DERCA Tool: A Set of Tests for Analysis of Elderly Dexterity in Information and Communications Technologies

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Abstract. The use of information technologies by the elderly remains a problem in today's society, which the pandemic problem by COVID-19 has highlighted, notably in the use of fixed and mobile media such as laptops, smartphones and tablets. The fight against info-exclusion and the promotion of digital literacy is not new. Still, we increasingly realize that the elderly population cannot handle the required skill. This electronic computer equipment has now become part of the daily life of the entire population, particularly the adult population, which has found itself confined and isolated, but which needs to keep in touch with family and friends. The present work began during the pandemic, constituting a set of tests that allow assessing how the continued use of information and communication technologies, namely through computers, mobile phones, and tablets with video conferencing support, the use of camera for photo manipulation, memory games, among other applications, increase the dexterity and cognitive ability of the elderly. The presented model establishes the methodology supported in the software development, a tool that makes it possible to test and evaluate the dexterity and the cognitive development and that is available for free use on various platforms. This tool is called DERCA Tool – that is a set of Analytical tests for Dexterity and Reasoning Capacity Analysis in Elderly.

Keywords: ICT · Computer systems · Mobile devices · Elderly training · Analytical tests

1 Introduction

The use of electronic equipment, such as desktops, laptops, smartphones and tablets, by people of advanced age is a problem that has greatly affected society, focused on combating info-exclusion. Several entities, such as senior universities, try at all costs to offer training to seniors, who, with greater or lesser success, are able to access content on the Internet, with particular emphasis on social networks [1, 2].

Physical training and rehabilitation, maintaining sensory stimuli in the elderly, preventing the ageing process from proceeding in an accelerated manner, in which many of the elderly would eventually lose their motor skills, in particular their mobility [3].

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On the other hand, the role of private social solidarity institutions is unequivocally a pillar in supporting active aging, promoting playful activities, physical training, and rehabilitation, maintaining sensory stimuli in the elderly, preventing the ageing process from proceeding in an accelerated manner, in which many of the elderly would eventually lose their motor skills, namely their mobility [3].

Over the past years, corresponding to the evolution of information systems and telecommunications equipment, such as mobile phones, more or less powerful, several authors have been analyzing and evaluating people's behavior in the use of such equipment, showing that natural evolution in children and young people quickly surpasses all expectations, being naturally more able to use information and communication technologies [4, 5].

However, the assessment of dexterity and learning ability in the use of these technologies in the elderly (age $>$ 64) has not been extensively worked, except in some studies that tested the use of tactile input devices such as touch screens, mouse computer, among others, in the execution of games and other computer programs, as referred to in [6].

Some authors have addressed other issues related to the use of technology by the elderly population, mainly in the area of domestic use of protective and safety equipment, remote monitoring, and equipment to help improve the quality of life. Particularly in [7], authors conducted a study in Australia, where they test and evaluate elderly care residents, who can no longer live independently at home due to physical or cognitive disabilities associated with aging. For this, the authors used virtual reality systems to support their playful activities and social interaction.

In another study presented in [8], the authors evaluated the impact that the use of video conferencing by Zoom had on the personal and social lives of the elderly, given the confinement dictated by the restrictions imposed by the pandemic by COVID-19, having tested and evaluated their behavior.

Other studies have focused on the evaluation of the ability of hand movements in people with various pathologies, such as dementia and Alzheimer's [9, 10], not focusing on the technology itself, but rather on how the loss of dexterity in people with these pathologies can be mitigated.

By analyzing several studies and works presented, we found that the assessment of dexterity and cognitive evolution of the elderly through the continued use of information and communication technologies has not been highlighted in the studies carried out. That is why we have focused on this aspect, with one main question: how can we evaluate the dexterity and cognitive evolution of the elderly through the continued use of information and communication technologies? To answer this question, we developed a computer tool, called DERCA Tool, an acronym for Dexterity and Reasoning Capacity Analysis for Elderly people.

2 System Concept

The proposed system in response to the question presented is based on a set of objects and concepts that are naturally associated with the use of information and communication technologies, both by children and young people, and by adults and the elderly, with particular emphasis on the latter group of individuals, aged 65 years and over. Several studies show that adults lose some faculties in terms of mobility and dexterity from this age onwards, requiring some additional therapy, in order to preserve their quality of life [11–13].

