assessment, sentence reading, numerical cognition (number writing and calculation), attention (broken hearts), praxis (imitation), memory recall and recognition (verbal memory and episodic memory), and executive test (task switching).

2.3.8 | Data analysis

Demographic data for the cohorts who completed versions A and B of the OCS-AU and the cohort that completed both versions were summarised using descriptive statistics. The Australian cohorts for versions A and B were then compared with the corresponding UK cohorts (Demeyere et al., 2015) using Pearson's chi-squared test for sex and education comparisons and Welch two-sample *t* test for age comparisons.

OCS-AU cut score indicating cognitive impairment

We hypothesised that the Australian cohorts would perform similarly to the corresponding UK cohorts. Our predefined criteria for retaining OCS cut-scores had no statistically significant difference between each OCS-AU and OCS scored items in either:

1. The fifth (95th) centile score based on the uncorrected sample score distributions (Clinical Outcomes-Oxford University Innovation, 2018) or
2. The group mean performance score

If an OCS-AU scored item did not meet either criteria we undertook a narrative analysis to determine what cut score to use. The fifth (95th) percentiles and group mean performance score for each scored item subtest were compared for the OCS and OCS-AU using Welch two-

sample t tests. Significance was set at $p < 0.05$ two-tailed for all score items.

All statistical analysis and data sorting were computed in R studio (R Core Team, 2021). For analysis, we used *readxl* version 1.3.1 (Wickham & Bryan, 2019) and *effsize* version 0.8.1 (Torchiano, 2020).

3 | RESULTS

3.1 | Phase 1

The consensus recommendations for the changes to the OCS for the OCS-AU task stimuli and instructions are shown in the Supporting Information. Of the 10 tasks, changes were made to six of the task stimuli for version A, to three stimuli for version B, and to two of the task instructions.

These recommendations considered the feedback from the five participants who undertook the pilot testing. The demographics of these participants were as follows:

- Female = 3, Male = 2,
- Age: median = 51 years, range = 42 to 76 years,
- Education level: low (year 10 completion or less) = 3; high (completion of university education) = 2;
- Living location: metropolitan = 5.

Australian versions of the two sentences for the reading task were designed to be culturally suitable for Australian participants. We followed the design principles of the original English sentences, including number of words, irregular words, and words with high neighbourhood frequencies. The two Australian sentences were preferred by the five participants and were ranked higher when compared with the OCS sentences. The order of preference (indicated by the test version and associated irregular words, lower scores = higher preference; lowest possible score = 5, highest = 20) was as follows:

- OCS AU version A (kneading, dough, chef, flour) = 8
- OCS-AU version B (chauffeur, island, choir, queue) = 11
- OCS version A (island, quay, colonel, yacht) = 16
- OCS version B (aunt, mauve, brooch, trough) = 17

3.2 | Phase 2

Eighty-three participants were recruited for normative data collection, with 35 participants performing both tests. The demographics for the cohorts who completed version A or B of the OCS-AU and the cohort that completed both versions are shown in Table 1. The comparison of age, sex, and education levels for versions A and B of the OCS and OCS-AU cohorts are shown in Table 2. Education level for version B was the only statistically significant different variable between the cohorts (12 years, $p = 0.002$), where the United Kingdom had greater levels of higher education. Given A and B are parallel versions, we did not expect a difference in the normative performance between A and B. If a difference was found, we planned to control for educational level as a potential confound. If not, it would suggest this statistical difference is not likely meaningful.

The centile scores and group mean comparisons for each task for the OCS-AU and OCS cohorts are shown in Table 3 (version A) and Table 4 (version B). All 16 scored items for the OCS-AU version B and 15/16 for version A met our criteria for retaining the OCS cut scores: There was no statistically significant difference for the fifth (95th) centile scores or the group means. The version A Praxis task did not meet either pre-specified criteria. When rounding the group means to whole numbers, both scored 11. It was decided to keep this OCS-AU cut score the same as the OCS as a more lenient cut-off. This should ensure clinicians do not inadvertently class people as impaired who may have motor and movement difficulties related to their stroke, or other comorbid conditions such as arthritis. In addition, given the relatively small normative sample here, with a relatively younger age distribution than the stroke population, it was determined that there was insufficient evidence to set a separate cut score.

