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Mindup: A Platform for Monitoring and Cognitive Enhancement for Patients with Alzheimer's Disease

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Abstract

Alzheimer's Disease (AD) is an illness that degenerates an individual's cognitive functions, leaving them unable to take care of themselves. Even without a definitive cure, AD should be treated with remedies and cognitive enhancement. This article presents an application that assists in the cognitive reinforcement of AD patients through games, supports the medical follow-up of patients, and facilitates the daily exchange of information between the caregiver and the doctor.

Keywords:
Smartphone; Alzheimer Disease

Introduction

Alzheimer's disease (AD) is the most common form of dementia, characterized by being a disease that destroys nerve cells, disrupting synaptic connections, causing severe memory loss in addition to other symptoms that worsen over time [1]. Currently, AD has no cure but can be treated through medication and cognitive enhancement activities to prevent disease progression [2].

In the literature, we have found several applications that may help in cognitive enhancement in patients diagnosed with AD through games, however, none of the applications presented a dedicated platform to specialized observation of patient's performance in the games by the doctor, that is, it does not provide a form of communication between them and the caregivers.

As a way to help doctors, caregivers, and patients with the initial level of Alzheimer's disease to have better interactions, this work presents an application called "MindUp" for mobile devices and web, where it's possible for patients to have access to specific games of cognitive exercise. These exercises serve as daily reinforcement of their functions in a controlled way and the caregiver can make out daily reports of the patient and assist the doctor monitoring the evolution of the disease.

Methods

This work began with a bibliographical review of studies done by neurology experts on Alzheimer's Disease and its predictions for the next years and generations, as well as informal interviews with neurology professionals to try to validate the idea and collect system requirements. In this context, the stages of the software development process, based on the ideas of the Scrum process [8] and adapted to the text of the work, were started. The requisites collected for the system were: A) Medical account management; B) Caregiver account management; C) Patient account management; D) Cognitive reinforcement exercises (games); E) Results; F) Exercise performance monitor (for doctors); G) Caregiver's Reports history and H) Daily Report Fill.

A comparative analysis was made with 4 applications that serve the same purpose: "Fit Brain Trainer" [3]; "Lumosity" [4]; "Elevate" [5] and "Peak" [6]. These applications are the ones closest to the approach proposed by this work. The comparison can be seen in Table 1, where C indicates that the application has the associated requirement and N/C where it doesn't. When observing the collected data, the proposed system has as a differential the functions related to A, B, F, G and H requirements in relation to the related applications.

Table 1 – Applications comparison

(R)	[3]	[4]	[5]	[6]	M
A	N/C	N/C	N/C	N/C	C
B	N/C	N/C	N/C	N/C	C
C	C	C	C	C	C
D	C	C	C	C	C
E	C	C	C	C	C
F	N/C	N/C	N/C	N/C	C
G	N/C	N/C	N/C	N/C	C
H	N/C	N/C	N/C	N/C	C

Based on these requirements, the "MindUp" system, composed of three dedicated interfaces for each user role (Doctor, Patient, and Caregiver), is being implemented. Figure 1 shows the activity flow of the actors in the proposed system. Subsequent sections explain in detail each step of this flow.

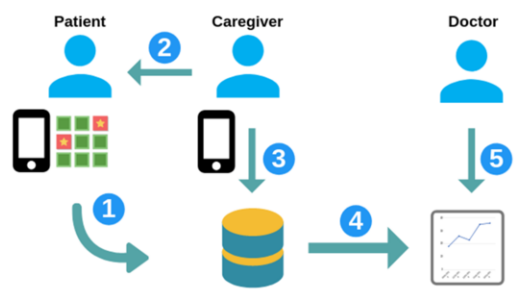

Figure 1 – Activity flow on MindUp

For the patient, the application has a simple and intuitive interface inspired by the guide to serious games for cognitive treatment [9], where the patient will have access to the game of cognitive reinforcement. In "MindUp", a memory game is used and can only be accessed at a determined time, which is

configured by the doctor, so that there is no overload of exercise and stress to the patient.

In step (1), the patient must access the platform at the time specified by the doctor and perform a round of play. Each round consists of 3 levels of difficulty, the first with 3 pairs of cards, the second with 6 pairs and the third level with 8 pairs.

For the caregivers, we used the test to catalog the daily behavior of the patient, which is observed by the caregiver in step (2), and capture details of the patient's daily life.

In step (3), the caregiver will be presented to 10 multiple choice questions that were developed by neurologist James E. Galvin, whose main purpose is to detect the level of the disease in patients, applying the questions seasonally [7].

The doctor can register their patients on the platform, giving each of them a credential, and configure the patient's times of use of the application. Subsequently, after processing the data collected by the patient's use and by the caregiver's follow-up, the system will generate data on the patient's daily income, as demonstrated in step (4).

The daily yield (Dy) is measured by the average points of each session (S) marked by the patient on a given day. The score of each session (S) is made by the average score (Pt) of each level of the game, which is calculated by the number of pairs of cards marked (x) times 10 divided by time (t). Therefore, the calculation made to gauge the yield is given by the following formulas adopted by the author 1)Ap = (10 * x) / t; 2)S = (Ap1 + Ap2 + Ap3)/3 and 3)Dy = (S1 + S2 + S3)/3

In addition, the doctor can access reports produced by the caregivers and can access the last one produced or of a certain date. This process is represented in step (5)

Results

Currently, the project is undergoing validation, prototyping, implementation, collection, and analysis of new requirements, as well as refinement of existing ones, and improvements in system architecture.

Figure 2 shows the main functionalities of the system, already implemented. The interface (1) demonstrates how its user interface (UI) is proposed by the Caregiver, who will answer the multiple choice questions; the UI (2) already demonstrates a use of the game of memory that will be accessed by the patient; Finally, the UI (3) demonstrates the proposal of the physician interface, which can be used to monitor the patient's treatment.

MindUp attempts to bring greater interaction among doctors, caregivers, and patients, collecting information onthe daily and specific behavior that may occur on sporadic days, and may encourage further research.

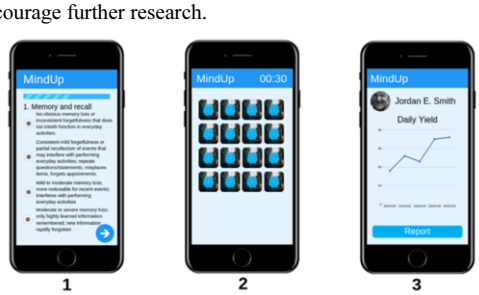

Figure 2 – UI for different roles in Mindup

Through informal interviews with neurologists, a great deal of acceptance was noted by practitioners. It was noticed that the application "MindUp" is useful those involved with Alzheimer's disease treatment, and therefore, we had a greater interaction of professionals in this project, where they were always giving ideas of what the proposed system could do.

The system proposed here differs from other related platforms in that "MindUp" proposes to be an open platform and most of the features that its competitors promise are paid. None of the related applications showed any interactivity with physicians and caregivers, showing the results of the training only for the end-user, and also does not give the caregiver the ability to record daily patient behaviors

Conclusions

The "MindUp" system still has the potential for growth, mainly because it has partnerships with professionals to understand, collect and validate requirements, which can bring new functionalities and integrating other types of cognitive reinforcement exercises.

Continuous use of the system, which has not yet been carried out, and a follow-up of a considerable number of patients can give new visions about the system and prove its relevance in the face to other available solutions.

Acknowledgments

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