The COVID-19-derived pandemic has been causing movement restrictions in the world population, forcing the elderly population to stay at home, being the most vulnerable group to the Sars Cov-2 virus. Consequently, family distancing, leading to many institutionalized older adults who could only see their relatives through the media, by videoconference, most often with the help of support staff and geriatric technicians. This phenomenon is also present in other situations, well before the pandemic, whenever social isolation is required [8, 14]. Thus, to answer the question posed, the system we propose must respond to a set of functional and non-functional requirements, serving the population that we intend to analyze and evaluate.

2.1 Functional Requirements

The system must respond to the following set of requirements:

- Color test: considering that age, vision, and color distinction tend to decrease, a test should be created that aims to use colors, with some degree of randomness, as a differentiating element in the process of carrying out the test.
- Number test: considering that one of the most frequent current activities of the population, namely the elderly, is related to the use of numbers in accounts, dates, hours, and other matters, a test with numbers should be created with some randomness in the presentation.
- Symbol test: considering that geometric figures are present on people's days, circles, rectangles, triangles, and the combination between them, a test with symbols should be created that should appear randomly.
- Timer: the system should allow counting of the time it takes to resolve a test.
- Demo mode: the system must have the training mode, allowing users to test the application without counting time, allowing the user to familiarize themselves with the system.
- Recording of results: the values obtained for each user must be stored in memory for later viewing and archiving.

Figure 1 shows the diagram of use cases with the specific roles assigned to the actor "researcher" who can view the recorded data. The "user" actor refers to the user who will be performing the test, and the system includes the start-time mechanism whenever the user starts the test. When starting the test, the objects must be randomly arranged so that positional tampering cannot occur, avoiding bias.

2.2 Non-functional Requirements

Alongside functional requirements, we must pay special attention to non-functional requirements, such as:

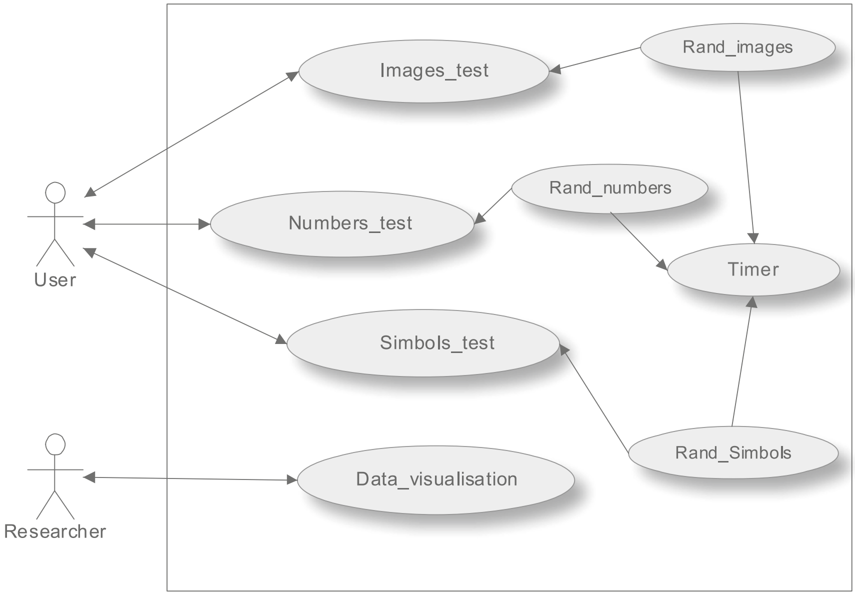


Fig. 1. Use case diagram.

– Accessibility: the system must be accessible to people with different levels of movement capacity and manual dexterity.
– Usability: the system must be easy to use, bearing in mind that the system's users are elderly who will have little or no digital literacy, and therefore it must be intuitive.
– Multiplatform: The system must be multiplatform, working in different environments and operating systems, to avoid restrictions on its use.

Considering the target audience, small mobile devices are naturally not recommended for carrying out the test since they will be challenging to use in terms of pressure on graphic objects. Therefore, it is recommended to use it on tablets or computers with screens of at least 10".

3 System Prototype

In order to comply with the goals defined concerning functional and non-functional requirements, the prototype of the system was developed, to answer the question posed at the outset. Thus, with this prototype, we hope to obtain information that allows us to assess the dexterity and reasoning ability of the elderly who perform the tests.

The system will be made available free of charge in online and Windows versions. It can be used freely in studies that the scientific community intends to perform, with due reference to the authors. The full application can be freely accessed and run in http://filesjpl.000webhostapp.com/app. Additionally, the full HTML5 application can be downloaded from: http://filesjpl.000webhostapp.com/app/psico_tests_v1_en.zip.

