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Research Article

Population-based Data for a Digital Cognitive test: Cognitive Healthy Participants Experience

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Abstract

As the population of the world increases, there will be a larger number of people with major neurocognitive disorder and an emerging need for prompt diagnosis and treatment. A digital cognitive test could lead to that more people can be tested without burdening healthcare. To explore elderly's experiences of using a digital cognitive test a cognitive healthy population of 70-year-olds were recruited from an ongoing longitudinal study in the north of Sweden. A qualitative study design was used, 132 participants conducted the cognitive test. After the test, the participants answered a short questionnaire of their experiences of the digital cognitive test. The free text comments were analyzed using systematic text condensation. Participants appreciated the opportunity to complete a cognitive test in digital form from their own choice of place and time and rated the cognitive test high. The participants expressed that they felt more relaxed when they were allowed to sit and complete the test by themselves. Negative experiences of fatigue and difficulty staying focused throughout the test were also reported.

Keywords: Cognitive impairment; Digital technology; Assessment; Experience.

Introduction

Major neurocognitive disorder (MCD), or as previously termed dementia, is currently a global driver of healthcare costs, and with an aging demographic, the disease burden of cognitive disorders will increase exponentially in the future. The prevalence is estimated to double every two decades, reaching approximately 80 million affected patients worldwide in 2030 [1]. In 2016, the global costs associated with dementia were 961 billion Euro and are currently projected to increase to 2 trillion Euro by 2030, corresponding to roughly 2% of the world's total current gross domestic product (GDP) [2,3].

As there will be a larger number of people with MCD and an emerging need for prompt diagnosis and treatment. Early dementia screening is the process by which is determined as having, or not having, the hallmarks of a neurocognitive condition. Dementia, or MCD, is an umbrella term for neurocognitive disorders with Alzheimer's disease (AD) being the most prevalent, constituting approximately 60% of all cases.

The concepts of mild cognitive impairment, or mild neurocognitive disorder, are useful in analyzing the patient in the early phase and describe subtle loss of neurocognitive abilities occurring before manifest MCD. The search for early MCD requires a comprehensive clinical evaluation, cognitive assessment, determination of functional status, corroborative history, imaging and cerebrospinal fluid. Primary care team with physicians, nurses, and occupational therapist, among others, are central in the screening process and are vital in initiating specialist investigation and treatment. Early MCD screening is especially important in an age where there is a search for disease modifying therapies and, if given early, might influence the natural history-hence the need for cost-effective screening measures for early MCD [4,5].

A common process for getting a cognitive diagnosis is a suspicion of memory problems, by the patient himself, relatives, or healthcare professionals. A first step is to conduct a cognitive test, supplemented by medical history and a symptom questionnaire that relatives fill out. If the suspicion persists or is confirmed, the patient can be referred to a specialist doctor where further investigation takes place. Today, assessment of cognitive functions still largely relies on analogue "pen and paper" based tests administered to patients by health care providers [6]. In Sweden two of the most used cognitive tests include the Montreal Cognitive Assessment (MoCA) and the Mini-Mental State Examination (MMSE) [7,8]. Although optimal cut-off points vary somewhat between different studies, a score lower than 26 on MoCA and 24 on MMSE are considered indicative of dementia [9-12]. These instruments are, however, coarse measurements of cognitive functioning and do not capture subtle cognitive impairment [11]. With the global aging population and with successful dementia medicines in clinical trials, there is a need for cognitive screening that is more sensitive to subtle cognitive impairment, is cost-effective and which can be made available to more patients who experience subjective cognitive decline. The use of digitized cognitive screening batteries for clinical purposes have been reported to lead to a possible increase in accessibility to earlier and more precise assessment as well as serial testing to evaluate treatment (Gualtieri and Johnson, 2006), and therefore have the potential to ascertain earlier assessment, earlier diagnosis and, eventually, better prognosis. World Health Organization states that digitized cognitive screening can be proposed as a method to track clients' health status and support health workers in decision making.

Computerized cognitive tasks can offer several advantages over traditional paper-and-pencil assessments that are particularly valuable when the patient does the test in their own choice of setting. The patient may feel more comfortable and the situation less stigmatized. For the caregivers the advantages include standardized administration, ease of scoring and administration, ease of generating alternate forms of tasks, and higher scoring precision [13].

