

PAPER

MentAlzh: Mobile Application Prototype for Early Detection of Cognitive Impairment

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ABSTRACT

The increasing incidence of neurodegenerative diseases has raised a pressing need for practical tools to detect mild cognitive impairment in its early stages. This study presents MentAlzh, a mobile app prototype that employs an interactive multimedia approach to cognitive assessment, adapting traditional methods. The app was developed using the design thinking methodology to engage the end-user; the prototype encompasses six cognitive tests inspired by established methods, focusing on orientation, clock drawing, fixation, language, calculation, and memory. A group of 21 participants, aged between 51 and 76, evaluated the app regarding usability, accuracy, and repeatability. Results demonstrated consistent performance on orientation and fixation tasks, while variability on memory and clock drawing tests indicated potential areas for further refinement. The MentAlzh prototype was found to have the potential to serve as an accessible and user-friendly tool for early cognitive screening.

KEYWORDS

Alzheimer disease (AD), early cognitive screening, mild cognitive impairment, mobile application

1 INTRODUCTION

The increase in life expectancy has led to a higher prevalence of neurocognitive diseases, particularly Alzheimer disease (AD), which accounts for 60% to 70% of dementia cases worldwide [1], [2], [3]. According to the World Health Organization (WHO), over 10 million new cases of dementia are reported annually [2]. In Latin America and the Caribbean (LAC), the prevalence of dementia in older adults ranges from 0.2% to 39.4% (see Figure 1a), with an average of 11% [4], [5] (see Figure 1c). In Colombia, studies highlight a significant prevalence of Alzheimer, particularly among individuals aged 80 and above, as well as a 23.6% prevalence of dementia in people over 60 years in Neiva City (see Figure 1d), Colombia, attributed to factors such as low education and socioeconomic status [6]. The burden of dementia in LAC is substantial, with an estimated 5.68 million cases in 2015, projected to rise to 9.94 million by 2030 [7] (see Figure 1b).

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These trends emphasize the urgent need for early detection, intervention, and coordinated governmental action to address this growing public health challenge.

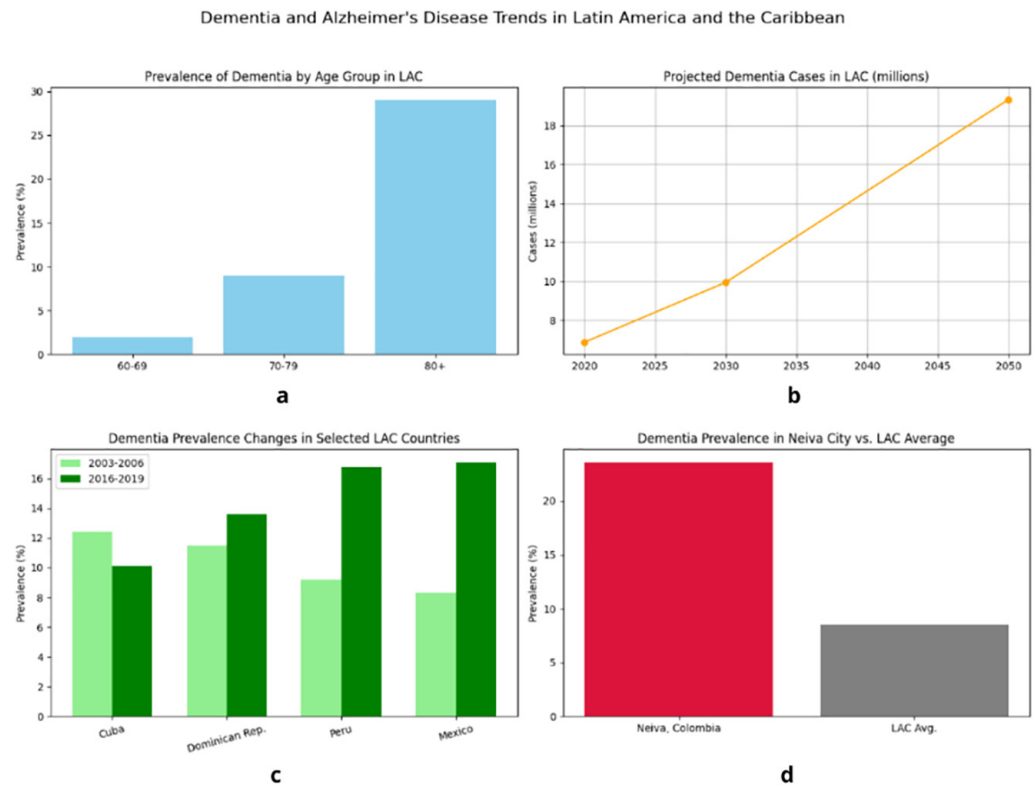


Fig. 1. Trends in dementia and AD in Latin America and the Caribbean

Early diagnosis of AD is essential for improving patient outcomes, but there are many factors that make early detection difficult. Due to the stigmatization, the early stages symptoms are often overlooked as normal symptoms of aging, and patients can avoid seeking medical care [8], [9]. Additionally, some healthcare providers may be resistant to diagnose AD because of the limited treatments and the lack of specialized diagnostic services [9]. Even with these challenges, early detection enables timely interventions, enhances symptom management, and reduces long-term care costs [9], [10]. Primary care physicians play a key role in early dementia detection and can initiate treatment to slow its progression [10]. Despite these advantages, limited research exists on the benefits and risks of early AD diagnosis, indicating a need for further study [9].

