Demo: UbiCAT - Wearable Technology for Ubiquitous Cognitive Assessment

Pegah Hafiz
Department of Health Technology, Technical University of Denmark
Lyngby, Denmark
pegh@dtu.dk

Jakob E. Bardram
Department of Health Technology, Technical University of Denmark
Lyngby, Denmark
jakba@dtu.dk

ABSTRACT

The Ubiquitous Cognitive Assessment Tool (UbiCAT) is a wearable technology designed for 'in-the-wild' cognitive assessment. UbiCAT includes three smartwatch-based applications adapted from the Stroop color-word, n-back, and two-choice reaction time tests, respectively. UbiCAT aims to measure selective attention and processing speed, working memory, and inhibition control. UbiCAT can be used for real-life cognitive assessment and for experiments on human cognitive performance. Within the field of ubiquitous computing, it contributes to the cognition-aware systems.

CCS CONCEPTS

• **Human-centered computing → Ubiquitous and mobile computing systems and tools**.

KEYWORDS

cognition; wearable technology; memory; stroop task; attention; application

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1 INTRODUCTION

Cognitive functioning plays a significant role in human daily activities. The cognitive domains include working memory, verbal memory, executive function, attention, and psycho-motor skills. Human cognition fluctuates during the day depending on several factors including time of the day, age or history of mental illness.

In this demo, we present the Ubiquitous Cognitive Assessment Tool (UbiCAT), which is a wearable technology designed for 'in-the-wild' cognitive assessment. The UbiCAT mainly collects two types of data; contextual data and cognitive assessment data as explained in the following subsections. We will collect such data to find a correlation between the contextual and cognitive features. The outcomes of such study will contribute to the cognition-aware systems [1].

1.1 Contextual Data

FitBit Ionic smartwatch allows developers to collect the contextual data via the FitBit API. The contextual data includes physical activity, heart-rate, sleep, and location.

1.2 Cognitive Assessment Data

The UbiCAT apps are standalone apps designed based on the FitBit guidelines. Each app provides an instruction set to clarify the test procedure. The average response time and the number of correct responses are the common performance measures of the UbiCAT apps beside their corresponding cognitive measure. The UbiCAT apps are adapted from the Stroop color-word test [3], n-back test [4] and two-choice reaction time test [2]. To simplify recalling the apps, we named them as Color test (Stroop), Letter test (n-back), and Arrow test (two-choice reaction time). A brief description of each app is presented below.

1.2.1 Color Test. This test presents a set of color names displayed in an ink color. Each stimuli is either congruent or incongruent. A congruent stimuli is a color name with the same ink color as its meaning, for example, 'blue' displayed in blue while an incongruent stimuli is shown in a different ink color, for example, 'yellow' written in green. A screenshot of an incongruent stimuli is presented in Figure 1. As it is shown, four colors are displayed on the screen for the user to select the correct ink color as fast as possible. The cognitive performance in this test is measured by the Stroop effect, that is the average response time to the incongruent stimulus minus congruent stimulus.

1.2.2 Letter Test. The stimuli of this test is a set of letters appearing sequentially. The parameter of this test is N. N-back measures working memory and as N increases, the test becomes more difficult. If N equals 1, the user should memorize one letter back in the sequence. Similarly, in case of N=2, the user should recall two letters back in the sequence. Users should determine whether the current letter matches the N letter back in the sequence or not by tapping on one of the app buttons labeled 'Yes' or 'No' within a time limit. Figure 2 shows an screenshot of the 1-back test where the stimuli and N are 'T' and 1, respectively.

1.2.3 Arrow Test. Two-choice reaction time test measures response inhibition. This test presents a set of arrows, each pointing either to the left or right side of the screen. Users should respond as fast as possible by tapping on the right app button if the arrow points

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Figure 1: A screenshot of the Color test

Figure 2: A screenshot of the Letter test

to the right, otherwise they should tap on the left app button. An arrow may appear on the right or left side of the screen regardless of its direction. An screenshot of the test is presented in Figure 3.

2 DEMO

During the demo session at UbiComp we will bring a number of smartwatches with the software installed. Volunteers will be able to use the apps for a duration of a day and we will be able to analyze their data together with them.

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Figure 3: A screenshot of the Arrow test

REFERENCES

[1] Tilman Dingler. 2016. Cognition-aware systems as mobile personal assistants. In *Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing: Adjunct*. ACM, 1035–1040.
[2] Franciscus Cornelis Donders. 1969. On the speed of mental processes. *Acta psychologica* 30 (1969), 412–431.
[3] Charles J Golden and Shawna M Freshwater. 1978. Stroop color and word test. (1978).
[4] Wayne K Kirchner. 1958. Age differences in short-term retention of rapidly changing information. *Journal of experimental psychology* 55, 4 (1958), 352.