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Optimizing Cognitive Assessment: A Detailed Analysis of Leading Tools

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***Abstract*—This review paper conducts a comprehensive comparative analysis of widely used cognitive assessment tools: the Mini-Mental State Examination (MMSE), Rowland Universal Dementia Assessment Scale (RUDAS), Self-Administered Gerocognitive Examination (SAGE), Alzheimer's Disease Assessment Scale (ADAS), and Montreal Cognitive Assessment (MoCA). These assessments are crucial for identifying cognitive impairments, particularly in early-stage dementia and Alzheimer's disease.Each assessment tool evaluates various cognitive domains. MMSE assesses orientation, registration, attention, calculation, recall, and language, lacking in comprehensive evaluation of executive function and visuospatial abilities [7][8]. RUDAS examines memory, language, praxis, orientation, and visuospatial skills. SAGE ADAS targets memory, executive function, language, and orientation. MoCA comprehensively covers visuospatial abilities, executive function, naming, memory, attention, language, abstraction, and orientation. The main aim of the paper is to determine and evaluate which cognitive assessment tool is suitable for a certain domain and present detailed description of pros and drawbacks of each.**

***Keywords*—Cognitive Assessment, Alzheimer's Disease, Montreal Cognitive Assessment(MoCA)**

I. INTRODUCTION

Cognitive assessment tools play a pivotal role in identifying cognitive impairments, especially in the early stages of dementia and Alzheimer's disease [8][9][10]. This comprehensive review paper conducts an in-depth comparative analysis of four widely utilized cognitive assessment tools: the Mini Mental State Examination (MMSE), Rowland Universal Dementia Assessment Scale (RUDAS), Self-Administered Gerocognitive Examination (SAGE) , Alzheimer's Disease Assessment Scale (ADAS), and Montreal Cognitive Assessment (MoCA). The analysis covers cognitive domains, accuracy, reliability, time efficiency, age group coverage, areas of the brain targeted, self administration, and clinical results, with a specific emphasis on Alzheimer's disease detection.

The cognitive domains covered by each tool are explored, revealing the strengths and limitations of assessments in areas such as memory, language, executive function, and visuospatial skills. Accuracy and reliability assessments demonstrate variations among tools, with the MoCA standing out for its high sensitivity in detecting mild cognitive impairment.[16] Time efficiency and age group coverage analyses showcase the practicality and suitability of each tool for different clinical settings and populations. The discussion on self-administration highlights the evolving trends in test accessibility and administration methods. Furthermore, a thorough methodology section outlines the systematic approach employed for data collection and comparison, involving literature searches and inclusion/exclusion criteria.

The discussion section critically examines the Montreal Cognitive Assessment (MoCA), shedding light on its advantages and limitations. While acknowledging its wide spread use, the paper identifies challenges associated with the mandatory training requirement, potential educational biases, cultural and language issues, and limitations in tracking long term cognitive changes. [13][14] The discussion emphasizes the importance of considering specific population characteristics, such as individuals with Parkinson's disease, and underscores the need for more comprehensive neuropsychological assessments for long- term monitoring.[15] In conclusion, this review provides a nuanced understanding of the strengths and weaknesses of widely used cognitive assessment tools. It underscores the necessity of considering multiple factors, including educational levels, cultural diversity, and the specific cognitive domains targeted, to make informed clinical decisions. The paper concludes by proposing avenues for enhancing the effectiveness of the MoCA and encouraging a thoughtful selection of assessments based on the unique needs of diverse populations.

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II. RELATED WORK

A. Background

The origins of Alzheimer's disease (AD) study may be traced to the early 1900s, when Dr. Alois Alzheimer made the initial discovery of the distinctive brain abnormalities in a patient, which subsequently led to the diagnosis of AD. Since then, important turning points and important discoveries have molded our knowledge of the illness. The disease's pathological description dates back to 1906, when Dr. Alzheimer discovered amyloid plaques and neurofibrillary tangles in the brain of a deceased patient. This paved the way for more investigation into the biological causes of AD in the future. The goal of study over the years has been to determine the biochemical and genetic components of the disease, which has led to the development of several hypotheses, including the amyloid and cholinergic hypotheses. Our knowledge of the disease's aetiology has also improved with the identification of risk factors such vascular disorders, genetic predisposition, and advancing age [5]. Numerous studies have examined the effects of AD on individuals, their families, and society as a whole, emphasising the need for all-encompassing methods of diagnosis, care, and treatment. The fact that disease-modifying therapies and diagnostic techniques have not progressed much in spite of AD's rising incidence highlights the continuous difficulties in treating this intricate neurodegenerative condition.

B. Definition and Epidemiology

The diagnosis criteria and definition of Alzheimer's disease: The degenerative neurological condition known as Alzheimer's disease results in a significant loss of memory and cognitive function that can significantly disrupt day-to-day activities. It is the most typical dementia cause. A comprehensive medical history, neurological and physical examinations, and a range of tests measuring language, memory, problem-solving, concentration, and other skills form the foundation for the diagnostic criteria for Alzheimer's disease. Blood testing, brain imaging (MRIs and CT scans), and neuropsychological exams are a few examples of these. The process of diagnosing usually involves ruling out other illnesses that could be causing the same symptoms.

