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Long Cognitive Dementia Screening Methods

Dementia Screening Battery-100 (DSB-100)

As discussed by (Bellaj et al., 2017), the DSB-100 covers 10 subtests, which evaluate memory, executive functions, apraxia, attention, language, and visuospatial functions. The approximated time taken to administer and to complete the test is 15-20 minutes on average. The subtests include Forward Names Span, Backward Names Span, Recall, Recognition, Verbal Fluency, Comprehension, Naming, Cognitive Estimation, Line-Object Orientation Judgment, Constructive Praxia.

There are two objectives of the study (i) to tackle the shortcomings of the previous screening instruments (Mattis, MMSE, MoCA, or 3MS) by integrating more accurate assessments of long-term, short-term and working memory, contextualized assessment of visuospatial functions, executive functions assessment and the admission of the less culturally biased procedures. (ii) To assess the sociodemographic variables such as sex, age, and education on the battery scores and examine the instrument's psychometric properties.

The rationale in constructing this screening test was motivated by two main reasons (i) Pursue to address the fundamental issues when using existing dementia screening tools (ii) Link the gap between fast evolving knowledge in the field of dementia and the validity of the dementia screening tools.

Comprehension Task

Token Test

Primarily developed to identify mild receptive language disorders in aphasic patients.
Contains 10 subtests for auditory processing complications inline to brain trauma, aphasia, and language or learning disabilities. The directions in the token tests are autonomous of repetitions in an unrestrained situation. The reference for all the commands to shapes, colours and sizes comprises of nonredundant words. For a marked action the objects don't give out a signal. To achieve the required action every content of the word must be understood. The original test includes 61 commands and subsequently a shorter version was developed as it was frequently utilised in clinical practice. The short version of the token test was developed by De Renzi & Faglioni in 1987 and suggested that this questionnaire as the standard test for diagnostic purpose (De Renzi & L.A., 1963)

Visuospatial capacity

Judgement of Line Orientation (JLO)

According to (Spencer et al., 2013), this test measures the correspondent's ability to pair the angle and orientation of lines in space. The test is including 30 items, but shorter versions have also been produced. The standardised test is aligned to evaluate the visuospatial skills

with the operation of the parietal lobe located in the right hemisphere of the brain. The outcome of the test for individuals with potential dementia are poor including respondents with Parkinson's disease because of task difficulty and not due to visuospatial discrepancies.

Verbal and Pictorial Stimuli

Battig and Montagues's verbal categorical database

Category standards for verbal items in 56 categories. A citation research accomplished in 2002 discovered that Battig and Montague standards were quoted over 16000 in papers published on over 220 distinctive journals which denotes the wide-spread recognition source of category standard data. A dataset was published by ('Battig function | R Documentation', n.d.) is available which comprises of 5231 words listed in 56 taxonomic categories by people who were asked to provide samples of a given category (e.g. a precious stone, unit of time, etc.). Respondents have 30 seconds to generate as many responses to each category after which the next category name was presented. An expanded and improved version was conducted by introducing 14 new categories which are sub-dived into several purpose like domain relevancy and ad-hoc. Also, response latency was also collected as a criterion where researchers can select and differentiate items (Van Overschelde, Rawson, & Dunlosky, 2004).

Snodgrass and Vanderwarts's pictorial database

As stated by (Snodgrass & Vanderwart, 1980), the pictorial database embodies 260 standardise pictures for utilisation in experiments concerning the investigation of discrepancies and similarities in the processing of pictures and words. The representation of the images is consistently outlined derived on a set of rules to provide uniformity. The standardisation of the images was aligned on four parameters of central significance to memory and cognitive processing such as (i) name agreement, (ii) image agreement, (iii) visual complexity and (iv) familiarity. These concepts were selected to accommodate samples from multiple widely studied semantic categories.