Some traditional cognitive screening tools such as Mini-Mental state examination (MMSE) and Mini-Cog are used to detect dementia and cognitive impairment [11], [12]. For dementia detection these tests have shown good diagnostic performance, demonstrating a sensitivity of 0.81 and specificity of 0.89 for dementia detection with the MMSE [12]. However, relying on face-to-face management by trained professionals can create barriers to accessibility and retard diagnosis [13]. Computerized tools such as the interactive internet-based computerized self-test (CST) have been developed to overcome these limitations, demonstrating higher accuracy than the MMSE and mini-cog in classifying cognitive impairment [14]. These informatics tools can facilitate early detection of cognitive impairment in primary care centers and allow more frequent monitoring of cognitive changes over time [13], [14].

Early detection of cognitive impairment is imperative for the effective management of conditions such as AD. However, access to conventional screening instruments is constrained by the requirement for trained professionals and adequate infrastructure.

Consequently, this results in delayed diagnoses and the failure to implement timely interventions. There is an evident necessity for a readily accessible and user-friendly solution that facilitates preliminary cognitive assessments in non-traditional settings.

Mobile applications have appeared to be very promising options for the early detection, management, and treatment of cognitive disorders [15], [16]. These technologies enhance the feasibility, validity, and reliability of cognitive testing, facilitating targeted use of advanced diagnostics such as MRI and CSF analysis [15]. Mobile platforms allow repeated and continuous monitoring, facilitating trend analysis and the detection of important changes [17]. Innovative strategies have been developed for the early detection of shortcomings in several cognitive areas, such as finger coordination, visual-spatial skills and instrumental autonomy [18]. Although the potential benefits, the methodological limitations remain, such as the paucity of randomized controlled trials and comprehensive assessments [18].

Mobile Alzhe_Alert and AlzhApp such as mobile applications have emerged as new solutions. Mobile Alzhe_Alert employs a questionnaire-based format to assess the risk of AD [19], while AlzhApp integrates diagnostic insights derived from optical coherence tomography [20]. Despite these advances, engagement and accessibility gaps remain for these types of solutions.

Mobile and tablet platforms have proven effective for scalable, user-centered cognitive assessment and training. M-Health assistance applications can improve quality of life by facilitating early detection in older adults [21], [22]. Similarly, culturally adapted tablet-based screening tests, which distinguish mild cognitive impairment from dementia, have achieved an accuracy of over 77% [23]. These findings set a benchmark for this study proposal.

This study presents MentAlzh, a mobile application prototype designed to address the accessibility gap in early cognitive assessment by enhancing traditional methods through an interactive, multimedia-based digital platform. By leveraging these features, MentAlzh aims to overcome the limitations of existing tools, providing an easy-to-use, scalable, and immediate solution to support early detection efforts, particularly for vulnerable communities. The main contributions and novelty of this work can be summarized as follows:

- A prototype of the MentAlzh mobile application is presented, offering a user-friendly and accessible tool for early cognitive assessment. The application adapts well-established cognitive assessment tools, such as the Mini-Cog and the MMSE, into an interactive multimedia format suitable for mobile devices.
- MentAlzh includes six distinct cognitive tests that evaluate orientation, memory, language, and calculation abilities, maintaining the clinical robustness of traditional tools.
- By facilitating digital, portable, and potentially self-administered testing, the tool promotes early detection and continuous monitoring without necessitating immediate intervention by healthcare personnel. This work addresses the gap between traditional clinical practices and modern e-health solutions by proposing a hybrid model that balances effectiveness and accessibility.

This paper is organized as follows: Section 2 details the methodology adopted for the design and development of the MentAlzh mobile application, including the adaptation of traditional cognitive assessment methods, the selection of appropriate development tools, and the integration of tests into a multimedia environment. Section 3 presents the results, emphasizing the detailed design of the application and its performance, which enables the assessment of various cognitive domains such as memory, orientation, language, and calculation. Section 4 discusses the relevance of the findings, analyzing both the strengths and limitations of the current implementation, as well as potential areas

for future improvement. Finally, Section 5 offers a summary of the main conclusions drawn from this work and explores the broader implications for the early detection and monitoring of cognitive impairment in diverse and underserved populations.