Worldwide and regional variations exist in the prevalence and incidence rates of Alzheimer's disease. The World Health Organisation (WHO) estimates that 50 million individuals globally suffer from dementia, with Alzheimer's disease being the most common cause. It is anticipated that by 2050, the prevalence will quadruple. An estimated 5.8 million Americans 65 years of age and older have Alzheimer's dementia[11]. Several cognitive assessment instruments, including the Mini-Mental State Examination (MMSE), the Montreal Cognitive Assessment (MoCA), and the Self-Administered Gerocognitive Examination (SAGE), can be utilised as at home examinations for the prediagnosis of the illness. These tests are occasionally used as a first stage in the diagnostic process and can assist in identifying early indicators of cognitive impairment; nevertheless, a thorough evaluation by a healthcare provider is required for a conclusive diagnosis.[12][13] Numerous factors, including age, genetics, and lifestyle, affect the prevalence and incidence rates of Alzheimer's disease [5]. Alzheimer's disease is predicted to become more prevalent as the world's population ages, raising serious concerns about public health.[14][15]

C. Cognitive Assessment Tools

This section outlines key cognitive assessment tools used to detect and monitor cognitive impairments, focusing on their strengths, limitations, and the cognitive domains they evaluate.

I. Montreal Cognitive Assessment (MOCA)

The Montreal Cognitive Assessment (MoCA) is a well-liked 10-minute diagnostic test for mild cognitive impairment. It evaluates executive functioning, memory, attention, orientation, abstract, computational, and language skills [6]. The exam, which is available in 36 languages, assesses multiple cognitive domains using exercises and questions. Any score of 26 or higher is considered average. The MoCA can be used for free in clinical or educational contexts. The Montreal Cognitive Assessment (MoCA), a thorough screening tool for mild cognitive disorders, has the following specific components.[9][10] They contribute to the overall assessment of a person's cognitive abilities by evaluating various cognitive domains. When taken as a whole, these subtests offer insights into an individual's cognitive functioning and can help identify any cognitive abnormalities or impairments.[22]

1) Alternating Trail Making: Management: Join numerals to characters in the following sequence (1 to A, 2 to B) without going over lines, beginning at 1 and finishing at E. Points: One point is awarded for accurately sketching 1-A-2-B-3-C-4-D-5-E without any crossed lines. Errors that are not self-corrected prior to the Cube task yield a score of zero. One does not score a point for drawing a line from E to 1.[9]

2) Visuoconstructional Skills (Cube): Administration: "Copy this drawing as accurately as you can," the examiner instructs, gesturing to the cube.[10]

Points: One point is awarded for a drawing that is done correctly. Three dimensions must be used in drawings, and every line must be drawn. There should be little to no space where any lines connect, and no new line should be added. Additionally, lines should be similar in length and comparatively parallel, with rectangular prisms being permitted. The cube's spatial orientation needs to be maintained. If any of the fore mentioned requirements are not satisfied, no point is given.

3) Visuoconstructional Skills (Clock): Administration: It is the examiner's responsibility to ensure that the subject is not distracted by a watch during the task and that the area is free of clocks. The examiner points to the proper area and provides the following guidelines: Sketch a clock. Enter all the digits and select "10 past 11" for the time. Scoring: The following three criteria are worth one point each:

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- Contour (1 point): Draw the contour of the clock (it can be a square or a circular). Only slight distortions are permitted. The contour is scored incorrectly if the numbers are placed in a circle but the outline is not sketched.

- Numbers (1 point): Every clock number must to be there, upright, and in the exact order. Accepted number systems are Roman. Approximately divide them into quadrants that are either inside or outside the clock's outline. No alternating point placement.
- Hands (1 point): The right time must be indicated by two hands together. The hour hand's shorter length than the minute hand must be obvious. The hands' junction should be in the center of the clock, with the hands positioned in the middle of the face.

4) Naming: Administration: Beginning from the left, the examiner asks, "Tell me the name of this animal," pointing at each figure.[13]

Points awarded: One point is awarded for every one of the subsequent answers: Three animals: (1) dromedary or camel;(2) rhinoceros or rhino; (3) lion.

5) Memory: Administration: Read aloud a list of five words, giving the subject instructions to retain and then retrieve as many as they can. No word deformation or sound- alike fixes. Read the list once more after the initial attempt. On both trials, the subject recalls; subsequently, more recall will be asked of them.[10][13]

Points: Trials One and Two receive no points.

6) Attention: Forward Digit Span: Administration: "I'm going to say some numbers. When I'm done, repeat them back to me exactly the way I said them," the examiner instructs. At a pace of one digit per second, the examiner reads the five-number sequence.[10][12]

7) Backward Digit Span: Administration: "Now I'm going to say some more numbers, but when I'm through, you must repeat them to me in the reverse order," the examiner instructs. At a speed of one digit per second, the examiner reads the three-number sequence. If the subject has already completed the procedure in forward order, the examiner may not request that they repeat it in reverse order at this time.

Points are awarded for every sequence that is correctly repeated (note: 2-4-7 is the right response for the backward trial).

8) Vigilance: Administration: The examiner begins by saying, "I am going to read a sequence of letters," and then reads the list of letters one letter at a time. For every A I pronounce, I'll tap your hand once. If you hear me pronouncing a different letter, please do not tap your hand.[11]

Points: If there is a zero to one error, one point is awarded (an error is defined as tapping on the incorrect letter or not tapping on letter A).

9) Serial 7s: Administration: Assign the individual the mental subtraction of 7 from 100. Until instructed otherwise, they ought to carry on in this manner. Emphasise the value of performing calculations mentally; using your fingers or paper is strictly prohibited. The examiner reiterates the instructions without restating the subjects' answers in response to queries about the final response or subtraction number[10][12].