Given the earlier reported estimated increase in dementia prevalence combined with possible disease-modifying drugs, there is an urgent need for increased access to cognitive tests. Additionally, the digital set up of the test eliminates administration bias from health care providers and creates a more homogenous diagnostic tool. A digital test recently reported in a proof-of-concept study, is the Geras Solutions Cognitive Test (GSCT), a self-administered digital screening tool for cognitive impairment, and a promising option for potential large-scale screening in the setting of cognitive deterioration [14]. The GSCT is a comprehensive digital tool that provides, besides the cognitive test, a medical history questionnaire that is administered by

the patient, and a symptom survey that is administered by the patient's next of kin. Overall, GSCT performed at least as well as compared to currently available screening tools for dementia disorders while simultaneously providing several advantages. The test is administered via a digital device, thus eliminating the time-consuming need for testing provided by health care practitioners while also increasing the availability of cognitive screening.

Aim

The aim of the study was to explore elderly's experiences of using a digital cognitive test.

Materials and methods

Study design and participants

This study was conducted from March 2021 to February 2022. The population were recruited from the Healthy Aging Initiative (HAI), an ongoing observational study of 70-year-old adults residing in the Umeå municipality in Umeå, Sweden which was first initiated in June 2012. The primary objectives of the HAI-study are to investigate traditional and novel risk factors for cardiovascular disease and injurious falls and fractures in 70-year-old men and women. Only two eligibility criteria apply: that the individual is residing in the Umeå municipal area and is 70 years of age at the time of testing [15,16]. The HAI study includes several tests and assessment instruments.

GSCT is a digital tool for memory assessments; it consists of a cognitive test battery, anamnesis, and a symptom survey. GSCT is developed on existing cognitive assessment tests (MoCA and MMSE) and includes additional proprietary tests developed at the memory clinic, Karolinska Hospital, Sweden. The test is suitable for digital administration through devices supporting iOS and Android. The test is composed of 16 different items assessing various aspects of cognition, developed to screen for cognitive deterioration in the setting of dementia and to ensure suitability for administration via mobile devices. The GSCT is scored between 0-59 points in total with six domains: memory (0-10 points), visuospatial abilities (0-11 points), executive functions (0-13 points), working memory (0-19 points), language (0-1 point) and orientation (0-5 points).

The digital test is constructed to be used in a reading tablet or smartphone. Smartphones and tablets use a touch screen to allow users to interact. This makes it possible for the user to listen to instructions, see examples with moving illustrations, to draw at the screen and allow recording of their voice when needed. The instructions in GSCT are voice based, written text and illustrated by showing how to perform, depending on the upcoming task. It is possible for the user to turn the voice off.

The sample included 144 individuals who underwent HAI testing during March 2021 to February 2022. Of those 132 gave written comments in an additional study questionnaire. Inclusion and exclusion criteria for the sample selection were as follows; Inclusion criteria: cognitively healthy individuals, fluent in Swedish, 70 years of age, provided written informed consent. Exclusion criteria: participation in a cognitive study within the last three months, cognitive problems (MMSE <26), diagnosis and/or symptoms of depression, serious somatic disease, any disease, or events affecting the central nervous system. Those who agreed to participate after the initially written information and a follow-up phone call, received instructions and were scheduled for testing 2-3 weeks later.

When answering GSCT, the participants also answered a study specific questionnaire to explore how elderly experience taking a digital cognitive test. The questionnaire consisted of three questions concerning participants' experience of using the GSCT: "How would you grade your overall experience of the digital test?" "What did you like about the test?" "What did you not like about the test?" And in addition, one section for comments: "Other comments"

Analysis

The first question could be answered by grading a 5-point Likert scale. The other questions were answered with free text. The questionnaire was anonymous. The free text comments were analyzed by the authors, following systematic text condensation (STC) described by Malterud. STC is a descriptive and exploratory method for thematic analysis of qualitative data. The method for systematic text condensation is suitable for the analysis of meaning and content [17,18]. The analysis followed four steps: (1) reading all material to gain an overall understanding, (2) identifying and coding units of meaning that represented experiences related to the aim of the study, (3) summarizing and condensing the content, and (4) synthesizing and describing concepts in categories.

Quantitative data such as, gender, education was collected from the original baseline of the included participants and is presented with descriptive statistics.

Ethics

The HAI was approved by the Umeå University Research Ethics Committee (no. 07-031M) and complied with the World Medical Association's Declaration of Helsinki. All participants provided written informed consent.

Results

A total of 144 participants (42% men [n = 61] and 58% [n = 83] female) were included in the major study. A total of 132 participants answered the study specific questionnaire (response rate 92%). The participants' educational level is displayed in Table 1.