2 MATERIALS AND METHODS

The project used design thinking, which is an iterative process that is user-centered and encompasses five key stages: 1) empathize, 2) define, 3) ideate, 4) prototype, and 5) test. This methodology was chosen for its structured yet flexible approach to address complex user-centered challenges, such as early detection of cognitive impairment.

During the empathy phase, techniques such as stakeholder mapping and stakeholder matrices specific to the methodology were used to analyze the interested users. These techniques allowed the identification of the primary needs and barriers, such as stigma, lack of awareness, and accessibility problems. The target group of this study included patients, caregivers, and health professionals.

The Define phase synthesized these insights into actionable problem statements. For instance, accessing diagnostic tools in underserved areas emerged as a critical challenge. Ideation followed, generating multiple concepts through brainstorming and comparative analysis of existing solutions. The best ideas incorporated gamification and user-friendly interfaces, addressing engagement and accessibility concerns.

Prototyping comprised an iterative development process for the application, incorporating feedback from test users to enhance functionality and design. The final stage, testing, evaluated the usability, effectiveness, and alignment of the prototype with user needs in real-world scenarios.

Furthermore, conventional detection methods, including the mini-cog and the MMSE, have been foundational in developing interactive tests within the MentAlzh application. Due to their simplicity and effectiveness, healthcare professionals have used these approaches for cognitive screening and diagnosis.

The mini-cog combines two main tasks: a three-word memory test and a clock drawing test. The first of these tests is short-term memory, which asks participants to recall and repeat three unrelated words after a short interval. The clock drawing test assesses visuospatial and executive skills by asking participants to draw the circumference of a clock and write the numbers and hands correctly within a given time. Thus, this dual approach makes it possible to differentiate individuals with cognitive impairment quickly and effectively.

Similarly, the MMSE is a more comprehensive cognitive assessment tool comprising five key domains. First, it begins with the orientation section, in which participants answer questions about the current date, place, and time to assess their awareness. The second recording section assesses immediate memory by asking participants to repeat three unrelated words. In the Attention and Calculation domain, tasks such as serial sevens (subtracting seven from 100) or spelling a word backward measure concentration and mental arithmetic abilities. The recall section asks participants to recall the previously registered words after a short delay, such as the mini-cog. Finally, language and comprehension are where expressive and receptive language skills are checked through tasks such as naming objects, following instructions, or writing a sentence.

Although very effective, both methods have limitations. The brevity of the mini-cog may overlook subtle cognitive deficits, and the requirement for professional administration of the MMSE limits its accessibility in underserved areas. In addition, these tools rely heavily on analog formats, which can be challenging for some users.

MentAlzh application digitizes traditional tests by adding drag-and-drop clock drawing and audio-visual recall cues. This preserves core assessment methods

while enhancing engagement and inclusivity through interactive multimedia. This approach retained the basic metrics while improving accessibility and interaction. In addition, the project uses questionnaires to estimate the risk of developing AD. MentAlzh builds on these advances by introducing dynamic and interactive exercises tailored to various user profiles.

Unity and Android Studio were selected as development platforms for their robust multimedia support and cross-platform capabilities. In addition, Plastic SCM was used for version control, which allowed for co-development and iterative refinement. The graphical user interface (GUI) was developed with a priority on accessibility and simplicity. Each interactive task was visually engaging, with clear instructions and responsive feedback mechanisms to guide users through the cognitive assessments.

The prototype was tested with 21 people over 50, focusing on ease of use, accuracy, and repeatability. Participants were asked to rate ease of use and overall compliance with the system, and the mean score obtained was 4.7 out of 5. Comparisons were made between the results and those obtained in traditional paper-based evaluations to ensure the accuracy of the results. To ensure consistent performance, the tests were re-run. The data obtained allowed successive improvements to be made so that the final product would meet the functional and usage needs of the target audience.

In Figure 2, the diagram outlines the stages of the app development process, from research to implementation. This diagram outlines the work in six key stages, ranging from the research phase to the technical implementation. First, an investigation was conducted into traditional methods for detecting cognitive impairment, selecting those with scientific backing. These methods were then adapted to multimedia environments, enabling the development of an initial version of the mobile application. Next, the most suitable development tools were selected, prioritizing those that would facilitate the implementation and testing of functionalities. Cognitive tests were subsequently developed within the application, incorporating interactive elements to enhance the user experience. Finally, effective methods for presenting test results were designed, thus completing a comprehensive development cycle focused on the usability and effectiveness of the proposed technological tool.



Fig. 2. Step-by-step structuring diagram

3 RESULTS

3.1 Prototype description

MentAlzh integrates six interactive tests based on the mini-cog and MMSE methodologies, each designed to assess specific cognitive abilities while preserving the

simplicity of traditional methods. The tests include an orientation test where participants answer questions about the day and month, a clock drawing test where users arrange numbers and hands to show 11:10, and a fixation test where participants recall three words from an audio prompt. Additionally, there is a language test that matches images to words, a calculation test based on progressive subtraction, and a memory test that asks participants to recall words from the fixation test. Each test has a clear scoring system to evaluate performance.