Points: There are three possible scores for this item. One point is awarded for a successful subtraction, two points are awarded for two or three successful subtractions, and three points are awarded for four or five successful subtractions. Every subtraction is assessed separately; correct subtractions made after an inaccurate initial number are added to the score.

10) Sentence repetition: The examiner states, "I'm going to read you a sentence. Listen carefully and repeat it exactly as I say it: 'I am aware that Joseph is the person to assist today.'" The examiner proceeds, "I'll read you a different sentence now," following the response. Pay close attention to what I say and repeat it exactly as I say it: "Whenever the dogs were in the room, the cat would always hide under the couch."[10]

Points are awarded based on the accurate repetition of each sentence. One point is given for each sentence correctly repeated, with no grammatical errors, changes in plurals (such as using "hides" instead of "hid"), omissions (such as leaving out "only"), or substitutions/additions (such as replacing "always" with "only").

11) Verbal fluency: Administration: "I'd like you to list as many words as you can that start with the letter J," the examiner instructs. "In a minute, I'll tell you to stop. Numbers, proper nouns, and different verb forms are not allowed. Are you ready? [Stop] [60-second timer] Time's up." If the subject says two consecutive words starting with a different letter, the examiner repeats the target letter if the instructions haven't already been reiterated.[10][13]

Points are awarded: If the participant produces 11 words or more in 60 seconds, they receive one point. The test sheet's back or margins are where the examiner writes down the subject's answers.

12) Abstraction: Administration: Instruct the subject to name the common category, such as "banana and orange," for word pairings. If accurate, confirm and indicate the category. Ask for another category if it's concrete. If false, confirm the right category. Next, move on to fresh pairs. Not much in the way of prompts.[10][12]

Two pairs are the only ones that receive points. One point is given for each pair that provides an accurate response. Appropriate responses are as follows: - bicycle and train are two ways to get about and travel; you use both - ruler and watch are measuring devices for taking measurements The responses given below are not appropriate: The train bike has wheels. - ruler-watch: the figures are visible.

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13) Delayed recall: Administration: The examiner says, "Previously, I mentioned some words for you to remember. Now, tell me as many of those words as you can recall." The examiner marks each correctly recalled word in the designated √ place. Points are given for each word remembered independently without assistance.[11]

14) Orientation: Administration: "Can you tell me today's date?" the examiner asks. If the respondent does not give a complete answer, the examiner prompts further, "Please include the year, month, exact date, and day of the week." Following this, the examiner inquires, "What is the name of this place and the city where it is located?"[10][11]

Points are awarded for each question that is answered properly. The time and location (hospital, clinic, or office name) have to be precise. If the respondent enters the wrong day and date by one day, they will not receive any points.

D. Reliability

Numerous investigations have looked into the MoCA's dependability. When given to the same person, it has shown strong test-retest reliability, indicating consistent scores across time. Overall, inter-rater reliability has been good, showing little difference in scores across other doctors. However, certain studies have highlighted questions about internal consistency, especially in relation to differences in specific subtests.[11][12]

E. Validity

Content Validity: In keeping with its goals, the MoCA addresses a variety of cognitive domains. But there are also disagreements on the weighting and equivalency of subtests, which calls into doubt their generalizability.[12]

Validity and Applicability: Studies back up the MoCA's capacity to distinguish between different types of cognitive impairment. It is clear that the MoCA and MMSE have concurrent validity, with the MoCA being more sensitive in identifying moderate cognitive impairment.[9][10] Even though numerous populations have validated these claims, prejudices related to education and culture continue to raise concerns.[13]

Sensitivity and Specificity: The MoCA is superior than the MMSE in diagnosing mild cognitive impairment (MCI) with a sensitivity of 90% and a specificity of 87% for detecting mild cognitive impairment respectively [9][10][13].

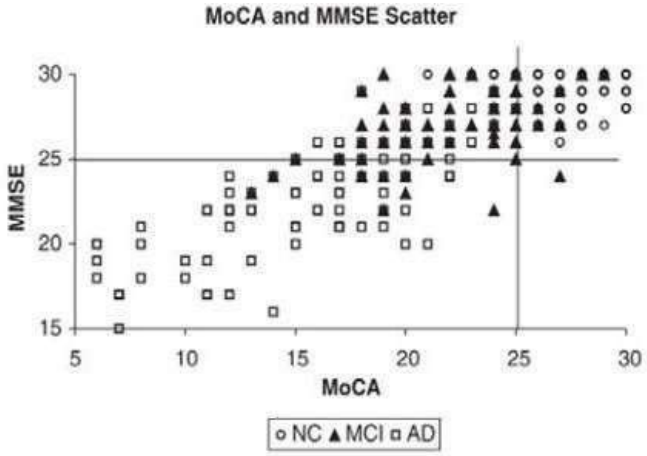

Fig. 1. The Mini-mental State Examination (MMSE) and Montreal Cognitive Assessment (MoCA) scores for people with moderate cognitive impairment (MCI) and mild Alzheimer's disease (AD) are plotted in a scatter plot with normal controls (NC).[23]

II. SELF-ADMINISTERED GEROCOGNITIVE EXAMINATION(SAGE)

A. What is the SAGE Test?

For people who suspect they may have dementia or who may be at risk for the illness, the SAGE dementia test is a written diagnostic tool. The Wexner Medical Centre at Ohio State University is where the Self-Administered Gerocognitive