Mattis Dementia Rating Scale 2nd Edition (MDRS-Second Edition)

As stated by (Matteau, 2011), the test contains 5 subtests (attention, initiation/preservation, construction, conceptualisation and memory) on which the subsets are presented in a chronological manner that is a correct answer to the initial subset of items allows the examiner to give credits for the subsequent items. Screening is administered around 10-15 minutes in healthy older participants and 30-45 minutes in severely impaired individuals. MDRS-2 can discriminate between Alzheimer's disease and other types of dementia such as PDD (Parkinson's disease with dementia). The approximated time to administer the test is 15-30 minutes that measures cognitive impairment. The test is sold under PAR (Psychological and assessment materials) its pricing range depends on what type (software, paper, etc) of test is purchased (Mattis, 2018)

SAGE: A Test to Detect Signs of Alzheimer's and Dementia

The Self-Administered Gerocognitive Exam (SAGE) is devised for early detection of signs of cognitive, memory, or thinking impairments. It appraises your thinking capability to help physicians determine how your brain functions. The test is a four-page test that takes around 10-15 minutes to administer but there is no time limit. A disadvantage of this test is that the results needs to be brought to a primary care physician to interpret the results thus lacking an algorithm to score the exam instantaneously ('SAGE - Memory Disorders | Ohio State Medical Center', n.d.).

Short Cognitive Dementia Screening Tests

General Practitioner Assessment of Cognition (GPCOG) Score

This tool is devised for GP (General Practitioner) screening tool for dementia. This test is comprised of two components (i) cognitive assessment directed with a patient and a questionnaire involving an informant (only if the results of the cognitive section are ambiguous, which is from 5-8). Results > 8 or < 5 on the GPCOG were assumed to be cognitively impaired or unimpaired, consequently for individuals requiring an informant questionnaire and scored 3 or less than 6 indicated cognitive impairment (Larner, 2013).

6-item Cognitive Impairment Test (6-CIT)

Developed in 1983 by Blessed Information Memory Concentration Scale (BIMC) which is useful for Dementia screening for primary care. Utilised in a large European Assessment tool (EasyCare). The screening tool is comprised of 6 questions and time taken to administer is around 4-6 minutes. Utilises inverse scoring and questions are weighted to produce a total of 28. The scores from 0-7 are considered normal and 8 is significant. The advantage of this method is it doesn't compromise specificity even the test has high sensitivity even in mild dementia its easily translated culturally and linguistically. But, one disadvantage is the scoring mechanism which is initially confusing, but computers have simplified greatly (Jefferies & Gale, 2013c).

Abbreviated Mental Test Score (AMTS)

The assessments are focused on orientation, registration, recall and concentration. Participants who falls on a score of 6 or below from a maximum of 10 have shown to screen with dementia. Its conciseness and ease of use have made it as a mainstream screening test in primary and secondary care non-specialist settings. Developed by geriatricians and best known in general hospital usage. AMTS falls short on score validation on screening populations for primary and secondary care. The validity of the data mostly correlates to MMSE (Mini Mental State Examination). The test is non-translatable, both linguistically or culturally without critique and some of the questions needs to be recalibrated to be up to date (Hodkinson, 2012).

Mini-Cog

This is a 3 minutes of short dementia screening test suitable for primary care. The test incorporates clock drawing test, three-item delayed word memory task which includes a practical scoring algorithm. It reveals high similarity of sensitivity and specificity to MMSE (Mini-Mental State Examination) in classifying dementia. The screening test was developed with regards to non-ethnicity base, non-English speakers. Mini-Cog suffice the standards for cognitive screening or exceeding the performance of the traditional methods and progressively improving in detecting natural cognitive impairment by primary doctors even dementia is in the developmental stages (Borson, et al., 2003)

Memory Impairment Screen (MIS)

A quick screening tool to assess memory to be able to evaluate an individual who exhibits some potential impairment in their capability to think and recall. It is more effective in identification of cognitive impairment and cost less than MMSE. The advantage of this screening tool is that it doesn't require individuals to write so it's a good choice if motor function is impaired. Performance of MIS show little of education level. Also, it is accurate in multi-cultural settings in different languages. A disadvantage is it can't be performed on a person who is unable to read, whether due to illiteracy or visual impairment. This test also doesn't evaluate executive functioning and visuospatial ability which is impacted by dementia.