	All patients (n = 144)	Male (n = 61)	Females (n = 83)	Education > 12 years (n = 87)	Education< 12 years (n = 57)
Age (years)	70	70	70	70	70
XXCT (points + SD)	46.0 (4.5)	46.3 (4.5)	45.7 (4.4)	47.0 (4.5)	44.4 (4.1)
MMSE (points + SD)	29.4 (0.7)	29.5 (0.6)	29.4 (0.8)	29.4 (0.7)	29.4 (0.7)

Table 1: Descriptive data; All values are presented as means and standard deviation.

After the GSCT was completed, the participants had the opportunity to answer the study specific questionnaire where the first question asked for their overall experience which the participants answered by grading a 5-point Likert scale. Most of the participants rated the test highly (Table 2 and figure 1).

Options	Dislike 1	2	Neutral 3	4	Very positive 5
Total					
N = 132	1	3	26	54	49
% = 100	0,8	2,2	19,0	41,0	37,0

Table 2: Overall experience of the digital test.

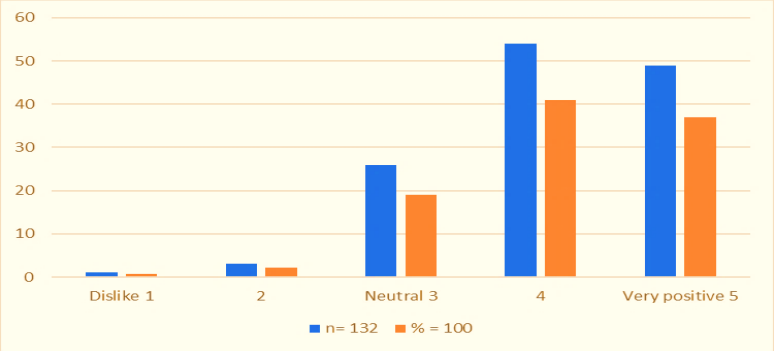

Figure 1: Overall experience of the digital test.

For the three open-ended questions, the analysis resulted in four categories described below.

General experience of the GSCT

Participants were asked to provide information about what they believed was good about the app and what they did not like. Many participants wrote about a specific part of the test, for example counting, while others described experiences related to the test as a whole. Positive comments were often about that there were many different parts with different levels of difficulty. Several pointed out the user-friendliness. The majority of the participants wrote that the GSCT was easy to use.

"*Simple good questions, easy to handle, easy to use*"

Some participants appreciated deciding for themselves when and where the test would be conducted.

"*That you could sit by yourself and fill in, it made you have time to think*"

However, negative comments were also provided, e.g., experiences of exhaustion and difficulties to stay focused during the test.

"*Got tired, long test*"

Experiences of test instructions

Several participants expressed a need for better instruction. Some of the participants wrote they were confused whether they were permitted to use both voice instructions and written instructions. There were also comments about experiencing difficulties e.g., concentrating due to an overwhelming amount of information with both text and images at the same time. Others described that the written instructions were too long and not always presented in a logical way.

"I read slowly and want instructions that includes less words but all necessary information"

One of the first tasks in the test is to repeat words, the instructions are to listen, repeat and remember the words. Some of the participants misunderstood the part of the instruction, that instructed them to remember the words.

"I didn't understand that I was supposed to remember the words"

Some of the participants found the digital technology in itself stressful, in addition they experienced stress over the whole situation of testing their cognitive ability

"*The instruction should emphasize that you should take it slow and not tense up*"

Technical qualities of the test

In relation to technical qualities of the test, participants comments were e.g., related to technical problems they encountered while taking test, but were not related to the app itself. For example, a few participants commented on technical problems with internet connections.

"*In the middle of the test I was thrown out, perhaps it was my own fault*?"

However, there were also problems related to the computerized voice for the voice instructions, which the participants experienced as difficult listening to.

"*I had trouble hearing the voice, it spoke too fast*"

One participant pointed out that the user-friendliness of the digital cognitive test for a visually impaired person was insufficient.

"*I have poor eyesight and had difficulty with the technology, so I had to restart several times*".

But there were also positive comments in relation to the technical aspects and qualities. Participants commenting on the test being easy to take and the opportunity to choose when you want to move on was experienced positively.

"*Easy and nice to do the test on an iPad*"

However, some participants worried beforehand that they would not manage to take the test.