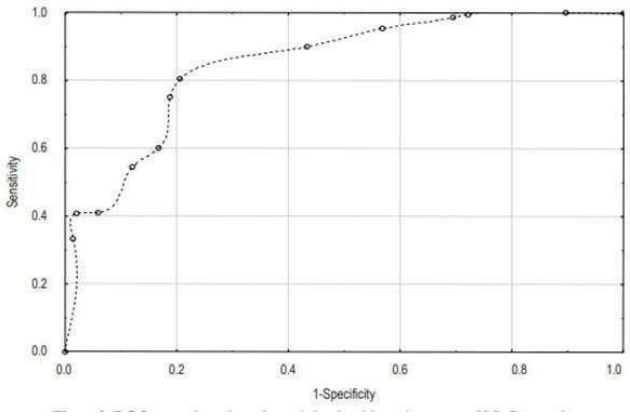

Fig. 2 ROC curve for distinguishing MCI from HC using the weighted mean of MoCA scores for each threshold point. [10]

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Exam, also referred to as the OSU Memory Test [3], was created. It has shown to be successful in detecting cognitive issues that might point to dementia[1], including Alzheimer's disease[2][15][16].

B. How Does it Work?

This evaluates an individual's ability in numerous cognitive domains related to communication and thought. An extra exam component asks candidates with dementia to draw three-dimensional boxes since they struggle with spatial awareness. Remember that the SAGE exam is not intended to be utilised in situations where self-diagnosis is required. Rather, a physician should review the data in order to accurately evaluate the examination and determine if additional testing is necessary. It can be challenging to identify dementia, including Alzheimer's disease and other types. The SAGE exam can help with some diagnosis methods in addition to others, such as a CT scan. Since there are several correct answers that can only be determined by medical professionals, there is no response
to the exam.[15][16]

C. Pros and Cons

1) Pros: - SAGE creates a baseline for comparison by tracking cognitive abilities over time [2][3]. - Four variations provide a variety of questions to test repeatedly, which helps in the diagnosis of dementia.[1] -A wide range of questions aids in identifying the precise cognitive effects of various dementia kinds.[15]

2) Cons: - This easy at-home test has almost no negative aspects. The lack of an answer sheet is the biggest disadvantage. This implies that you must visit your physician in order to have the test findings interpreted by a medical specialist.[16]

D. Accuracy

In studies, the SAGE test was given to hundreds of participants aged 60 and above, and the results showed an accuracy rate of almost 95% in correctly diagnosing patients.[15] Compared to the Mini-Mental State Examination, which is given by a physician and has questions identical to those on the SAGE, it has shown to be marginally more accurate.

The accuracy rate of the Mini-Mental State Examination is roughly 90%.[1]. Table I provides a comparison [23] of SAGE and MMSE scores for normal, MCI, and mild stage dementia subjects, showing how both tests differentiate between these cognitive conditions. The most reliable method of identifying whether someone is exhibiting early symptoms of dementia without having to visit a doctor is to do the SAGE test [2].
The effects of age and education on SAGE (Self- Administered Gerocognitive Examination) scores have been studied. Research suggests that while a greater education level improves cognitive test scores, a lower education level is associated with a lower total SAGE score Fig. 4. Age can also affect SAGE results [3]; individuals 80 years of age and older are advised to add one point [3]. It has been demonstrated that the SAGE test is sensitive to cognitive decline; a 2- to 3-point fall in scores over a 12- to 18-month period is considered notable for the purpose of early dementia conversion diagnosis. The exam may not provide useful information regarding changes over time for those who consistently score below 5, suggesting in certain cases a floor effect for SAGE results Fig. 3.

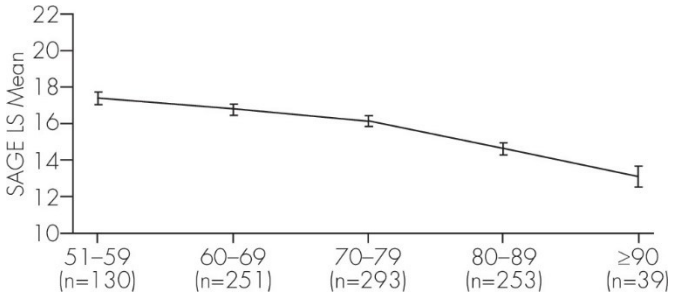

Fig. 3. Age Effect on SAGE Score[3]

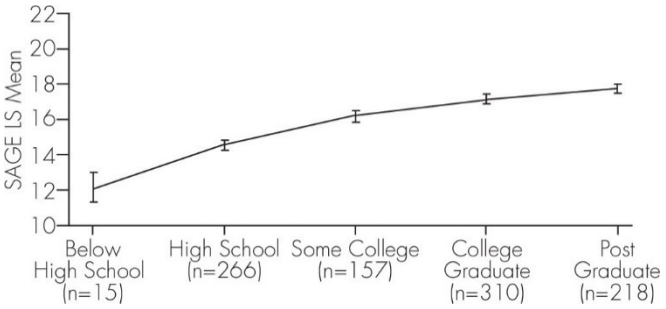

Fig. 4. Education Effect on Sage Score[3]

E. Interpreting the Results

On the SAGE exam, 22 is the maximum possible score. A score of less than 17 may suggest cognitive impairments [1][3], so consulting a specialist is advised [2]. With a score of 15 or 16, an individual may be considered to have moderate cognitive impairment (MCI). Scores of fourteen or below suggest that dementia is most likely the diagnosis. Physicians rate the test results; there is no answer sheet provided. Still, reviewing your loved one's completed test should make it clear if they struggled with any of the questions or the tasks.[15][16]