4 | DISCUSSION

The OCS-AU provides clinicians with an Australian, stroke-specific cognitive screening tool. The OCS-AU adaptation of the OCS was conducted as per the predefined Oxford Cognitive Screen Translation and Linguistic Validation Process (Clinical Outcomes-Oxford University Innovation, 2018). This study has taken the important step of adapting the OCS and providing normative data for scoring the OCS-AU for an Australian population. Relevant cultural changes and adaptations were made to several of the stimuli and instructions for versions A and B. Cut scores for the OCS-AU remained the same as the OCS.

The OCS-AU is the first English adaptation of the OCS. The adaptation was required as Australian English is recognised as a distinct dialect of English, with its own lexical, morphosyntactic, phonological, and phonetic features (Przewozny & Viollain, 2016). While the majority of OCS-AU stimuli and instructions remained the same as the OCS, minor cultural adaptations were required.

While it is not surprising OCS translations to another language have adopted culturally appropriate sentence

TABLE 1 Demographics of participants who completed version A and B and both versions of the OCS-AU for normative data to determine OCS-AU cut point scores

Demographic	Version A $n = 58$	Version B $n = 60$	Both versions $n = 35$
Age			
Mean (years)	61	62	64
SD (years)	15	13	11
Age group [n (%)]			
<65 years	32 (55)	32 (53)	17 (49)
65–75 years	14 (24)	18 (30)	11 (31)
>75 years	12 (21)	10 (17)	7 (20)
Sex [*n* (%)]			
Female	36 (62)	32 (53)	19 (54)
Male	22 (38)	28 (47)	16 (27)
Non-binary	0 (0)	0 (0)	0 (0)
Prefer not to answer	0 (0)	0 (0)	0 (0)
Identify as Aboriginal or Torres Strait Islander [n (%)]			
Aboriginal	0 (0)	1 (2)	0 (0)
Torres Strait Islander	0 (0)	0 (0)	0 (0)
Both	1 (2)	1 (2)	1 (3)
Neither	57 (98)	58 (97)	34 (97)
Living location [*n* (%)]			
Metropolitan	37 (64)	38 (63)	25 (71)
Regional	21 (36)	22 (37)	10 (29)
Education level [*n* (%)]			
Year 10 (or equivalent) or less	13 (22)	18 (30)	10 (29)
Year 11–12 (or equivalent) or other vocational certificate eg TAFE	22 (40)	19 (63)	13 (37)
University or higher	23 (40)	23 (38)	12 (34)
Standardised mini-mental state examination (score out of 30)			
Mean	29.36	29.20	29.34
SD	1.09	1.36	1.16

TABLE 2 Demographic comparisons of the OCS-AU and UK OCS normative data cohorts for versions A and B using Pearson's chi-squared test (sex and education) and Welch two-sample *t* test (age)

Demographic	Test statistic	*df*	*p*
Version A			
Sex	$x^2 = 1.65$	1	0.20
Education	$x^2 = 4.5$	2	0.11
Age	$t = 1.33$	73.28	0.19
Version B			
Sex	$x^2 = 0.23$	1	0.63
Education	$x^2 = 12.30$	2	0.002
Age	$t = -0.08$	97.85	0.93

reading tasks (Hong et al., 2018; Huygelier et al., 2019; Mancuso et al., 2016; Robotham et al., 2020), we also changed the sentences for versions A and B. The Australian adaptation team members agreed that the sentences were not culturally suitable, with some of the irregular words too unfamiliar or difficult for Australian stroke survivors. We developed the Australian versions of the sentences, following the design and syntactical principles prescribed for OCS adaptations: 15 words long, and containing four irregular words and four high frequency neighbourhood words. These two sentences were preferred by the pilot testing participants. We also made the relevant changes for the subsequent Task 9 - Memory recall and recognition, which relies on the sentence reading task.