Administering one exam per domain avoids application saturation and reduces user fatigue, thus maintaining engagement. The principle is to preserve the structure of the original exams and to take advantage of the interactivity offered by multimedia tools.

Orientation test. The orientation component was designed to elicit responses relating to the environment, the identity of the individual and the current date or place. To adapt this component into a test, it was determined that two questions concerning the day of the week and the month the user is in at the time of application use would be necessary.

The orientation test interface includes 19 buttons divided into two groups: days of the week and months. Buttons are spaced for easy interaction, with uppercase text for readability and simplified score verification. Selected buttons are highlighted in green, allowing users to change their choice within each group while ensuring only one option is selected per group, Figure 3a. Selecting the “Continue” button activates the validation, which checks whether a day and month have been selected and compares them with the system date and time. Each correct option rewards one point, with a maximum score of two points.

Fixation test. The fixation test involves the presentation of three words (peseta, horse, and apple) through audio playback. The recipient listens to the recording and chooses from among several options the one containing the three words, earning one point for each correct answer. The interface is presented in Figure 3b. The upper part contains a “Play Audio” button and prompts to encourage users to recall the words for the memory test that are not specified from several indicated options to avoid bias. The bottom portion shows three options, each with a set of words that require users to determine the correct combination. This design assesses both memory and attention effectively.

Table 1 shows all combinations with the corresponding results. This analysis provides insight into how user actions influence system responses and how different interactions impact performance.

Table 1. Combinations of actions in the fixing exercise

Listened to the Audio	Chose an Option	Pressed the Continue Button	Result/Output
NO	NO	NO	Is not finished
NO	NO	YES	Error I
NO	YES	NO	Error II
NO	YES	YES	Error I/II
YES	NO	NO	Is not finished
YES	NO	YES	Error I
YES	YES	NO	Is not finished
YES	YES	YES	Next Test

The first three columns of Table 1 outline the actions a user can take in this exercise: listening to the audio, selecting an option, and pressing the “Continue” button. All three actions must be performed to complete the exercise and proceed to the next task (final row of the table). If not, three outcomes are possible. The first case, “Error 1,” occurs when the user selects the “Continue” button without fully completing one or both actions, which is the most common error. The second case, “Error 2,” occurs when the user chooses an option before having listened to the audio, ensuring that the exercise sequence is followed. The third error occurs when the user has not fully interacted with the exercise; for example, they continue listening to the audio without selecting an option or have not intervened in any element.

A special case in the fourth row occurs when the user selects an option without listening to the audio and then presses the “Continue” button without closing the error panel. The error message updates in this case, but the panel remains visible throughout the interaction. As in the orientation exercise, the button selected by the user is highlighted in green. If the user selects a different button, the previous one returns to white and the new selection is highlighted, ensuring clarity and preventing multiple selections.

Language test. The language component of the task presented challenges due to its reliance on direct patient interaction, such as repeating phrases or following instructions. One task involved categorizing word pairs, such as “pear” and “apple” as fruits. This was adapted into a digital format, where users match images to words, such as associating a pencil image with the word “pencil.” The test evaluates associative and comprehension skills, with scoring based on correct matches.

The exercise interface arranges images and words in two columns, with users dragging the images to match the words. Each word is placed on a white rectangular background for clarity, Figure 3c. Once all images are matched with the correct words, both disappear from the screen.

