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Design and Implementation of a Web-based Application to Assess Cognitive Impairment in Affective Disorder

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CCS CONCEPTS

• **Software and its engineering** → *Software design engineering*;

KEYWORDS

Design; Implementation; Cognitive Assessment

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1 INTRODUCTION

Affective disorder causes mood disturbance and includes depression and bipolar disorder. Cognitive impairment is one of the determinants of poor functioning in patients suffering from an affective disorder. For example, memory impairment in bipolar patients brings about confusion in their daily life. Other cognitive domains include attention, executive function, and psychomotor speed. Cognitive function of these patients are assessed by means of neuropsychological tests such as California Verbal Learning Test (CVLT) and Trail Making Test (TMT) that are used to examine verbal memory and psychomotor speed, respectively.

The “Screen for Cognitive Impairment in Psychiatry” (SCIP) is a simple and brief screening tool for psychotic disorders including bipolar disorder and depression. It examines cognitive skills namely verbal learning, working memory, verbal fluency, and psychomotor speed [2]. SCIP is a paper-based test battery and is used in clinical setting, in which the examiner explains the instructions and read several words and letter-number sequences to the patient.

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However, current computerized test batteries require direct supervision of clinicians in a clinical setting. To our knowledge, none of the computerized test batteries for affective disorders have implemented SCIP in a form of a patient-administered assessment tool.

In this project we are developing a web-based cognitive assessment tool called “Internet-based Cognitive Assessment Tool” (ICAT) for bipolar and depressive patients. This application is a computerized and web-based version of SCIP, in which the third part of SCIP – the verbal fluency task – is replaced with Wechsler Adult Intelligence Scale (WAIS) letter-number sequencing task. In total, ICAT then consists of five sequential tasks, which are explained in section 3.

The aim of this project is to design and implement ICAT as a web-based cognitive assessment tool and examine its validity by running a clinical trial, which compares ICAT with the paper-based SCIP test as the golden standard.

2 RECENT WORKS

Computerized applications for cognitive assessment are currently limited. The Cambridge Neuropsychological Test Automated Battery (CANTAB) [5] is one of the validated test batteries implemented for a wide range of mental disorders. However, CANTAB has inadequate tests to cover affective disorder. The NIH EXAMINER (Executive Abilities: Measures and Instruments for Neurobehavioral Evaluation and Research) [3] is a computerized test battery which measures several cognitive domains. Although this application has multiple tests, a clinician should read a set of words to the patients when assessing verbal memory, which points to the direct supervision of clinicians. THINC-it [4] is a computerized cognitive assessment tool developed for Major Depressive Disorder (MDD) patients. It uses cognitive tasks like Digit Symbol Substitution Test and TMT (part B). However, this system doesn't support cognitive assessment of bipolar patients.

3 ICAT SYSTEM

3.1 Design Methods

The ICAT system is being developed in a user-centered design process involving neuro-psychologists, psychologists, computer

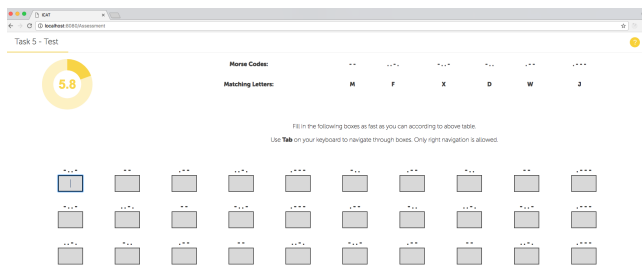


Figure 1: Task 5 uses a table of Morse codes and their matching letters to assess psycho-motor speed.

scientists, and front-end developers. Once the first prototype of ICAT is implemented, it is been planned to test it with some affective disorder patients.

3.2 ICAT Cognitive Tasks

ICAT includes five tasks which are described below:

- **List Learning:** A list including 10 words are read to the patient using a sound file. The patient should recall as many words as possible. This task is repeated 2 more times with the same set of words. It measures declarative memory and the score ranges from 0 to 30.
- **Consonant Repetition:** It has three letters, a starting number, and a delay (in seconds) for each of the 8 items. The patient counts backwards from the starting number. Then, after a delay, the patient should recall three letters. It measures working memory and the score ranges from 0 to 24.
- **WAIS Letter-Number Sequencing:** It has 7 sets, each set includes 3 letter-number sequences. For each sequence, the numbers should be sorted in ascending order and the letters in alphabetical order. The patient can proceed to the next set only if at least one of the sequences in the current set is reproduced correctly. It measures working memory and the score ranges from 0 to 21.
- **Delayed List Learning:** The word list in task 1 is not played and the patient is asked to recall the earlier words. It measures declarative memory and the score ranges from 0 to 10.
- **Visuo-motor Tracking:** A table including 6 letters and their matching Morse codes are shown to the patient. In 30 seconds, the patient should type the matching letters for 30 Morse codes. It measures executive skills and the score ranges from 0 to 30. (See Figure 1)

3.3 Feedback

Scores of all tasks are displayed to the patients at the end of the assessment. Later during a face-to-face visit, the examiner can interpret the results for the patient and compare his or her performance to a healthy reference group.

3.4 Implementation

The front-end of ICAT system is built using React v16.2.0. We are using the Open m-Health platform [1] as the data back-end. For this purpose, we are designing a Open m-Health JSON schema for cognitive functions, which will be used to store patient's cognitive profile. This profile includes cognitive skills such as memory and executive function.

In the original paper-based version of the SCIP method, the examiner reads the instructions, words, and letter-number sequences aloud to each participant. The main challenge in the implementation of this system is to convert the role of an examiner from in-person to a digitized format. For this reason, we are examining the use of Google speech recognition web API. It is developed for over 110 languages and will enable us to store each word that patients recall in text format for task 1 and 4.

3.5 Clinical Verification

ICAT will be subject to usability tests focusing on the ability for test subject to understand and perform the cognitive assessment tasks. Once ICAT has been improved based on the usability testing, a clinical verification trial is planned. The goal is to verify and compare the computerized ICAT system against the manual SCIP method as the golden standard.

4 CONCLUSION

We are creating a set of simple and short tasks similar to SCIP in a web application. The use of speech recognition module is supposed to maintain the short duration of the tasks. It has been estimated that 10,000 affective disorder patients in Denmark will use ICAT along with the progress of this PhD project.

5 ACKNOWLEDGMENTS

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