TABLE 3 Comparison between each scored item for each subtest on the OCS and OCS-AU, version A: OCS-AU 5th (95th) centile score v OCS cut score, and OCS-AU and OCS mean scores for group

Subtest order and name/[maximum (or optimal) score]	Measure	UK OCS mean	UK OCS median	UK OCS 5th centile	UK OCS 95th centile	OCS-AU mean	OCS-AU median	OCS-AU 5th centile	OCS-AU 95th centile	Cohens *d*	Consensus OCS-AU cut score
Version A											
1. Picture naming (max = 4)	Overall accuracy	3.35	4	3		3.93	4	3		−0.93*	Less than 3
2. Semantics (max = 4)	Overall accuracy	2.52	3	3		3.00	3	3		−1.11*	Less than 3
3. Orientation (max = 4)	Overall accuracy	3.48	4	4		4.00	4	4		−1.17*	Less than 4
4. Visual field assessment (max = 4)	Overall accuracy	3.98	4	4		4.00	4	4		−0.09	Less than 4
5. Sentence reading (max = 15)	Overall accuracy	14.76	15	14		14.91	15	15		−0.15	Less than 14
6. Numerical recognition											
Number writing (max = 3)	Overall accuracy	2.94	3	3		2.97	3	3		−0.12	Less than 3
Calculation (max = 4)	Overall accuracy	3.88	4	3		3.95	4	4		−0.17	Less than 3
7. Attention (broken hearts) (max = 50)	Overall accuracy	47.13	48	42		47.50	49	43		−0.12	Less than 42
Left neglect	Object asymmetry (left inattention > 0, right <0)	0.02	0	0[a]	0[a]	0.00	0	0	0	0.05	**More than 1**
Right neglect											Less than −1
Left neglect	Space asymmetry (left inattention > 0, right <0)	−0.13	0	−2	3[b]	0.03	0	−2	3	−0.12	**More than 3**
Right neglect											Less than −2
8. Praxis (imitation) (max = 12)	Overall accuracy	10.68	11	8		11.29	12	9		−0.36^	Less than 8
9.Memory: Recall and recognition											
Verbal memory (max = 4)	Verbal memory recall and recognition	3.91	4	4	3	3.79	4	3		0.32	Less than 3

(Continues)

TABLE 3 (Continued)

Subtest order and name/[maximum (or optimal) score]	Measure	UK OCS mean	UK OCS median	UK OCS 5th centile	UK OCS 95th centile	OCS-AU mean	OCS-AU median	OCS-AU 5th centile	OCS-AU 95th centile	Cohens *d*	Consensus OCS-AU cut score
Episodic memory (max = 4)	Episodic recognition	3.85	4	4	3	3.76	4	3		0.21	Less than 3
10. Executive test: task switching (optimal = −1)	Executive score accuracy (sum of single tasks minus mixed task)	−0.24	0		4	−0.36	−1	−2	5	0.06	**More than 4**

Notes: UK OCS cohort data from Demeyere et al., 2015. Mean differences comparisons were conducted using Welch two-sample *t* tests; statistically significant difference based on criteria of $p < 0.5$: actual *p* value:
*$p < 0.001$, ^$p < 0.01$.
[a]For a more conservative approach: use cut off of 1 (Demeyere et al., 2015).
[b]For a more consistent approach: use cut off of absolute value >2 (Demeyere et al., 2015).

Substitutions were made to two drawings in the picture naming task in version A. The hippopotamus was substituted with a giraffe, to minimise the risk of semantic errors. Both animals met the OCS concept elaboration document criteria; large, herbivorous mammal found in sub-Saharan Africa that are wild animals that live in groups, and the pictures should be mildly challenging to the stroke survivor; therefore, the animals and objects should not be particularly common. Clinicians in our team who administer the MOCA and the OCS with people after stroke reported that sometimes the rhinoceros in the MOCA is named as hippopotamus, and the hippopotamus in the OCS as rhinoceros. Armstrong et al. (2013) also identified that clinically “hippo” was a common response to the rhinoceros MOCA item for people with Parkinson’s disease. They conducted a study in people with Parkinson’s disease without dementia and identified 23% (27/119) named the rhinoceros as a “hippo” or “hippopotamus” (Armstrong et al., 2013). In order to future-proof the OCS-AU, we substituted the drawing of a filing cabinet with a chest of drawers. Younger people may not recognise this once-familiar office item.