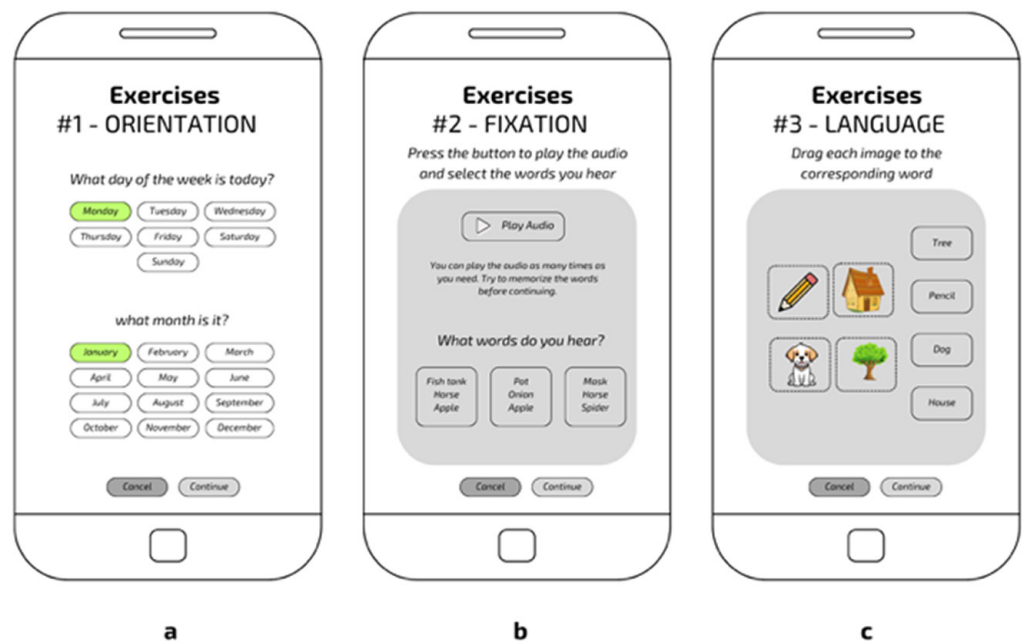


Fig. 3. Interfaces of the orientation, fixation, and language tests in MentAlzh

A collision-based system triggers the disappearance of matching elements, and the internal counter is incremented for each successful match. The colliders are carefully designed for precise interaction, and the words have slightly smaller colliders so that there is some margin for error. If the user tries to continue without

completing the matches, an error panel notifies them to finish before continuing, ensuring full engagement in the task.

Calculation test. The calculation test consists of two components: a successive subtraction task and a concentration exercise. The subtraction task, where participants subtract 3 five times, was retained for digital adaptation. In the app, participants input their answers directly, rather than responding verbally. The test is scored out of 5, with one point for each correct answer, preserving the structure of the original assessment while utilizing the interactive features of the app.

The interface was created to present the answers required for the successive subtraction task; at the top of the screen, a problem is shown, followed by fields for users to enter their answers. A reference answer is provided for the first subtraction, while the remaining fields are left blank for the user to enter their answers. The exercise interface is illustrated in Figure 4a.

Users are required to complete the answer fields in descending order, with no shuffle mechanism to prevent confusion. Fields are supplied by tapping and entering numbers using the keyboard of the device, which is automatically displayed for numeric input. The fields accept only integer values, blocking non-numeric or alphabetical characters.

When the user clicks the “Continue” button, a validation process is performed to verify that all fields have been filled out. If the condition is met, the exercise is marked as complete, and the program evaluates the responses of the users. Only predefined correct answers are considered valid for scoring; each correct answer is worth one point. Users can earn between 0 and 5 points, depending on their answers.

If any field is left blank, an error panel prompts the user to fill out all fields before continuing, ensuring that an attempt has been made to complete the exercise in its entirety and maintaining the integrity of the task and evaluation criteria.

Memory test. Participants must identify the three words presented during the fixation task to assess the memory component. In the digital version, users select the correct words from a list that includes distractors, upholding the cognitive challenge. The test has a maximum score of 3 points, with 1 point granted for each valid selection.

The interface for this exercise follows a design like the orientation exercise, with options distributed across the screen. Unlike the orientation test, all options are grouped into a single set. The words are arranged in three columns, each containing four similar words. Figure 4b shows the organized layout of this interface.

Users can recognize word similarities and avoid selecting multiple words from the same column. Each column represents a group of related words, with one target word per column. They must choose three words they heard during the fixation exercise, one from each column. Selecting more than one word in the same column highlights only the most recent choice.

When the “Continue” button is pressed with three selected words, the exercise is marked complete, and the program evaluates the answers—scoring awards one point per correct word, with a maximum of three points. If fewer than three words are selected, an error panel prompts users to complete their selections.

Clock drawing test. The clock drawing test was simplified while maintaining the objectives of the original exercise. Participants are given all clock components, including numbers and hands, and must arrange them to form a complete clock. Scoring is done by awarding one point if all numbers are correctly sequenced and the hands are in the 11:10 position. If any of the conditions are not met, no points are granted.

Figure 4c shows the test as it appears in the app. The clock drawing exercise ensures that the numbers are placed in a specific order and that the clock hands

indicate the correct time [12]. To achieve this, the numbers are randomly placed at the top of the screen at the beginning of each session. Unlike other exercises where the shuffling process is visible, the numbers are shown in their new positions. A similar strategy is used for the clock hands, whose initial positions are randomly assigned within the circle to prevent correct placement without user interaction.

The fundamental requirement in this activity is pushing the “Continue” button. Once started, the program checks if all numbers are within the clock circle by computing their distance from the center of the clock using the Pythagorean Theorem. This approach accurately validates the location of the numbers in Equation 1.

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \quad (1)$$

The variables x_1 and x_2 represent the X-coordinates, while y_1 and y_2 represent the Y-coordinates of the number and the center of the circle, respectively. The distance d between the number and the center is calculated using the Pythagorean Theorem.

The numbers must be located within 280 units from the center of the clock, which implies a margin of error beyond the 250-unit radius. If validation fails after the user has placed the number, a notification prompts the user to correct it.