3.1 Interface

The interface of the DERCA Tool system is quite simple, as defined in the requirements, so that elderly users do not have to read a user guide, options, parameterization, among other more complex processes. The anonymity of the electronically collected data is guaranteed, and a code can be added for each user, which will remain active throughout the session. Figure 2 shows the main screen, where three types of tests are presented: colors, numbers and figures, and it is possible to see the results obtained and stored in memory in the session.

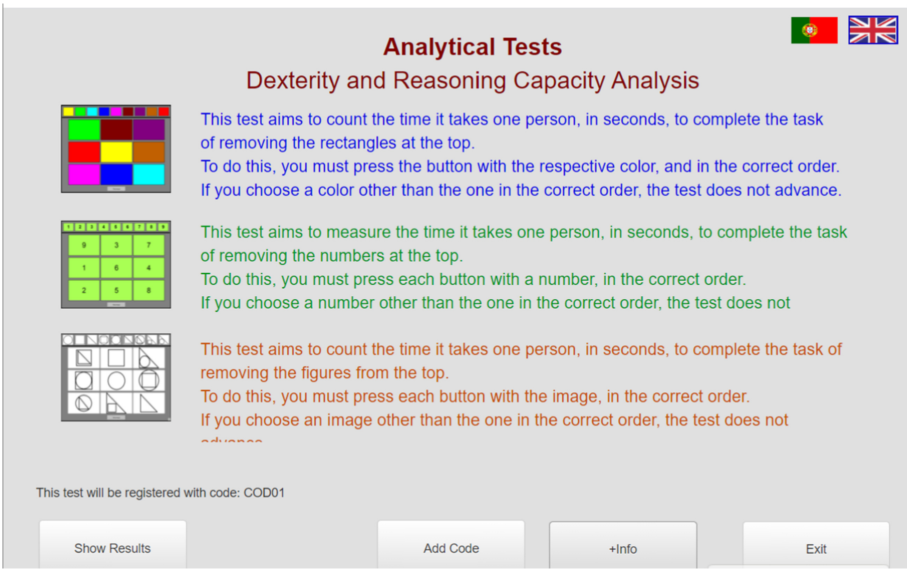


Fig. 2. Main program interface.

In Fig. 3, we show the interface of the tests related to primary and considerably different colors.

This test aims to count the time it takes one person, in seconds, to complete the task of removing the color rectangles at the top. The user must press the button with the respective color and in the correct order. If the user chooses a color other than the right order, the test does not advance.

Fig. 3. Random color test interface.

Figure 4 shows the test interface with numbers, where the numerical layout is generated randomly. The order at the top is not the natural order, so there is some difficulty in memorizing. Otherwise, the test was too obvious.

Like present in the previous screen, this test aims to measure the time it takes one person, in seconds, to complete the task of removing the numbers at the top.

Fig. 4. Random number test interface.

Figure 5 shows the test interface with figures, where the figure layout is randomly generated. This is the test with the most significant margin to be changed and may use image bank in the future.

Like present in the previous screen, this test aims to measure the time it takes one person, in seconds, to complete the task to remove figures at the top.