From our normative data study, cut scores for the OCS-AU scored items remained the same as the OCS. This is in keeping with previous findings of considerable consistency of OCS cut scores from normative studies for versions of the OCS from six countries (Huygelier et al., 2019). Some OCS adaptations have demonstrated age- and education-related group differences for several cognitive tasks, and the authors of these studies established different cut scores for these tasks (Huygelier et al., 2019; Kong et al., 2016; Mancuso et al., 2016).

4.1 | Study limitations

There may be limitations with the generalisability of the OCS-AU for Australian populations. The OCS-AU may not be culturally appropriate for Aboriginal and Torres Strait Islander people, or people from culturally and linguistically diverse backgrounds. An Aboriginal member of the team applied an Aboriginal cultural lens to the adaptation. Aboriginal and Torres Strait Islander people represent approximately 3% of the Australian population (Australian Bureau of Statistics, 2022b) and 4% of participants in the normative study identified as Aboriginal or Torres Strait Islander. However, this does not ensure the OCS-AU is suitable for all First Nations people. There are over 250 different and distinct Aboriginal and Torres Strait Islander nations, each with their own culture, customs, language, and laws (Victorian Aboriginal Child Care Agency et al., 2022). Our inclusion criteria for participants were that they needed to be born and educated

TABLE 4 Comparison between each scored item for each subtest on the OCS and OCS-AU, version B: OCS-AU 5th (95th) centile score v OCS cut score, and OCS-AU and OCS mean scores for group

Subtest order and name/[maximum (or optimal) score]	Measure	UK OCS mean	UK OCS median	UK OCS 5th centile	UK OCS 95th centile	OCS-AU mean	OCS-AU median	OCS-AU 5th centile	OCS-AU 95th centile	Cohens *d*	Consensus OCS-AU cut score
Version B											
1. Picture naming (max = 4)	Overall accuracy	3.35	4	3		3.97	4	4		−1.00*	Less than 3
2. Semantics (max = 4)	Overall accuracy	2.52	3	3		3.00	3	3		−1.11*	Less than 3
3. Orientation (max = 4)	Overall accuracy	3.48	4	4		3.98	4	4		−1.12*	Less than 4
4. Visual field assessment (max = 4)	Overall accuracy	3.98	4	4		4.00	4	4		−0.09	Less than 4
5. Sentence reading (max = 15)	Overall accuracy	14.76	15	14		14.90	15	14		−0.14	Less than 14
6. Numerical recognition											
Number writing (max = 3)	Overall accuracy	2.94	3	3		2.98	3	3		−0.21	Less than 3
Calculation (max = 4)	Overall accuracy	3.88	4	3		3.85	4	3		0.07	Less than 3
7. Attention (broken hearts) (max = 50)	Overall accuracy	47.13	48	42		47.48	48	42		−0.12	Less than 42
Left neglect Right neglect	Object asymmetry (left inattention > 0, right <0)	0.02	0	0[a]	0[a]	−0.10	0	−2	1	0.25	**More than 1** Less than −1
Left neglect Right neglect	Space asymmetry (left inattention > 0, right <0)	−0.13	0	−2	3[b]	0.03	0	−2	2	−0.12	**More than 3** Less than −2
8. Praxis (imitation) (max = 12)	Overall accuracy	10.68	11	8		11.28	12	8		−0.35^	Less than 8
9. Memory: Recall and recognition											
Verbal memory (max = 4)	Verbal memory recall and recognition	3.91	4	4	3	3.77	4	2		0.32	Less than 3

(Continues)

TABLE 4 (Continued)

Subtest order and name/[maximum (or optimal) score]	Measure	UK OCS mean	UK OCS median	UK OCS 5th centile	UK OCS 95th centile	OCS-AU mean	OCS-AU median	OCS-AU 5th centile	OCS-AU 95th centile	Cohens *d*	Consensus OCS-AU cut score
Episodic memory (max = 4)	Episodic recognition	3.85	4	4	3	3.88	4	3		−0.07	Less than 3
10. Executive test: task switching (optimal = −1)	Executive score accuracy (sum of single tasks minus mixed task)	−0.24	0		4	−0.22	−1	−2	6	−0.01	**More than 4**