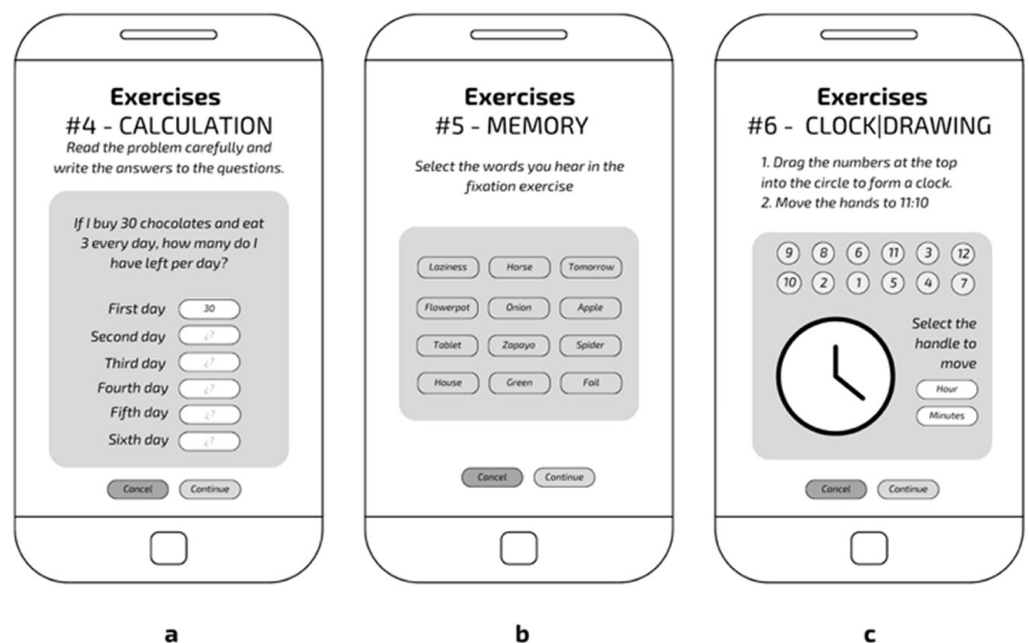


Fig. 4. Interfaces of the calculation, memory, and clock drawing tests in MentAlzh

After verifying that all numbers are correctly placed, the system assesses their order and the alignment of the clock hands. Both criteria must be met to achieve a score. The system uses sensors to detect alignment, increasing an internal count when numbers and hands match their intended positions. Perfect placement of all elements results in points being awarded.

Clock hands can be adjusted by selecting their respective controls and dragging them anywhere within the clock area, ensuring ease of interaction while preserving a realistic design.

In this prototype, results (scores and times) can be accessed through the results screen within the application and via email. The results screen appears after completing all exercises and has two main sections: overall results, displaying the total

score and time, and individual results, showing the score and time for each of the six exercises. Figure 5 illustrates the layout of the screen.

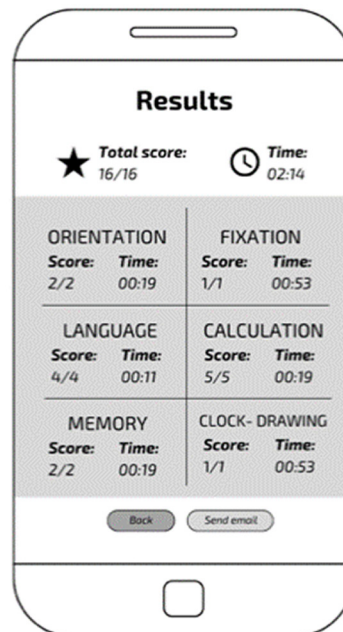


Fig. 5. Results interface

Scores are recorded in separate variables and totaled after the final exercise. Time is tracked by a global session timer and individual timers for each exercise, managed by a state machine. Results are displayed in minutes and seconds on the results screen. Additionally, users can receive their results via email, with a notification panel informing them that their data will be shared with the development team for analysis and application improvement.

A link¹ was created to show how the application works. It is clarified that the application was developed for people demographically located in Colombia, where the official language is Spanish. The respective repository can be found on GitHub².

3.2 Scores per test and totals

The evaluation included 21 participants aged between 51 and 76. Of these, 71% were women, and the remaining 29% were men. The orientation test showed that participants achieved a maximum score of 2/2 correct, demonstrating their awareness of time and space. Completion times varied between 5 and 12 seconds, with most users completing the test in 8 seconds.

In the clock drawing test, 81% of participants completed the task by accurately arranging the numbers and positioning the hands to indicate 11:10, earning the entire score of 1 point. The remaining 19% failed to meet the criteria, scoring 0 points. Completion times showcased a learning curve, with initial attempts taking up to 66 seconds and subsequent iterations showing improvement, averaging around 40 seconds.