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III. Alzheimer's Disease Assessment Scale(ADAS)

A. What is ADAS-Cog

The Cognitive subscale of the Alzheimer's Disease Assessment Scale (ADAS-Cog) is a frequently utilised tool in clinical trials related to Alzheimer's disease. This test lasts between thirty and thirty-five minutes and assesses a number of cognitive domains, such as language, memory, praxis, and orientation.[18] Higher scores (which range from 0 to 70) signify more impairment.[18] It has demonstrated efficacy in determining the degree of moderate- to late-stage dementia as well as in distinguishing between healthy controls and Alzheimer's patients. The validity of the ADAS-Cog is supported by high inter-rater and test-retest reliability; nevertheless, standardization and variations in administration across clinical trials have drawn criticism [18].

B. How does it work ?

An evaluation of visual-spatial ability and ideational praxis are included in the ADAS Cog portion of the Alzheimer Disease Assessment Scale (ADAS), which includes typical measures of language, comprehension, memory, and orientation. This includes writing geometric shapes and carrying out manual chores like folding paper into an envelope. Scores are assigned to patients on a range of 0 to 70, where larger numbers denote lower performance.[18] The ADAS-Cog is thought to be more sensitive, dependable, and less affected by educational attainment and language proficiency than the Mini Mental State Examination (MMSE).[18] It is recognized as being more subjective and intricate despite its benefits. The test takes 45 to 60 minutes to complete, and those giving it who don't have to be doctors must complete specialized training. The ADAS- Cog is a tool that is frequently used by researchers studying Alzheimer's disease, particularly in clinical trials[21][18][17]. It is essential for tracking the illness's course and evaluating how drugs affect cognitive function [20][15].

1) Pros of ADASCog: ADASCog encompasses multiple tasks including word recall, naming objects and fingers, executing commands ranging from one to five steps, assessing orientation by questioning the subject about various temporal and spatial aspects, evaluating word finding difficulty, constructional and ideational praxis, word recognition, comprehension of spoken language, and memory.[17]
The test is an amazing tool for tracking disease progression and enables to keep note of progress or deterioration of a patients condition. The ADASCog is assessed longitudinally where individuals are assessed at multiple points over an extended period of time this feature has another leverage over showcasing the change in condition of an individual over time. It has been widely used in clinical trials and research studies thus is trusted for assessing cognitive functions in dementia. This test has been in use for several decades dating back to 1980s and has been improved tested to its most efficiency thus can be trusted.[17]

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TABLE I
SELF ADMINISTERED GEROCOGNITIVE EXAMINATION (SAGE) SCORES AND MINI-MENTAL STATE EXAMINATION (MMSE) MILD COGNITIVE SCORES OF NORMAL, IMPAIRMENT (MCI), AND MILD STAGE DEMENTIA SUBJECTS

	Normal (n=21)	MCI (n=21)	Dementia (n=21)
SAGE Scores	**Mean ± Std Dev**	**Mean ± Std Dev**	**Mean ± Std Dev**
	19.8 ± 2.0	16.0 ± 3.2	11.4 ± 3.9
	(Range: 22-15)	(Range: 21-9)	(Range: 17-4)
MMSE Scores	**Mean ± Std Dev**	**Mean ± Std Dev**	**Mean ± Std Dev**
	28.7 ± 1.1	27.7 ± 2.2	22.1 ± 3.5
	(Range: 30-26)	(Range: 30-23)	(Range: 28-16)

TABLE II
DIAGNOSTIC PERFORMANCE

Diagnostic Task	Cut-off Score	Normal (n)	MCI (n)	Dementia (n)	AUC	Specificity (%)	Sensitivity (%)
Detecting any cognitive impairment	≤ 16	21	42	42	0.919	95	79
Detecting MCI from normal subjects	≤ 16	21	21	0	0.988	95	62
Detecting dementia from normal subjects	≤ 16	21	21	0	0.988	95	95
Detecting dementia from non-dementia subjects	≤ 14	21	42	21	0.906	88	81

2) Cons of ADAS-Cog: Greater in complexity and duration compared to alternative cognitive evaluation instruments. The variability brought about by ADAS-Cog modifications may restrict comparisons between studies. contains errors in the original edition that disregard certain cognitive processes, including executive function and planning.

C. Accuracy

The cognitive function of individuals with Alzheimer's disease is commonly assessed using the Alzheimer's Disease Assessment Scale–Cognitive Subscale (ADAS-Cog). To enhance its effectiveness, the ADAS-Cog has undergone a number of alterations; however, these changes have added variability, which may restrict comparisons between studies. Certain adaptations, such the ADAS-Cog-IRT, have been shown in some studies to exhibit higher responsiveness to treatment effects in Alzheimer's disease as compared to the original ADAS-Cog-11[20][15]. Even with these changes, the ADAS- Cog is still regarded as a fairly reliable tool for identifying individuals with normal cognitive function from those who have cognitive impairments.

