Information Technologies for Cognitive Decline

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Abstract. Information technology (IT) is used to establish diagnosis and provide treatments for people with cognitive decline. The condition affects many before it becomes clear that more permanent changes, like dementia, could be noticed. Those who search for information are exposed to lots of information and different technologies which they need to make sense of and eventually use to help themselves. In this research, we have systematically analyzed the literature and information available on the Internet to systematically present methods used in diagnosing and treatment. We have also developed an artifact to help users obtain information with help of illustrations and text. The final user groups are all those for whom the cognitive decline is of concern. Medical professionals could be interested to direct their patients to use the artifact to gain information and keep learning at their own pace.

Keywords. Cognitive decline, information technology (IT), diagnosis, treatment

1. Introduction

Cognitive decline is difficult to understand. Initial signs are memory lapses that can be attributed to exhaustion or stress alone. They are frequently linked to more serious brain abnormalities that can escalate into permanent disorders. Early diagnosis of illness progression is the focus of clinical research. The difficulty lies in detecting the problem and connecting many tests to establish a diagnosis as early as possible [1]].

Clinical tests provide an objective way of documenting symptoms, but there are other tests used by doctors and psychologists. Most of them appear to be done on paper and during medical consultations. There are numerous strategies and procedures used in clinical practice when it comes to therapy of dementia, but it is less clear how to identify cognitive decline and understand its severity as well as keeping it under control. The questions that both health care professionals and patients face are choices of appropriate methods for diagnosing and treatment. IT provides many tools, but it is not always clear what would be the most appropriate for cases at hand. Even medical experts are commonly asked about possibilities based on IT to help patients monitor their condition and treat it. To that end there are many IT solutions designed for patients including games [3], virtual reality (VR) [4][5], and personalized service robots [6]. In this research we aimed at formulating what user demands could IT solutions address, and how [1]. The

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goal of this study is to assess various IT approaches to recognize cognitive decline and to prevent its development into diseases such as dementia.

2. Method

In this research, we have combined two methods, first the comprehensive literature review to obtain the knowledge structure. In addition, the artifact was designed to provide users the possibility to search for and explore different IT solutions used in cognitive decline.

2.1. Literature review

Keywords used were *cognitive decline, information technology (IT), diagnosis* and *treatment*. A total of 39 papers were analyzed in detail. In addition, the Internet was searched for information on websites which included clinical information, patient information, and games available for people with cognitive decline. YouTube was searched for information on the decline instructions, clinical testing, instructions for those interested in a healthy lifestyle, and understanding symptoms and signs of decline.

2.2. Prototype development

A prototype was developed through two iterations, low-fidelity, and mid-fidelity. The latter was implemented in Figma [7], which allows modeling with intended user groups and enabling user-centered design. The code can be imported into the final product [7].

3. Results

3.1. Literature review

Figure 1 shows the division of the IT solutions according to their applications. Clinically relevant is the severity of the condition.
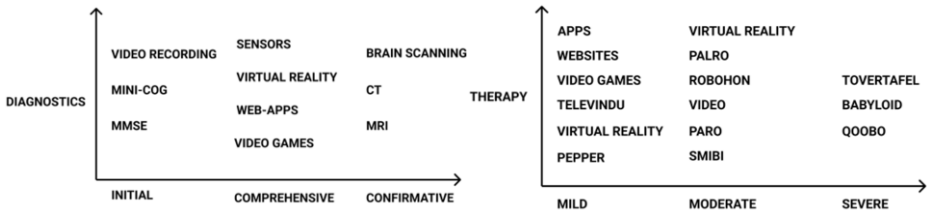

Figure 1. Division of the IT solutions according to their clinical applications.

Some of the technologies are in form of information systems, while the others are including sophisticated medical equipment such as computed tomography (CT) and magnetic resonance imaging (MRI). They are considered reliable tools for establishing an exact diagnosis. However, due to the cost of such medical examination, many other pure IT solutions are appealing and are developed intensively to meet users' needs.