¹ https://drive.google.com/drive/folders/1-o80kfYENOGKKDL7sAqH1yfUWTa_Iyji?usp=sharing

² <https://github.com/dangomezgir/MentAlzh>

On the other hand, the results of the fixation test had a success rate of 95%. Only one participant obtained a score of zero. Completion times varied between 9 and 21 seconds. In the language test, 71% of participants scored a maximum of 4 points. The other 24% scored 2 points, while 5% scored zero. Completion times ranged from 6 to 12 seconds.

In the calculation test, 81% of users scored the maximum of 5 points, while 10% and 9% scored 3 and 1 point, respectively. Completion times improved with repeatability, starting at 25 seconds on average and reducing to 17 seconds in subsequent iterations. The memory test exhibited the most significant variability among participants. While 48% achieved the maximum score of 3 points, 28% scored 2 points, and 24% scored only 1 point. This variability highlights the diverse cognitive capabilities among the test group. Completion times showed significant disparity, ranging from 11 to 178 seconds, reflecting individual differences in memory recall.

The total scores across the six tests ranged from 9 to 16 points, with a mean score of 14. Participants completed the exercises between 147 seconds and 769 seconds, with an overall mean completion time of approximately 290 seconds. Figure 6 summarizes these tests.

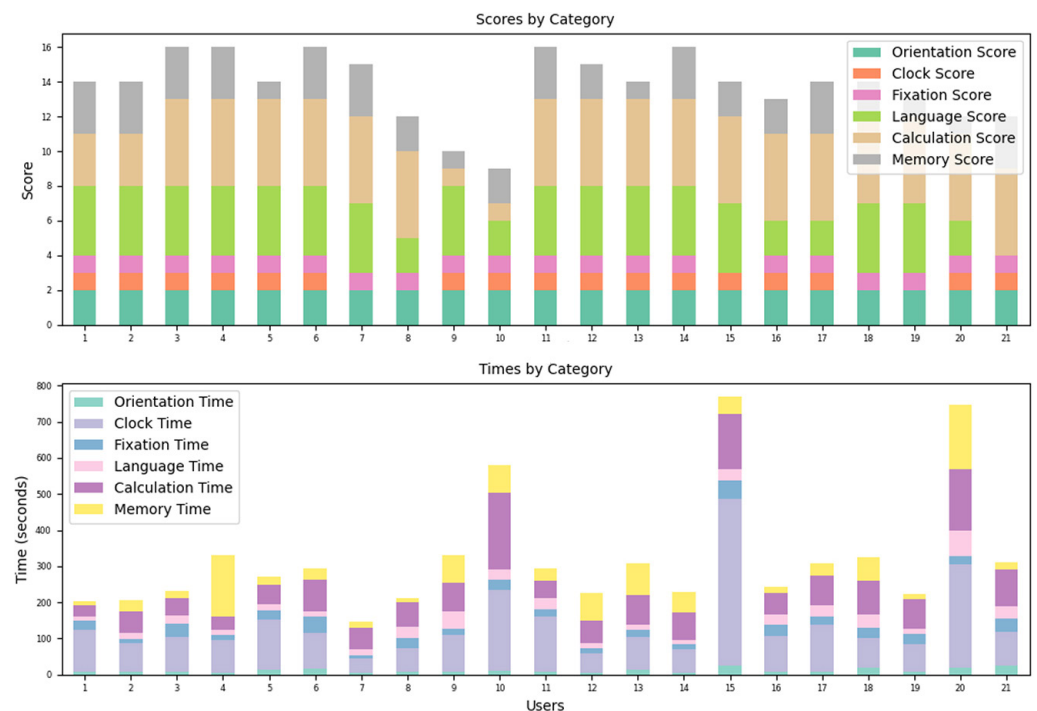


Fig. 6. Summary of test results

4 DISCUSSION AND EVALUATION

4.1 Discussion

The digital adaptation of traditional cognitive tests such as the Mini-Cog and MMSE proved effective, with most participants achieving high scores in tests such as orientation, fixation, and calculation. The consistent performance of these tests validates the ability of the application to deliver accurate and reliable results.

The variability observed in memory and clock-drawing tests suggests that specific exercises may require further optimization to enhance clarity and user interaction.

Interactive elements, including drag-and-drop mechanics and audio prompts, significantly boosted user engagement. Participants noted that these features made the exercises more intuitive and enjoyable than traditional methods. However, motor-skill-intensive tasks, such as arranging numbers and clock hands, presented challenges for older participants, highlighting areas where interface design could be improved to enhance accessibility.

Completion times varied significantly across tests, with the clock-drawing and calculation tasks requiring the most time due to their complexity. In contrast, the orientation test was completed quickly, indicating its straightforward nature. This variation underscores the need to balance cognitive demands across exercises while accommodating diverse user capabilities.

The repeatability of the tests was carefully analyzed to ensure that results remained consistent across multiple attempts by the same participant. Tests such as orientation and fixation exhibited high repeatability, with minimal score variation and completion times. This reliability underscores the robustness of these tasks as cognitive assessment tools. In contrast, the memory and clock tests showed more significant variability between attempts, suggesting that these exercises may be more sensitive to external factors, such as user familiarity with the interface or environmental distractions. Addressing these discrepancies through refinements in test design and delivery could further enhance the repeatability and reliability of the application.