D. How to Administer the Test

When a patient is given the ADAS-Cog, a qualified health- care professional will interview them in person. The normal ADAS-Cog is not a timed exam, thus finishing the test quickly has no bearing on the subject's score. The exam, which can be finished in around 30 minutes, consists of 11 components that assess language and memory skills. The items should be given by the clinician to ensure that the session proceeds smoothly and swiftly, but not so quickly that the subject feels under pressure to answer. The ADAS-Cog provides versatility in test administration as it can be given via computerized version or conventional pen and paper [20]. When separating people with normal cognitive functioning from those with impaired cognitive functioning, the ADAS-Cog has proven to be highly accurate. [18]

E. Interpreting the Result

Greater levels of cognitive impairment are indicated by higher scores on the ADAS-Cog scale, which goes from 0 to 70. It's essential to grasp that while improvement in ADAS- Cog often indicates clinical improvement or stability, deterioration in ADAS-Cog can be observed in many cases evaluated as showing clinical improvement. It's crucial to remember that the ADAS-Cog may not be able to measure clinically relevant decrease or all clinically essential effects. As such, it's important to take into account the full clinical picture and not just the test results when interpreting the ADAS-Cog results. [18]

IV. ROWLAND UNIVERSAL DEMENTIA ASSESSMENT SCALE(RUDAS)

In order to address the challenge of identifying dementia in populations who are culturally and linguistically diverse (CALD), the RUDAS was created in Australia in 2004. The RUDAS is a valuable generic cognitive assessment instrument for multi-ethnic communities because it was created to be utilised with interpreters who speak different languages. Dementia therapy and early diagnosis are critical, and this evaluation is a critical first step in assessing the validity of a screening instrument appropriate for CALD populations. [23][14]

A. Target condition being diagnosed

All-cause dementia or any of its subtypes, including fronto temporal dementia, dementia with Lewy bodies, vascular dementia, and Alzheimer's disease dementia, are the target condition; mixed forms can also happen. The syndrome known as dementia is marked by a progressive loss of cognitive

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function and an accompanying inability to carry out daily activities. It affects people, carers, communities, and society as a whole. It is a major global cause of disability and dependence. Globally, dementia afflicted 47 million people in 2015; by 2050, this figure is predicted to quadruple. Due to the ageing of the global population, many dementia patients reside in low- and middle-income nations, where they are predicted to account for almost 71% of all cases worldwide by 2050. According to estimates, the cost of dementia is currently over $1 trillion USD and is expected to grow in the next ten years.[14]

B. Result Analysis

The Rowland Universal Dementia Assessment Scale (RUDAS) is a concise cognitive screening tool created to reduce the impact of cultural and linguistic diversity on the evaluation of initial cognitive abilities. It evaluates a range of cognitive areas such as spatial orientation, motor skills, cube replication, analytical thinking, memory, and verbal fluency. With a maximum score of 30, higher scores indicate superior cognitive performance. RUDAS has demonstrated good performance in identifying for mild cognitive impairment and dementia, with an area under the ROC curve ranging from 0.87 to 0.95. The reliability measures for RUDAS have been reported to be excellent, with Cronbach's alpha values ranging from 0.73 to 0.99 and inter- rater reliability values ranging from 0.82 to 0.99. The tool has been translated into numerous languages and is unaffected by gender and language, although educational levels have been shown to impact test performance in certain studies. The RUDAS cannot be used to diagnose dementia or mild cognitive impairment, but it can be used to identify individuals who require further evaluation. When administering the RUDAS, it's crucial to ensure that the individual is prompted to communicate in their preferred and proficient language, and to ensure that the test taker feels as relaxed as possible, as test anxiety can disrupt cognitive test performance.[24]

V. MINI-MENTAL STATE EXAMINATION (MMSE)

The Mini-Mental State Examination (MMSE) is a widely employed tool in clinical settings intended for assessing cognitive function among elderly individuals. Folstein and colleagues devised this test to evaluate various cognitive aspects such as attention, language, memory, orientation, and visual- spatial abilities. The MMSE is a unique exam that takes 10-15 minutes to screen for cognitive impairment, estimate severity, track changes over time, and assess treatment outcomes. On a scale of 0 to 30, higher scores imply improved cognitive function.

When interpreting scores, it's important to consider a patient's language, educational background, and cultural influences, which can impact performance [7]. The Mini-Cog, revised Addenbrooke's Cognitive Examination, and Montreal Cognitive Assessment are alternatives to the MMSE, which is useful for assessing cognitive impairment but not for diagnosing dementia [8].

A. Analysing MMSE results

The Mini-mental State Examination has a score range of 0 to 30, with a score of 25 or more being considered to represent normal cognitive status.

Extreme cognitive decline: 0–17 Mild
cognitive decline: ages 18 to 23 No
cognitive decline: 24–30

The patient's native language, educational background, and cultural background must all be considered when interpreting the results of the mental status assessment because they may have an impact on performance.

B. Limitations of MMSE Test

Because the MMSE loses sensitivity at scores more than 24, further cognitive tests, such as the MoCA, or intensive neuropsychological testing are required to identify minor neurocognitive problems [8]. In severe dementia (scores 10), the MMSE may have a "floor effect" that renders it unresponsive. to monitor the subsequent reduction Fig.1. Because the MMSE is primarily concerned with memory and language, it is less sensitive in measuring executive function issues [7]. As a result, the MMSE prioritizes verbal cognitive ability over skills from the non-dominant hemisphere. The MMSE does not assess executive function or visual memory [7].

VI. COMPREHENSIVE COMPARATIVE ANALYSIS OF COGNITIVE ABILITY TESTS: MMSE, RUDAS, SAGE ADAS, AND MOCA.

In the quest for improved Alzheimer's diagnostics, we analyze five cognitive tests: SAGE, RUDAS, ADAS, MMSE, and MOCA. Evaluating factors such as cognitive domains covered, accuracy, reliability, time to administer, age group coverage, and areas of brain targeted, this study aims to assist in selecting the most effective tools for clinical and research applications in Alzheimer's disease.[12][14][15][16].