"*I felt worried that I would not handle the technology and became stressed.*"

Reactions receiving the test result

The most frequent comment about taking the test was that the participant felt stressed taking the test due to the knowledge that it was a cognitive test and that they were concerned about the test result.

"I worried about the result, but it's good to be able to do it anyway. The test is voluntary"

There were also participants who expressed that the result gave them a reassuring message and that they felt relieved that there were no problems.

"*Nice with reassuring message*"

Discussion

Using a sample of middle-aged and older adults this study not only describes the experience of using the test but also in some way the concurrent validity of the cognitive tests since the useability showed to be high. Qualitative research has the potential to provide insights that can be missed when using a quantitative method. However, qualitative studies of patients' experiences of cognitive tests are limited, and more so when it comes to digital versions of cognitive tests. We sought to address these knowledge gap by conducting a survey administered to a population of healthy 70-years old men and women. Our purpose of the study was to explore elderly's experiences of using a digital cognitive test. It is often a challenge to develop new technology and discover all potential pitfalls. In addition, when the target group might not be used to operate smartphones and apps, the developer needs to be extra responsive and take this into consideration.

The GS cognitive test battery was designed to be administered unsupervised, and, although there were staff members present in the clinic during test administration, participants were expected to work through the cognitive assessment independently without a tester observing. Because no tester was there to help participants understand the test instructions, the onscreen instructions for each test must be clear.

Digital care services are a natural part of the future care. Used correctly, it can contribute to more accessible, efficient, and equal care. The development of digital care services has been fast in recent years. And the demand for digital contacts has also increased during the pandemic. A continued development of new working methods with the support of digitization has great potential to make care both better for patients and more efficient

for society. Digitization is a powerful tool for streamlining care, working more preventively, and meeting an increased need for care without a corresponding increase in costs. To summarize, this study, indicate that the users of the GSCT rate the test high due to usability. Before discussing the results in more detail, we address some methodological limitations of this study.

The questionnaire was not constructed to identify specific usability issues or provide detailed information on efficiency of the test that was evaluated. For an in-depth evaluation, usability testing or other forms of usability evaluations would be necessary. However, to gain an overall understanding of the level of usability of the GSCT the study was valuable. It is not possible to determine whether the participants of our study are representative of all potential users. The participants had agreed to join an extensive health survey, HAI, and were then asked to take a digital cognitive test. It was not possible to connect this data of education or gender to individual participants, since the study specific questionnaire was anonymous.

As in most survey studies, the participants form a small sample of all possible users. All the participants were from the north of Sweden. The participants had a higher education level than the general population. Among our participants, 60.42% (87/144) had higher education, whereas only 42% of the general Swedish population does [19-21]. Therefore, we cannot tell whether the composition of our sample is due to well-educated persons are more likely to answer a survey or are more used to digital technology.

Carrying out a test often means thinking about the results and how you perform. In this case, the knowledge about the purpose of the test, to find early signs of cognitive difficulties, also made some participants to think more about the possible consequences of the outcome. Stress taking the test was commented on by the participants in our study. Stress can affect the results and the literature shows that in some cases stress causes poor performance. The level of stress interferes with your ability to recall knowledge from memory as well as your ability to use higher-level thinking skills effectively [22]. In the GSCT as well as other cognitive tests, stress is a factor that must be taken in consideration when interpreting the results.

The findings in this study showed that the participants rated the possibility to use a digital cognitive test high. The possibility of taking the test from anywhere using a device such as phones or tablets and consequently be in a comfortable environment, creates conditions for a more trustworthy result. In this study we could see that participants appreciated the increased accessibility and the experience of independence. Other findings were positive impact on time spent for travel. Most patients felt that the cognitive digital test was easy to handle. Digital care services can contribute to make care more equal, since more patients can get access to a medical assessment.

Since the GSCT is built on a platform, its design and functionality are the same for all users. This is positive because a caregiver's personality or interpretation of answers does not affect the result. The results of this study have shown that the digital test can be successfully used based on patients' preferences.

The big advantage of digital tests is to reduce the time that health care spends on cognitive tests. Data show that a time saving, and thus cost savings can be demonstrated without the result being jeopardized. On the contrary, the standardization means that collected data is estimated to be more relevant by healthcare professionals [23].

Conclusions

We conclude that the participants of this study rated usability of the GSCT high. The overall experience was that it is easy to use a digital app to test cognitive ability. In addition, the participants appreciated the opportunity to sit by themselves and complete the cognitive test. Further research into more specific usability areas is needed to ensure usefulness and ease of use in the future.

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