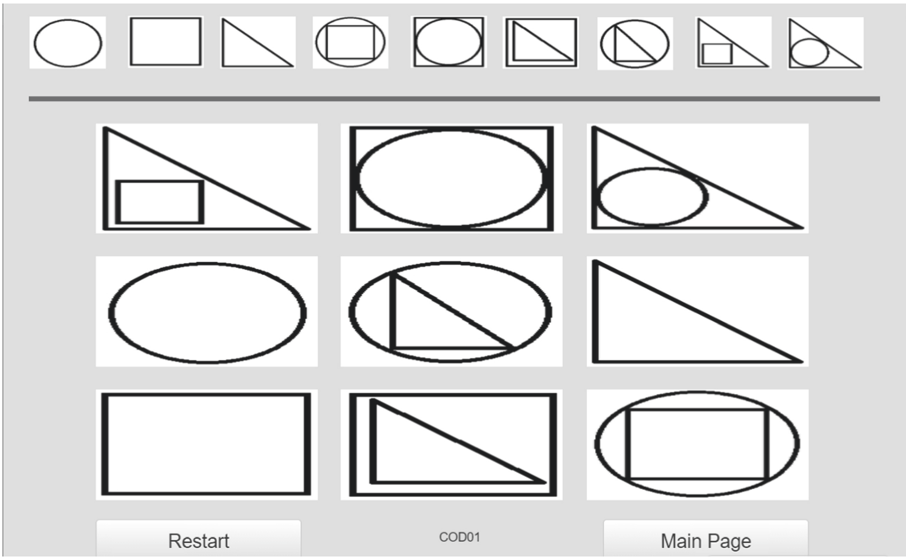
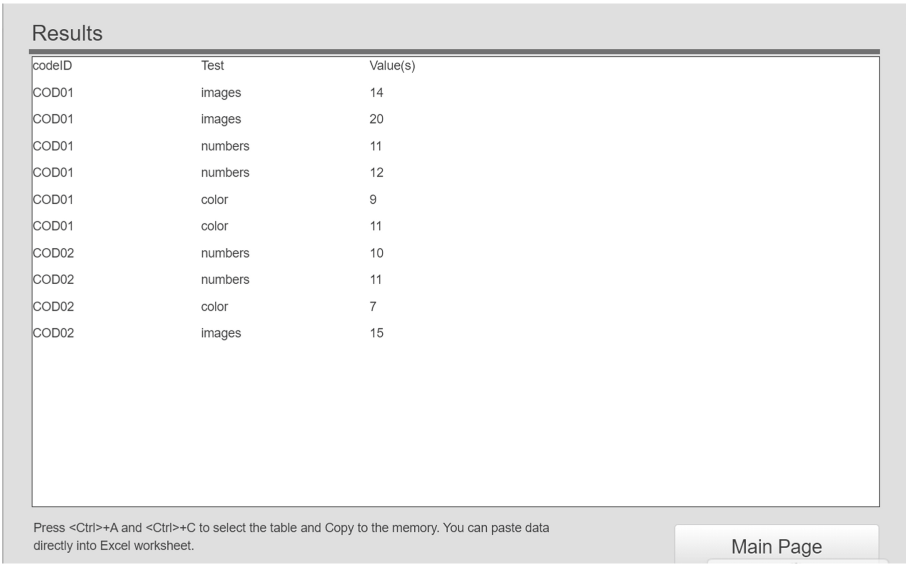


Fig. 5. Random figures test interface.

In Fig. 6, we have the interface where we can visualize the obtained data. These data can later be selected, copied, and pasted into a spreadsheet for statistical treatment, as shown in Fig. 7.


Results

codeID	Test	Value(s)
COD01	images	14
COD01	images	20
COD01	numbers	11
COD01	numbers	12
COD01	color	9
COD01	color	11
COD02	numbers	10
COD02	numbers	11
COD02	color	7
COD02	images	15

Press <Ctrl>+A and <Ctrl>+C to select the table and Copy to the memory. You can paste data directly into Excel worksheet.

Main Page

Fig. 6. Results screen, where data can be copied to the memory.

3.2 Data Analysis

After data export, the user conducting the study will have the possibility to analyze the evolution evidenced by the elderly in the use of computer tools, comparing the data obtained in two or more evaluation moments, also comparing the results with the test group and the control group.

It should be noted that the system can be easily adapted to perform dexterity and cognitive development tests using mathematical calculus and other forms of data presentation. However, in this version, we only intend to show the system's potential for the dexterity tests in the elderly population.

It should be noted that the target audience of these studies will be conditioned to a set of variables that extrapolate the objectives and goals of the proposed system, since factors such as age, the capacity of movements, or the psycho-motor capacity, among others, may condition the results, therefore the studies should be directed to the person, preferably.

This tool should be used in conjunction with other qualitative analysis tools and preferably accompanied by researchers from multidisciplinary fields, such as sociologists and psychologists, and is not a tool for obtaining isolated results from simple tests without a control group nor iterations within a time space.

	A	B	C	D	E
1	Results				
2	codeID	Test	Value(s)		
3	COD01	images	14		
4	COD01	images	20		
5	COD01	numbers	11		
6	COD01	numbers	12		
7	COD01	color	9		
8	COD01	color	11		
9	COD02	numbers	10		
10	COD02	numbers	11		
11	COD02	color	7		
12	COD02	images	15		
13					
14					

Fig. 7. Results copied to Excel spreadsheet.

4 System Validation

In order to validate the system presented we propose an application scenario, showing how a study can be conducted in the future using this tool.

4.1 Flowchart

In Fig. 8, we show the conduction flowchart of a study using the DERCA Tool.