Figure 2 is a graph containing the main technologies used in cognitive decline. The tree like structure was designed to make a search for information easier. Here a user can

see for example techniques used for diagnosing such as self-testing (mini mental status exam), sensors, brain imaging, and VR. For treatment often used are robots, games, websites, and VR. The design is intuitive and navigated by clicking on the nodes to get more detailed information. Some techniques are suitable for both diagnosing and treatment which could be further explained under the nodes.
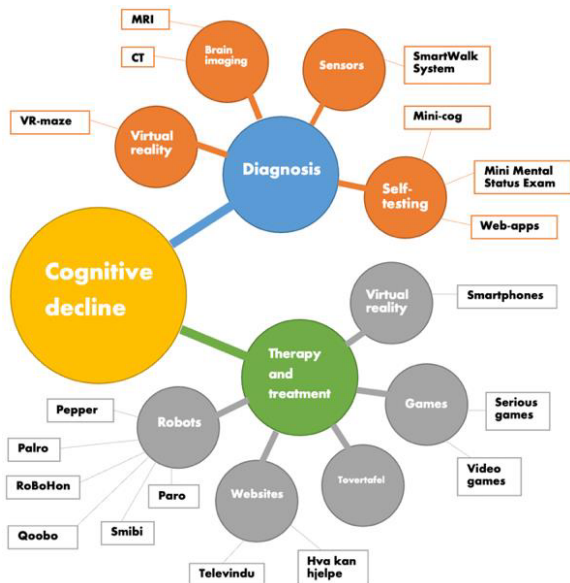

Figure 2. Overview of IT solutions for diagnosis and treatment of cognitive decline.

3.2. Prototype

The prototype is designed for a broad user group searching for information and knowledge on cognitive decline. It is intended for medical professionals, but also as a tool they could recommend to their patients. It was required that information should be easy to read and that there would be a good overview of all technologies available. The goal is that the system could be implemented within different kinds of websites by importing code in Figma. Figure 3 illustrates a mid-fidelity prototype. The colors are chosen according to the recommendations [8]. Preferred are strong colors like red against a neutral background and contrasting colors like black and white for technical details [9].
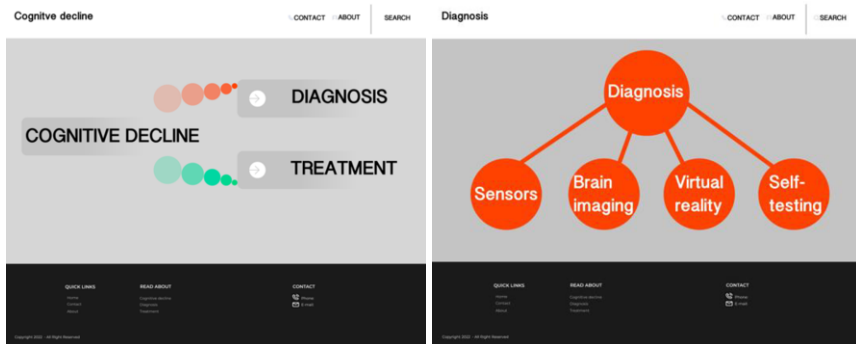

Figure 3. Mid-fidelity prototype for MacBook 14´ with landing and the diagnosis page.

4. Discussion

There is a lot of information on cognitive decline, but it takes time and effort to structure knowledge and understand applications, benefits, and impact for a person with cognitive decline [1][2]. The clinical picture is also complex since it is not clear when the decline has begun, how severe it is, and what can be done to prevent the decline [1]. We aimed at structuring all the information in a user-friendly way to make it available to the public. For that it was necessary to perform a comprehensive analysis of the results and develop a user-friendly prototype that would allow users to read and process all the information successively and their own pace [9]. The starting point was clinical using the literature since it was difficult to approach all intended users. A set of requirements could vary for different user groups, and especially those in whom cognitive decline has already started. This group would be different from people with diabetes who have a clear picture of their situation [2]. Our intention was however to make all the information accessible and easy. The prototype was implemented to enable user experience and provide feedback. It is essential for implementing the prototype to include health care and medical field professionals. The knowledge on the decline is evolving, so the prototype should be regularly updated with new facts. The current design allows for that due to its modular structure. The development is multidisciplinary and concerns both clinical and IT aspects. The study limitation relates to the use of literature only, hence missing clinical input.

5. Conclusions

Depending on the severity of the condition several tools are usually available for cognitive decline. Resulting of this research is knowledge structure and a mid-fidelity prototype that enables users to interact and follow their inquiries to learn through both illustration and text. The future work entails evaluation by IT and medical experts to refine design and address the clinical complexity.

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