PROLOG: Evaluating Attentional Capacity in Special Working Centers

Kinect technology tasks for cognitive assessment of disabled workers

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***Abstract*—The PROLOG project aims to provide a complementary tool for the assessment of cognitive skills of mentally disabled working people. The project provides a platform to evaluate, in a quick and personalized way, the attentional performance of users through specific tasks. Interaction with the tests is done by Kinect technology. The platform records the worker's performance on various tasks and presents the evolution over time in order to detect possible cognitive impairment. Longitudinal evaluation of cognitive impaired workers will help the existing unbalanced retirement practices.**

Keywords: cognitive impairment; evaluation; attention; Kinect.

I. INTRODUCTION

Elder mentally disabled people may suffer cognitive impairment associated with premature ageing. This impairment is usually related to difficulties in maintaining attention and problems associated with memory, plus many other physical related challenges.

The employment of cognitive impaired people -or mental illness- is a social objective that contributes to improve the quality of life of cognitive impaired workers, providing many benefits such as a full social integration [3]. The deterioration of these basic cognitive abilities may hinder the performance of job duties or even stay in employment. For example, the inability to maintain sustained attention (concentration) can hamper the worker to complete the tasks or steps in a process; or problems with memory may make it difficult to remember already learned tasks or learn new ones. Thus, there is a need to have a longitudinal assessment throughout the working life of these workers in order to ensure that the employee retains the skills that were described in the initial evaluation. Thus, tools to help assess the degree of disability and the development of the individual throughout his/her working history are required to optimize the evaluation process.

The PROLOG project aims to provide a complementary tool for the assessment of cognitive skills of mentally disabled working people. The project develops an Information and Communication Technologies tool with a set of tests to assess cognitive impairment of people with intellectual disabilities working in special employment centres. PROLOG has its innovation in incorporating Kinect technology [6] that recognizes body movements and voice to interact with applications. This technology, as applied to the field of rehabilitation of disabled people, is being used for the first time to develop tests to assess attentional capacity.

Currently, the tests used to assess attentional capacity are not adapted for people with cognitive impairments. Furthermore, the tests use to be paper-based and need to be carried out by a specialist, taking considerable administration.

The project presents three important improvements regarding the current evaluation tools: 1) Creation of new interaction of existing attentional tests which are already in use for evaluation of workers with cognitive disabilities; 2) Creation of evaluation benchmarking to correlate the results of attentional tests. Values will be objective and numeric, allowing a longitudinal evaluation across the working life of the person; and 3) Creation of personalised exercises, complementary with tests, to exercise attention and maintain skills. Also, the user-centric approach of the project contributes to an added value, since it makes the application friendly for any group of users.

In the following Methodology section, the content of the tests is presented. Then, the paper outlines the contribution of the project as well as future work.

II. METHODOLOGY

In this first stage of the project, we designed a series of new tests based on validated psychological tests. Specifically, attentional capacity was chosen because it is a fundamental cognitive function that is usually seen rapidly affected in the presence of cognitive impairment, making it difficult for other executive functions to take place. The project also provides a platform to record the execution of various tasks and users and their carers can see the evolution over time in order to detect possible cognitive impairment.

Currently, the tests are being implemented and we expect to have a preliminary version of the tests ready for pilot testing by February 2014.

We aim to create attractive and motivating tasks, using similar stimuli and goals presented in videogames. During the first year, three tests are being designed to evaluate different dimensions of attention. Specifically, the tests aim to evaluate sustained attention (two tests) and selective attention (one test). The design of such tests is presented below.

A. Evaluating sustained attention

Sustained attention can be defined as the ability to maintain attention during continuous and repetitive activity.

We designed two tests aimed at assessing the ability to sustain attention over a period of time.

We adapted the test Sustained Attention to Response Task, SART [2][4]. This test aimed at measuring the ability of a person to inhibit responses to infrequent and unpredictable stimuli during a period of rhythmic and rapid responses to a frequent stimuli (generally associated with the detection of an unlikely-to-occur stimuli). SART test presents only one digit at a time, and the participant's task is to quickly respond to all numbers except to one in particular (e.g., touching the screen in every trial, except when the number 3 is presented). Thus, it is a reaction time task that evaluates sustained attention through an element of response suppression.

