Assessing Visual Attention in Children Using GP3 Eye Tracker

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Abstract— **Abstract— The aim of this research is to propose an integrated platform for assessing visual attention in school-aged children. Due to several challenges in the use of standard psychological tests, technology-based instruments can represent a future opportunity for increasing accuracy in the psychological evaluations. The use of GP3 Eye Tracker together with OGAMA application can help to identify children that are at risk of developing learning or attention problems. By developing an integrated platform we will be able to accurately assess their visual attention skills, interpret accurately the data and predict their reading abilities.**

Keywords— eye-tracking; visual attention; learning problems; integrated platform

I. Introduction

Visual attention represents an important factor for the development of academic, and social skills [1]. The visual cognitive abilities can also be observed through eye movement using eye-tracker devices, from this point of view in this method the eye-tracker, as an infocommunication device a human- computer interface, is used to analyze hidden cognitive processes and fits in the field of Cognitive infocommunications in a synergistic way [2-3].

Definitions of visual attentions center mainly on three dimensions the orientation, vigilance and executive attention ; these factors taken togheter help the individual to focus and shift attention, as well as to maintain the alert state and inhibit automatic responses [4-5]. Visual attention deficits are highly correlated with learning and attention problems and with several specific abilities necessary for school, such as reading. This issue is important for the domain of special education since according to a recent survey (2012 developed in Romania by European Commission) 1 in 5 school-aged children have problems in reading and writing [6]. Considering that visual attention is linked with several learning problems, with specific reading disorders, such us dyslexia, there is a need to prevent the occurrence of learning problems in children. As we have stated above visual attention is a prerequisites of reading and types of processing that is believed to be impaired in dyslexia.

For example, some researchers [7] found that in a specific task that measures visual focus, individual that have difficulties in reading spent more time in finding the target compared to individuals that don't have these difficulties. Prevoius studies [8-9] also found that participants with dyslexia demonstrated reduced sensitivity to exogenous cues; suggesting that the cues did not attract attentional resources as efficiently in the group with dyslexia as in the control group.

II. MEASUREMENT OF VISUAL ATTENTION

In visual attention assessments, performance on a task is usually measured with self-reports scales [10-11] or tasks in which the participants need to decide whether or not the target stimulus is similar with the previously presented one [12]. Previous studies have emphasized the difficulties in assessment of visual attention, especially because the evaluation tasks include hundreds of trials, which are extremely boring and are not suitable for young children [13].

Considering these domain limitations or challenges our main objective will be to develop a computer based tasks that can be used together with eye tracking for developing suitable tasks for assessing visual attention in children. In order to achive our goals we need : a. develop comparable and suitable tasks for early school-age children (because is the proper age to train visual attention); b. to compare children's performance with data obtained in a classic tasks, and c. clearly identify children at risk to develop learning problems, by identifying the underlying mechanisms (such as visual attention). The tasks are difficult to develop since children that we want to screen are early school-age and have no capacity to read.

A. The use of eye-tracking for measuring visual attention

Eye tracking is a method that can detect and characterize subtle variation in spontaneous visual patters and is applicable for different types of individuals, including children with special needs, regardless of their level of motor or verbal abilities [14]. An important outcome that we target with this new technology is eye movements, which represent a natural information source that analyze the behaviors of the user, with the aim to infer implicit relevance feedback from gaze [15]. We will focus on detecting the eye movement since we base our model on hypothesis developed by Carpenter in 1980, which emphasizes the connection between the direction of the human gaze and the focus of attention [16]. In the domain of education, eye-tracking measurements proved to be useful in identifying ways in which existing user knowledge and attitude could influence visual patterns while using one educational game [17]. Previous researchers [18] used data such as gaze direction and gaze paths to identify the strategies used in interaction in some specific game levels.

B. GP3 Eye Tracker

One possible way to observe and record the look's trail, is by using units containing infrared LEDs (Fig. 1.), that have been successfully used by other studies so far. [19-20].

Fig. 1. GP3 Eye Tracker

The tool has 0.5-1°view angle accuracy, 60 Hz sampling, 5 or 9 points calibration option, easy usability, API and SDK supporting development, which enables 25 cm horizontal, 11 cm vertical and 15 cm depth motion.