Test Your Memory (TYM)

This screening method was developed at Addenbrooke's Hospital in Cambridge, England to by Dr. Jeremy Brown to detect early signs of Dementia and Alzheimer's Disease. The time taken to administer the test is an estimated time of 2-10 minutes, individuals with significant dementia takes longer time to administer the test. The TYM involves ten simple tasks including the ability to copy a sentence, correlation of items to each other, simplistic math and recall ability. The exam needs to be downloaded by a valid medical practitioner. TYM test are more sensitive to mild Alzheimer's disease than the conventional MMSE, and research has shown that TYM is easy to use and administer (Jefferies et al., 2013)

Standardised Mini-Mental State Examination (SMMSE)

As discussed by (IHPA, 2015), SMMSE was introduced by Marshall Folstein et al. in 1975 and is the most commonly used test to assess problems with memory and other cognitive functions. The tests assess the following areas Ii) orientation to time (ii) word registration and recall (iii) attention and calculation (iv) language abilities and (v) visuospatial abilities. Scoring ranges from 0 to 30 with scores 25 or higher is considered normal while 10-19 indicates moderate dementia. People with early detection of dementia or AD falls from 19-24. However, scores may need to be adjusted or interpreted differently to account for a person's age, education, race and ethnicity. MMSE is widely used, validated and reliable method for screening AD and dementia. SMMSE, was devised by Dr. D William Molloy and Timothy Standish in 1997 to establish a scoring instruction clear-cut guidelines for the administration of the MMSE tool to increase reliability and reduce variability. It has been spearheaded by

the IHPA (independent Hospital Pricing Authority) to purchase the intellectual property rights in Australia with the permission of Dr. William Molloy. It is now freely used for health care facilities and aged care in Australia.

Montreal Cognitive Assessment

Originally developed for MCI (Mild Cognitive Impairment) that can be administered in 10 minutes by any clinician. The test evaluates the attention/concentration, executive functions, conceptual thinking, memory, language, calculation and orientation. A score of 25 is considered showing cognitive impairment performs like MMSE that includes dementia screening. It's been widely translated as it evaluates executive functions much specifically helpful for patients with vascular impairment, including vascular dementia. The test directions is freely available at on the MoCA website and best of all no authorisation required for educational or clinical utilisation.

Functional Screening Methods

SCIDS (Short Concord Informant Dementia Scale)

SCIDS is a shorter version of CIDS (Cognitive Information Dementia Scale) which originally comprises of 31 items that addresses the major domains in CDRS (Clinical Dementia Rating Scale) which is memory, orientation, judgement and orientation, involvement in community and personal care including language. SCIDS, the shorter version covers 12 items that covers only memory and orientation. Majority of the items were taken from IQCODE. Questions are rated from a scale of 0 (no signs of changes) to 3 (much worse) (Cherbuin, et al., 2007).

IQCODE (Informant Questionnaire on Cognitive Decline in the Elderly)

According to (Jefferies et al., 2013) IQCODE evaluates two cognitive domains (i) memory function (retrieval and acquisition) and intelligence (verbal and performance. This test was formatted to be easily administered by informants and comprises 16 questions since it was discovered its high correlation of 98% with the full version of 26 items and inherits comparable validity against clinical diagnoses. This screening method is conducted with an informant and can be very useful when combined with cognitive tests like MMSE. The questions compare the state of the respondent 10 years ago from today covering various activities.

Comparative Analysis

A comparative analysis is useful to acquire a general overview of the technical specifications for the short screening tests as it will allow us to select which method would be appropriate for this project build. The aim of table 1.1 below is to display the existing instruments used to detect early dementia and to specify which cognitive domains are assessed based on an assessment standard such as DSM (Diagnostics and Statistics Manual for Mental Health Disorders). Screening methods that assess MCI (Mild Cognitive Impairment) also known as pre-dementia phase and defined within the context of a decline in cognitive ability but doesn't require help to perform the function includes MMSE, AMTS, 6-CIT, MoCA, and ACE-R. All the questions are equal and below 15 items and can be administered in a primary, secondary, care-giver, family member, and self-assessment. The cut-off scores are displayed below with respect to its sensitivity and specificity.

Screening Methods Selection

There are two screening methods synergised as an integral part of the mobile app that was deliberately selected based on the criterion that these methods were (i) widely utilised and validated by health care practitioners (ii) covers the cognitive and functional domains evaluated under DSM-IV (Diagnostics and Statistics Manual for Mental Health disorders) and CDR (Clinical Dementia Rating). The dementia screening methods were selected to evaluate both cognitive and functional domains to have a more robust screening outcome from early dementia.