4.2 Evaluation

To elicit subjective experiences of the participants with MentAlzh, a 12-item questionnaire was developed. The questionnaire is organized into four domains: The first component of the study is usability and navigation, which is comprised of five items that assess interface clarity, task flow, control responsiveness, error message helpfulness, and load times. The second component is perceived utility and reliability, which is comprised of four items that assess confidence in cognitive measurements, trust in result reporting, early-detection potential, and multimedia enhancement. The third component is overall satisfaction, which is comprised of one global rating. The fourth component is recommendation and open-ended feedback.

All quantitative items employed a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). For the evaluation of usability and navigation, the domain mean was determined to be 4.2 ± 0.6 . The perceived utility/reliability metric achieved an average of 4.4 ± 0.5 , while the overall satisfaction metric attained a mean of 4.3 ± 0.7 . A total of 18 out of 21 participants (86%) expressed their intention to recommend MentAlzh to their acquaintances. A significant proportion of respondents expressed their satisfaction with the drag-and-drop mechanics and audio prompts, with 67% providing positive feedback. Additionally, 43% of respondents suggested expanding the interactive buttons, and 29% advocated for simplified error notifications. The results of this study provide further evidence that MentAlzh is both functionally sound and favorably received as a preliminary cognitive screening tool.

4.3 Comparative analysis

A feature-based comparison of six representative cognitive-screening methods was performed using seven key criteria: the number of cognitive domains assessed, mode of administration (face-to-face versus digital), requirement for a trained professional, offline operability, support for multimedia elements (e.g., audio or graphics), level of interactivity (ranging from static questionnaires to drag-and-drop interfaces), and capacity for unsupervised, self-administration. This analysis demonstrates that MentAlzh not only evaluates the broadest spectrum of domains but also uniquely integrates offline functionality, rich multimedia interaction, and full self-administration within a single mobile platform. The summary of this comparison is shown in Table 2.

Table 2. Feature-based comparison of MentAlzh and other cognitive screening tools

Method	Domains Assessed	Administration	Professional Required	Offline Capable	Multimedia Support	Interactivity	Self-Administered
Mini-Cog	Short-term memory, visuospatial (2)	Face-to-face	Yes	No	No	Low	No
MMSE	Orientation, memory, attention, recall, language (5)	Face-to-face	Yes	No	No	Low	No
CST [14]	Orientation, memory, visuospatial (3)	Web-based	No	Yes (caching)	Text-only	Moderate	Yes
Mobile Alzhe_Alert [19]	Risk questionnaire (1)	Mobile online	No	No	Text-only	Low	Yes
AlzhApp [20]	OCT-derived metrics (1)	Mobile offline	No	Yes	Static imaging	Moderate	Yes
MentAlzh (ours)	Orientation, memory, language, calculation, visuospatial, fixation (6)	Mobile offline	No	Yes	Audio cues, drag-drop	High	Yes

By including Mini-Cog and MMSE in the comparison, it is evident that MentAlzh uniquely offers broad domain coverage, offline self-administration, and rich multimedia interaction—features missing in traditional tests and only partially available in other digital tools—providing a clear, qualitative framework for evaluating trade-offs beyond diagnostic metrics.

5 CONCLUSIONS

The MentAlzh prototype demonstrated effectiveness in assessing cognitive impairment across six domains: orientation, clock drawing, fixation, language, calculation, and memory. Across 21 participants, total scores ranged from 14 to 21 points, with performance times ranging from 147 to 769 seconds.

The findings indicate that the clock drawing and calculation tests exhibited the most significant variability among participants, underscoring their potential as key indicators for the early detection of cognitive decline. Conversely, the consistently high scores observed in the orientation and language tests suggest that these cognitive domains remain well-preserved across the sample population.

The survey results indicated that MentAlzh is both intuitive and reliable, with an average usability rating of 4.2 and a perceived utility rating of 4.4. Additionally, the survey revealed an 86% recommendation rate for the program. The qualitative feedback indicated that the drag-and-drop interaction and audio prompts were highly regarded, while proposing minor UI modifications. These findings serve to validate the effectiveness of the application and the level of user satisfaction.

Finally, an analysis of demographic trends revealed that older participants required more time to complete the tasks. In contrast, female participants tended to perform tasks faster in specific domains, emphasizing potential differences in cognitive performance linked to age and gender.

6 ACKNOWLEDGMENT

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7 DECLARATION OF GENERATIVE AI IN SCIENTIFIC WRITING

During the preparation of this paper, the author(s) employed ChatGPT to enhance the writing process by improving clarity, ensuring consistency, and providing language support. Following the utilization of this tool/service, the author(s) reviewed and edited the content as necessary and assumed full responsibility for the content of the publication.

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