C. OGAMA application

The OGAMA (OpenGazeAndMouseAnalyzer) is an open-source application written in C# high-level programming language, which was developed to track, record and examine eye and mouse motion. The application, among others, can store the data of different eye and mouse motions into a database, whereas exporting helps different stats software packages to evaluate them. The software supports several eye motion tracker units, including the Gazepoint GP3 to be used, moreover, thanks to its open-source feature, we can easily modify that according to our needs. The software was used as the result of several studies so far. [21-24]

D. Possible computer tasks that measure visual attention

The development of the tasks that measure visual attention in children of early school-age must take into consideration their motor skills and hand-eye coordination. Simultaneously they need to allow us to use evidence-based types of measurements, such as: reaction time measurements; attentional blink; eye-movements (with his subtypes of outcomes: fixation time, saccades, location of gaze and visual patterns). Considering all the above factors, one of the targets of our future work will be to develop computer based games, that could accurately measure visual attention (all three dimensions) and discriminate between typically developed ability and visual attention deficit and also that keep the children engaged in the task.. Below there are some examples of possible tasks that measure visual attention (indicated in Fig. 2).

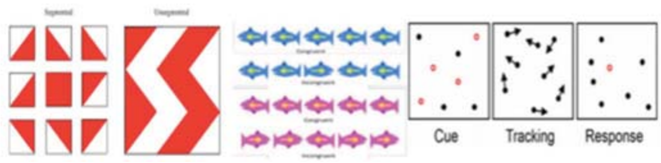

Fig. 2. Block Design Task, The Flanker Task, Multiple-object tracking task

The block design (see Fig.2a) [25] is widely used to discriminate a typical neuropsychological development since these children perform poorly in different ways compared to typically developing children. In this task participants need to arrange several blocks respecting a given pattern. **The Flanker Task** (see Fig.2b) measures the ability to suppress responses that are inappropriate by using inhibition [26]. **Multiple-object tracking task (**see Fig.2c**)** measures the capacity to track the positions of moving targets among distractors [27]. During this task the users need to follow the targets on the screen and then at the end, the targets become stationary and the user has to select the targets [28].

E. Challenges in the development of the tasks

The scientific and practical challenges for the development of these tasks from the educational point of view will be to: a. develop comparable (with standard tasks) and suitable tasks for early school-age children; b. compare children's performance with data obtained in classic tasks, and c. clearly identify children at risk to develop learning problems, by identifying the underlying mechanisms (such as visual attention). The tasks are difficult to develop since children that we want to screen are early school- age and have no capacity to read and must take into consideration their motor skills and hand-eye coordination. Simultaneously, these tasks need to be compatible to gathering objective data – through the eye tracker device – such as: manual responses reaction time measurements; attentional blink, eye-movements (with his subtypes of outcomes: fixation time, saccades, location of gaze and visual patterns). In order to measure visual attention in children and to be able to extract all the above mention outcome, which are relevant to visual attention ability, we need to develop a suitable methodology – both in terms of the platform that we will use to test the ability and in terms of the way we collect the data.

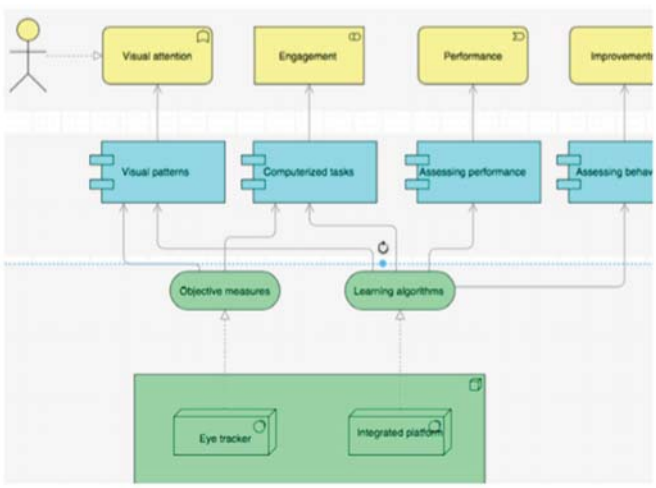

Fig. 3. Integrated platform

III. EXPECTED RESULTS

We expect to develop an integrated platform in each to include data gained with the GP3 Eye Tracker and analysed with OGAMA, which will corroborate data also from the tasks developed on the computer measuring visual attention. In this way we could measure visual attention, engagement of the child in the task, his/her performance and provide a solid plan for interventions for children with visual attention problems. (see Fig. 3)

IV. CONCLUSION

Considering the importance of visual attention in predicting learning [29], [30] or attention problems we propose a technology-based paradigm in which to accurately measure psychological outcomes. Also we believe that different obstacles in the assessment of executive functions [31], [32] can be overcome with the use of new technologies, such us eye-tracker system.

Based on the results the recognition of attention together with cognitive load/functions [33-42] the necessary development can be more comprehensively defined and may provide some important considerations to develop modern ICT and VR based learning environments [43] to improve the opportunities of VR and AR supported education [44-50], cooperative, cooperation methods [51-52], gamification [53-54] and ICT [55-61] and computer assisted learning [62]-[66].

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