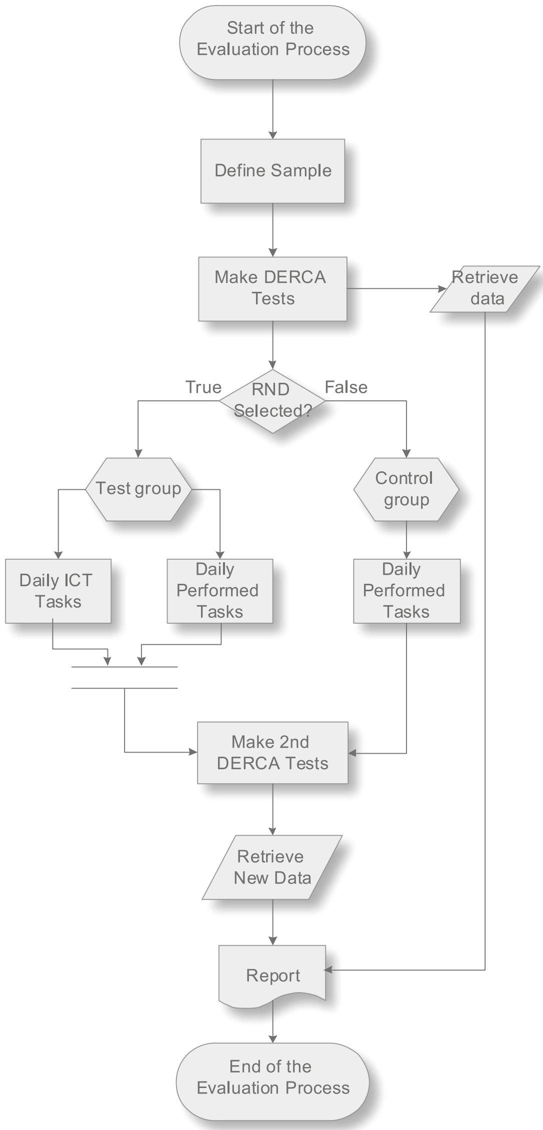


Fig. 8. Conduction Flowchart of a dexterity study with DERCA Tool.

4.2 Application Scenario

Let us consider an A entity that intends to assess the dexterity in terms of the use of computer means of the elderly who are assisted by a social solidarity institution B, to whom it plans to provide computer equipment to communicate with the family.

For this purpose, entity A selects a group of N users to whom, after having shown and explained the study's objective and collected informed consent, starts to perform the tests present in the DERCA Tool system.

Each test, of colors, numbers, and figures were performed three times to obtain the average time to complete the test tasks. Of these N users, the test group was selected with 50% at random. For two months, they began to use computer devices daily, similar to those used in the test, to perform tasks related to word processing, memory games, among others, in addition to regular maintenance and other activities.

The other 50% maintained their daily maintenance activity, physiotherapy, and recreational activities, thus constituting the control group.

At the end of these two months, entity A's team passed the tests using the same methodology for measuring the average times for carrying out the difficulties with the DERCA Tool system.

After obtaining the results, each test group member should be compared in terms of average testing times, allowing it to validate whether the skill in terms of using the computer equipment has benefited or not from the fact that, for two months, the user's test group have used computer equipment.

This application scenario will allow entity A to propose to institution B a solution in terms of the use of IT equipment, that improves users' performance in the use of this type of equipment. Information and communication technologies are currently quite useful because COVID-19 has led to a physical estrangement of institutionalized elderly persons from their other family, often being the only way to communicate.

5 Conclusion and Future Work

In conclusion, we can state that the system presented here has great potential in conducting studies based on dexterity tests in the elderly population. The natural aging process continually degrades its motor and psychic faculties, diminishing their dexterity's abilities.

On the other hand, computer illiteracy on the part of the target audience, combined with advanced age, makes this type of system and studies a real challenge for their authors, always aiming to improve people's quality of life.

The concern with making the tool available for free on various platforms is especially aimed at the management teams of social solidarity institutions, who may see this tool as an ally for decision-making in terms of adopting a specific information and communication technology.

As future work, we intend to make the application dynamic, with a test database, differentiated and stratified by sectors of activity, adapted to different target audiences, and allowing direct export of data to standard formats, namely CSV.

Also, in future terms, it is intended to implement a set of parameters that will allow a behavior adjusted to different users and various behaviors in terms of randomness.

Last but not least, to support other languages, making the application open source and with customization in this parameter can count on the collaboration of members of the community that support the opensource software.

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