A. Cognitive Domains Covered

1) SAGE (Self-Administered Gerocognitive Exam): Memory, language, executive function, and orientation.[12]
2) RUDAS (Rowland Universal Dementia Assessment Scale): Memory, language, praxis, and visuospatial skills.[14]
3) ADAS (Alzheimer's Disease Assessment Scale): Memory, language, and praxis.[[15],[16]]
4) MMSE (Mini-Mental State Examination): Orientation, memory, attention, and language [7][12].
5) MOCA (Montreal Cognitive Assessment): Attention, memory, language, and executive function.[10][12]

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B. Accuracy

1) SAGE: Good sensitivity and specificity.[12]
2) RUDAS: Known for accuracy, especially in culturally diverse populations.[14]
3) ADAS: Widely used in clinical trials, showing sensitivity to changes in cognitive function. [15][16]
4) MMSE: Widely used as a screening tool, though sensitivity to mild cognitive impairment may be limited [7][8][12].
5) MOCA: Particularly sensitive to detecting mild cognitive impairment.[10][12]

C. RELIABILITY

1) SAGE: Generally high reliability with consistent results over repeated administrations.[12]
2) RUDAS: Demonstrates good reliability across different settings and populations.[14]
3) ADAS: Shows high internal consistency and test-retest reliability.[15][16]
4) MMSE: Demonstrates good test-retest reliability.[12]
5) MOCA: Demonstrates good internal consistency and test-retest reliability.[10][12]

D. Time Taken to Administer

1).SAGE: Approximately 15 minutes.[12]
2). RUDAS: Typically takes about 20 minutes.[14]
3). ADAS: Administration time varies but can take up to 60-90 minutes.[15][16]
4). MMSE: Approximately 10-15 .[12]
5). MOCA: Takes approximately 10-15 minutes.[10][12]

E. Age Group Coverage

1) SAGE: Suitable for adults aged 50 and above.[12]
2) RUDAS: Applicable to a wide age range, including older adults.[14]
3) ADAS: Primarily designed for older adults. [15][16]
4) MMSE: Primarily designed for older adults. [12]
5) MOCA: Suitable for adults of all ages.[10][12]

F. Areas of Brain Targeted

1) SAGE: Targets both cortical and subcortical regions.[12]
2) RUDAS: Provides a comprehensive evaluation by targeting various brain regions [5][14]
3) ADAS: Targets various brain regions involved in memory and cognition.[15][16]
4) MMSE: Focuses on cortical functions related to memory and cognition [7][12]
5) MOCA: Targets a broad range of cognitive functions across different brain regions.[10][12]

G. Self-Administration

1) SAGE: Designed for self-administration.[1][12]
2) RUDAS: Usually administered by a clinician, limiting self-administration.[14]
3) ADAS: Typically administered by trained professionals.[15][16]
4) MMSE: Typically administered by a clinician. [12]
5) MOCA: Generally administered by a clinician.[10][12]

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H. Clinical Results

1) SAGE: Positive results may indicate the need for further clinical evaluation.[12]
2) RUDAS: Abnormal scores may suggest cognitive impairment, prompting further assessment.[14]
3) ADAS: Elevated scores may indicate cognitive decline or Alzheimer's disease progression.[15][16]
4) MMSE: Lower scores may indicate cognitive impairment, requiring further evaluation [7][12].
5) MOCA: Lower scores may indicate cognitive impairment or early signs of Alzheimer's disease.[10][12]

I. Alzheimer's Disease Detection

1) SAGE: Effective in detecting early signs of cognitive decline, including those associated with Alzheimer's.[12]
2) RUDAS: Efficient in detecting early signs of cognitive impairment, such as Alzheimer's.[14]
3) ADAS: Sensitive to changes associated with Alzheimer's disease.[15][16]
4) MMSE: Efficient in identifying moderate to severe cognitive decline linked with Alzheimer's [8][12].
5) MOCA: Particularly sensitive to early stages of Alzheimer's disease and mild cognitive impairment.[10][12]

VII. METHODOLOGY

This review paper consists of an in dept analysis of the several cognitive assesments techniques including the Mini- Mental State Examination (MMSE), Rowland Universal Dementia Assessment Scale (RUDAS), Self-Administered Gerocognitive Examination (SAGE) Alzheimer's Disease Assessment Scale (ADAS), and Montreal Cognitive Assessment (MoCA).[10][12][14][15][16]
To assess the drawbacks and limitations of the moca test in comparision to other cognitive assessment tools available, we implemented a thorough and systematic approach involving essential steps pertaining to the identification of relevant studies, research articles, and meta analysis for data collection and comparison.[12] We used some inclusion and exclusion criteria for selecting the studies, data and research papers used in the comparative anaylsis.
We conducted a comprehensive literature search using several databases recommended by our mentor like google scholar and PubMed.[10][12]

VIII. DISCUSSION

The Montreal Cognitive Assessment (MoCA) is a commonly employed cognitive screening instrument crafted to evaluate different cognitive areas, encompassing attention, memory, language, and cognitive control. This test takes around 10 mins to be administered.