In our test adaptation, we replaced the digits for images (insects, for example) in order to make it more attractive to users. The goal of the game would be to hunt insects in a forest with a network hunt. During the test, images of insects appear rhythmically in various predetermined positions of the screen. Similar to SART test, the task is to "catch" all the insects, except one in particular. The user has to perform a motor response (i.e. raise the hand simulating the action of grasping) when the stimuli is detected, or do nothing when appropriate. Thus, the user has to pay attention to avoid hunting a pre-defined insect or element. The test finishes when the participant exceeds a determined number of errors, or when a time limit is over. After the test, performance results are presented such as for how long the test lasted or the number of errors during a predefined interval of time.

In a second task, we adapted the TAP test [5]. This task requires the comparison of two subsequent stimuli in order to determine if these two stimuli have a predetermined feature in common. This procedure requires the use of working memory and flexibility and, in a more complex variant, the ability to divide attention, as two aspects of the stimulus must be taken into account.

In our adaptation for Kinect, users ware presented with a background image (e.g., a forest) with some highlighted regions where the stimuli may appear. Following the example of the insects, the user's task is to detect as quickly as possible whether the stimulus is the same as before (e.g., same insect), or not. Thus, there are two possible answers (same or different) that the user perform raising right or left hand in order to activate buttons showed in the screen. When the tests finishes, results such as the percentage of correct answers, errors and omissions, as well as reaction time are presented.

B. *Evaluating selective attention*

Selective attention is the ability to attend one or two important stimuli, while deliberately suppressing the consciousness of the distracting stimuli. In order to assess selective attention, we adapted the Flanker Compatibility Effect [1]. This is an experimental task designed to study factors that may affect selective attention, and to what extent information processing of irrelevant information occurs. The experimental task is to attend a central stimulus flanked by other stimuli called flanks or distracters. The subject's task is to identify the central stimulus (for example, a letter) and ignore the side letters.

In our adaptation of the test, the stimuli are images of insects that point to a particular direction (for example, images of three caterpillars pointing to the left). User task's is to say whether the central insect looks to the left or right (caterpillars presented on the sides can point to the same direction or the opposite). The user must indicate if the direction of the track is to the right or left. At the end of the test, performance results would inform about percentages of correct responses, errors and omissions, as well as the average reaction time.

In all tests, the results can be displayed for a particular session, or in graphical comparisons between multiple sessions (of the same or different users). Also, given the user centric approach of the application, the test parameters can be modified through a configuration screen before starting, and these parameters can be saved for each user in the platform in order to adapt the difficulty of the tests to different users. For example, it may offer the possibility to choose a category of stimuli (fruits, colours, shapes, etc.), or to define which particular element is defined as target stimulus within a category. Additionally, other parameters may be configured such as presentation time of the stimuli, the duration of the interval between stimuli, or the number of trials in each test.

In the final phase of the project, we will conduct a validation test. In this sense, the tests will be carried out to employees of several special working centres in Catalonia. Two groups will be defined in order to compare tests results, one group showing signs of cognitive impairment or not. To verify the concurrent validity of the tests, the results of both groups will be compared with other existing assessments (e.g., ICAP test, medical evaluations, etc.), and potentially affecting variables will be controlled.

III. CONTRIBUTION

The PROLOG assessment tool will have an important impact. Health and safety risks will be monitored, and, when an employee is no longer able to work, it will be possible to show the progression in the deterioration, avoiding the existing reality of disabled workers having to work until the retirement age of 67, unable to perform any task, still having to go to work every day.

IV. CONCLUSION AND FUTURE WORK

The implementation of the evaluation tool, together with the platform to manage will allow working special centres to assess their employees and detect and confirm possible cognitive impairments. Despite the fact that the project it is in its first version, the usefulness of the tool had been appreciated by the psychologists from the special working centres. The first preliminary tests showed the value of the tasks as a complementary assessing tool as well as an engaging way of training attentional skills.

In the future, it is planned to extend the number of tests to assess other cognitive skills such as memory or executive functions. Also, new exercises with Kinect will be created as training sessions to improve or maintain cognitive abilities.

Regarding the platform, it is expected to provide support for a possible protocol to evaluate the continuity on the workplace, containing extra information from other medical and neuropsychological tests. Thus, the evaluation tool would be useful to the users themselves (to see their evolution), the company-employer, and finally the government.

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