Notes: UK OCS cohort data from Demeyere et al., 2015. Mean differences comparisons were conducted using Welch two-sample *t* tests; statistically significant difference based on criteria of $p < 0.5$: actual *p* value:
*$p < 0.001$, ^$p < 0.01$.
[a]For a more conservative approach: use cut off of 1(Demeyere et al., 2015).
[b]For a more consistent approach: use cut off of absolute value >2 (Demeyere et al., 2015).

in Australia. Australia has a large (30%) multicultural immigrant population (Australian Bureau of Statistics, 2022a). For Aboriginal and Torres Strait Islander people, and for people from culturally and linguistically diverse backgrounds, clinicians may need to consult local Elders and Community on the suitability of the OCS-AU for their people, and on how to determine if the OCS-AU is suitable for an individual stroke survivor.

There are some limitations due to the age representativeness of our normative data cohorts. Our cohorts had a relatively younger age distribution than the Australian stroke population. In Australia, 71% of people who have a stroke are aged over 65 years (Australian Institute of Health and Welfare, 2021); however, only 45% (version A) and 47% (version B) of our cohorts were aged over 65 years. Our cohorts were similar in age to those used for the OCS (Demeyere et al., 2015) and other OCS adaptations (Huygelier et al., 2019; Ramos et al., 2018; Shendyapina et al., 2019). Our version A cohort was two participants short of the recommended minimum of 60 (Clinical Outcomes-Oxford University Innovation, 2018). Recruitment and data collection occurred during COVID-19 pandemic, including during periods of lock down, and before adults could receive multiple COVID-19 vaccinations. This made recruitment challenging particularly for older Australians, who minimised their contact with others during this time.

5 | CONCLUSION

This study has important implications for clinical practice and for future research. The resulting OCS-AU provides the stroke community in Australia with a first-line cognitive screening tool study, specifically designed for use in a stroke population. Clinicians using the OCS-AU can identify if key cognitive domains affected post-stroke are spared or impaired. Accurate early identification of stroke deficits will empower clinicians to adapt their treatment and management of stroke survivors and as a result improve patient care and outcomes. Domain-specific cognitive screening for people after stroke aligns with best practice recommendations from the Australian stroke guidelines (Stroke Foundation, 2020). Future research may include determining if the OCS-AU is culturally appropriate for Aboriginal and Torres Strait Islander people, and for people from culturally and linguistically diverse backgrounds. If so, cut points for scoring from a normative cohort will need to be established. The sensitivity and specificity of the OCS-AU to distinguish between stroke survivors with cognitive impairment and those without based on gold standard neuropsychological cognitive assessments should also be examined.

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AUTHOR CONTRIBUTIONS

Colette Sanctuary and Luisa Hewitt (co-first authors)- Conceptualisation (co-lead), methodology (co-lead), data curation (co-lead), investigation (co-lead), project administration (co-lead), formal analysis (co-lead), writing – original draft preparation (co-lead), writing – review & editing (equal). Nele Demeyere- Methodology (equal), resources (lead), formal analysis (equal), writing – review & editing (equal). Kirsti Kankkunen - Methodology (equal), investigation (supporting), formal analysis (equal), writing – review & editing (equal). Vincent Oxenham- Investigation (supporting), formal analysis (supporting), writing – review & editing (equal). Dawn Simpson- Conceptualisation (co-lead), methodology (equal), writing – review & editing (equal). Rene Stolwyk- Methodology (equal), investigation (supporting), writing – review & editing (equal). Artemis Synn- Methodology (equal), investigation (equal), formal analysis (equal), writing – review & editing (equal). Sam Webb- Data curation (co-lead), formal analysis (equal), writing – review & editing (supporting). Di Marsden- Conceptualisation (co-lead), methodology (co-lead), formal analysis (co-lead), project administration (equal), supervision (lead), writing – original draft preparation (co-lead), writing – review & editing (lead).

CONFLICTS OF INTEREST

Nele Demeyere developed and authored the Oxford Cognitive Screen. The other authors have no conflict of interest to declare.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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