While the MoCA is a valuable instrument, it does have some limitations that should be considered while and during every single assessment.
The MoCA test helps find early signs of memory and thinking problems. Right now, anyone in healthcare can give and understand the test if they have had the right training.
But, starting from September 1st, 2019, it is mandatory to have MoCA training and a certificate [6].
Understandably, this is aimed to ensure consistency and accuracy with the MoCA results. Those who wish to ad- minister the test will have one year to complete standardized training and certification through the website. The certification and training program is available on the official site and costs around $125 which Is a hefty sum for many individuals.[12]
The MoCA may be influenced by an individual's level of education. Some components of the test include brain storming activities , such as the trail-making task and cube copying, which could tend to be may be more challenging for individuals with lower education levels [6][12] majorly students and people from backward areas where the access to education is limited , potentially leading to a lower score that does not accurately reflect cognitive impairment, Affecting the overall accuracy of the test result thus leading to the misinterpretation of cognitive abilities.
The Montreal Cognitive Assessment has been adapted into 36 different languages and dialects and has been utilized across various populations [6][12]. In a study evaluating the cognitive abilities of individuals from various ethnic backgrounds (Caucasian, Black, and Asian), the majority (62%) had results under 26 on the MoCA. Among the Caucasian participants, the average result was 25.6 out of 30, slightly below the usual threshold of 25/26.However, it is important to know that in this study, they did not do more detailed assessments like standard cognitive tests, neurological exams, or brain imaging on the healthy volunteers. Because of this, they might have missed subtle cognitive problems, neurological issues, or brain abnormalities, which could explain why some individuals did not perform as well on the assessment. Such occurrences are more common among individuals with less education and in ethnic communities with higher chances of having health problems that affect the brain. Even though the test is available in different languages it may still have cultural and language biases that could affect the performance of individuals from diverse linguistic and cultural backgrounds.
The MoCA may not be as effective in detecting cognitive decline in individuals with very high baseline cognitive function [4]. This is known as a ceiling effect, where the test may not be sensitive enough to detect subtle changes in individuals with already high cognitive abilities. The ceiling effect is a common concern in cognitive assessments, and it underscores the importance of using tools that are sensitive enough to detect early cognitive changes in specific populations, such as those with Parkinson's disease and mild cognitive impairment. [12][13] Individuals with a high baseline cognitive function may perform well on the MoCA, even if they are experiencing subtle cognitive changes, leading to a failure to identify early

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cognitive impairment. [[Researchers and clinicians may need to consider using more comprehensive and specific cognitive assessments that are less prone to ceiling effects when evaluating individuals with PD- MCI to ensure accurate and reliable results.]]

Although the MoCA encompasses a wide array of cognitive areas, it may lack a detailed evaluation of specific cognitive functions. The MoCA test looks at different aspects of how the brain works, like memory and attention. Some individuals with specific types of cognitive impairment, such as frontal lobe dysfunction, may perform poorly on the MoCA due to its reliance on intact executive function. This can limit its sensitivity to certain types of cognitive disorders. While it is commonly used in various clinical settings, its general nature may not address the unique cognitive challenges as- sociated with Parkinson's disease, limiting its specificity for this population [4]. Thus the moca test could be inaccurate for individuals with Parkinson's disease. The MoCA test is mainly meant to quickly check if there are any signs of cognitive issues, but it may not be the best choice for keeping a close eye on how someone's thinking abilities change over a long period. To get a more detailed and thorough understanding of cognitive changes over time, it is usually advised to use more comprehensive neuropsychological assessments [4]. These assessments go into more depth, providing a broader and detailed picture of someone's cognitive function, making them more suitable for monitoring changes in thinking abilities over the long term.

There are several other cognitive assessment tool, such as RUDAS, SAGE, MMSE, and ADAS, offers unique strengths compared to the Montreal Cognitive Assessment (MoCA). RUDAS is notable for its cultural sensitivity and explicit focus on minimizing cultural biases, making it suitable for diverse populations which was a drawback in case of MoCA. SAGE stands out with its online administration capability and enhances accessibility for remote or self-assessment[1]. MMSE is widely recognized and used, valued for its brevity and familiarity among healthcare professionals. ADAS-Cog, tailored for Alzheimer's research, specifically targets memory and cognitive domains affected by the disease, with sensitivity to changes over time.[14][15]

IX. CONCLUSION

The Montreal Cognitive Assessment (MoCA) has several limitations that include sensitivity to education levels as the test does not take into consideration the level of education received by the respondent taking the test, the potential cultural and language biases despite translation efforts taking into making moca tests in around 60 different languages. A ceiling effect that may limit its effectiveness in detecting cognitive decline in individuals with high baseline, as well considering the fact that MoCA cannot be used to track the progress of an individual and is only useful in determining the state of cognitive abilities at a certain point.

Understanding these limitations is very important for making use of all the cognitive assessment tool available. Awarness of these limitations enables clinicians and researchers to avoid wrong judgement of test results and ensure accuracy of the results obtained thus enabling in important care to the needed individual. Recognizing the strengths and weaknesses of different tools and tests like MMSE, SAGE, RUDAS etc promotes the selection of assessments with enhanced sensitivity and specificity, facilitating more targeted treatment.

To enhance the effectiveness of the Montreal Cognitive assessment several areas of improvement can be considered. The adaptiveness of the test can be enhanced by making it more sensitive to educational levels of an individual and minimize biases across different and diverse populations. Changes to address the ceiling effect in individuals with high baseline abilities by collaborating with different other tests and taking inspirations to improve MoCA overall. Since this test does not keep account of progress of an individual, parts could be added to specifically target the aspect of storing and comparing previous performances to track progress in an individual's cognitive abilities. By doing all these things, we can make the MoCA a better and fairer tool for checking how well people's brains are working.[12]

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