6-CIT (6-Cognitive Impairment Test) according to (Jefferies et al., 2013) the assessment method selected under cognitive screening is 6-CIT which was derived from a 26 questionnaire Blessed Information Memory Concentration Scale (BIMC) as an abbreviated version. The brevity and simplicity of use for medical practitioners and patients for this test suits best with the integration to a mobile application as it's easy to use and administer which typically is completed with an average duration of 7.5 minutes. Also, this test can detect dementia in its earliest stages and is easily translatable to other languages, therefore this were the major considerations that is why we preferred it over MMSE. Nevertheless, 6-CIT possess limitations as it's insensitive to detecting MCI (Mild Cognitive Impairment) and AD (Alzheimer's Disease). The specificity and sensitivity showed noteworthy rates (Brooke et al., 1999).

SCIDS (Short Concord Informant Dementia Scale) as discussed by background (Waite et al., 2010) is the screening method chosen for the functional assessment, which evaluates the domains in the Clinical Dementia Rating (CDR), namely orientation, memory, judgement, judgement and problem solving, community involvement in home and hobbies, personal care and language. The test derived from the standardised 31-item test devised to evaluate changes on a previous five-year span. The specificity showed superior rates than IQCODE while sensitivity displayed an acceptable ratio. In addition, this screening test manifests no link with education and even a smaller fraction of relationship with the National Adult Reading Test than MMSE. Therefore, this test possesses the advantage of everyday operational functioning that offers a measurement on previous deterioration on performance and

unbiased of educational background of a respondent thus confirms the value as a screening test for dementia.

Table 1.1 Comparative table for Cognitive Screening Methods

Instrument	cognitive domains	# of questions	Time to use (min)	Gold standard	Cut-off	Sensitivity	Specificity	Administered	Reference
MMSE	orientation, attention, memory, language and visual-spatial skills, MCI	15-16	5–10	DSM-IV diagnosis	23/24	0.79	0.95	primary care	Hancock and Larner [2011]
SMMSE	orientation to time and place, short- and long-term memory, registration, recall, constructional ability, language and the ability to understand and follow commands.	12	10		24	?	?	health/aged care facilities in AU	Ihpa. [2014]
AMTS	orientation, registration, recall and concentration, MCI	10	3–4	Clinical diagnosis / MMSE	6/7 on total score	0.81	0.84	primary/secondary care non-specialist settings	Antonelli Incalze et al. [2003]
6-CIT	Memory, calculations, orientation, MCI	6	3–4	Clinical diagnosis of dementia /MMSE	7/8 on total score	0.90	1.00	primary care	Brooke and Bullock [1999]
GPCOG	time orientation, visuospatial, information, recall	11	6	DSM-IV dementia	10/11 on total score	0.82	0.83	General Practitioner / Informant	Brodaty et al. [2002]
Mini-Cog	Word registration, word recall, visuospatial (clock-drawing)	3	3	Independent clinical diagnosis of dementia	Probably normal/	0.76	0.89	Primary Care	Borson et al. [2003]
TYM	Orientation, ability to copy a sentence, semantic knowledge, calculation, verbal fluency, similarities,	10	5–10	DSM-IV dementia	30/31	0.73	0.88	can be completed under supervision of health professional	Hancock and Larner [2011]

	naming, visuospatial, recall								
MoCA	orientation, short-term memory, executive function, visuospatial, language, abstraction, animal naming, attention, clock-drawing, MCI	10	10	Clinical diagnosis of Alzheimer's disease	25/26	1.00	0.87	no special training for health professionals	Nasreddine et al. [2005]
ACE-R	orientation, attention, memory, verbal fluency, language, visuospatial, MCI	26	15–20	DSM-IV dementia	73/74	0.90	0.93	primary care/secondary care	Hancock and Larner [2011]
MSQ	orientation in time and place, remote memory, and general knowledge	11	< 5	DSM IV, CAM	5/6 on total score	0.86	0.91	Primary Care	Buschke et al. [1999]
HDS-R	dyscalculia, orientation impairments	15	5 to 10	9 dimensions including assess-ments for dyscalculia, orientation impairments, and others	20/30 on total score	0.90	0.82	hospital staff or family member	Takase et al., 2015

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