EyeGrip as a tool for assessing dementia

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Abstract

In this study, we investigated the characteristics of eye movements while watching a set of scrolling images on a computer screen with a specific focus on the target images that draw more visual attention. EyeGrip is a novel eye-based interaction technique that monitors users' optokinetic nystagmus eye movements (OKN) whilst watching moving visual content on a screen. We explore how the OKN eye movements vary across different groups of participants (younger and older control subjects, and dementia patients) and whether EyeGrip could be used as a diagnosis tool for studying people with dementia.

In the first phase of the project, we compared the eye movement data between two groups consist of 6 younger and 6 older subjects. The finding is used as a baseline for the second phase which will include testing dementia patients. The results of the first phase showed that there is significant difference between OKN characteristics in younger and older subjects.

Motivation

Emerging evidence reveals that eye movement deficits develop with dementia (Crawford, et al., 2005). One of the well-studied symptoms caused by Alzheimer's disease (AD) is the inhibitory deficits (difficulty in preventing gaze toward salient stimuli (Crawford & Higham, 2016). Another symptom is exaggerated attentional blink during rapid serial visual presentation. A recent study has shown that people with AD have a unique form of attentional masking where they miss the first target but identify the second, depending on the number of intervening distractors (Kavcic, V., & Duffy, C. J., 2003). Other cognitive impairments that lead to different eye movements are top-down attentional process impairments and memory loss. Since in the task used in the EyeGrip test both top-down attentional process and attentional blink are involved, we are interested in finding out whether there Is any relationship between age (particularly on people with dementia) and the changes in the pattern of the eye movements when they look at moving images in an EyeGrip test.

Experimental Setup

Participants

Younger group: 6 participants (mean age = 28, SD = 7.1)

Older group: 6 participants (mean age = 68, SD= 6.3)

Procedure

We used a Smart Eye remote eye tracker for recording eye movement data that helped us to run the study in an unobtrusive way (eye tracker was 3 meter away from the user) at home environment. We recorded data in three sessions: 1- smooth pursuit test, 2- OKN test, 3- EyeGrip test. In the smooth pursuit test, participants looked at some target circles on the screen. In OKN test the participants looked at a series of scrolling images of well-known faces (actros/actress/politicians) while in the EyeGrip test they were searching for a target image. They were asked to press Space key when they found the target image. In each session we repeated the trial in three speeds: slow/medium/fast.

Design

Between group study, number of trials = 12 (participants)x3 (tests)x3 (speeds) = 108

Fig1: Experiment setup

EyeGrip

EyeGrip technique was originally introduced as an automatic method for detecting object of interest among other scrolling visual content by only looking at the user's eye movements (Jalaliniya, S., & Mardanbegi, D., 2016). Different pattern of eye movements were observed when the user looks at scrolling images in a search task that involved bottom-up attentional mechanism, compared to when the user is searching for a particular image involving top-down attention (Jalaliniya, S., & Mardanbegi, D., 2016).

Results

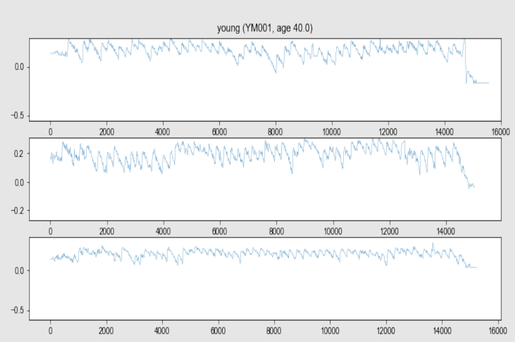

Fig2: The OKN eye movement signals for 3 speed conditions for one of the younger subjects

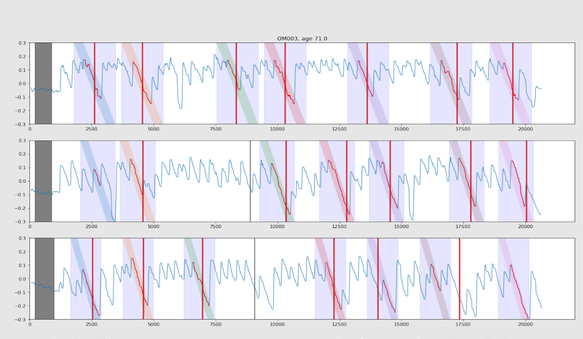

Fig3: The eye movement signals from the EyeGrip test for 3 speed conditions for one of the older subjects

In a preliminary study, we have identified a set of key metrics that can be obtained from the OKN eye movements recorded in an EyeGrip test:

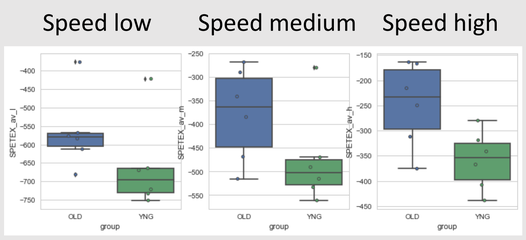

Fig4: The latency between the target-SP end and the target

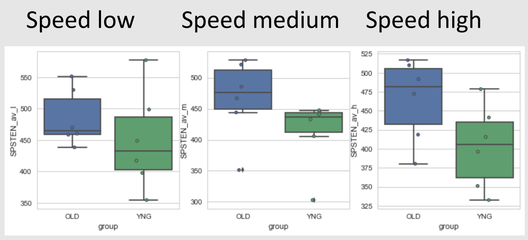

Fig5: The latency between the beginning of the SP on the target (target-SP) and the target enter

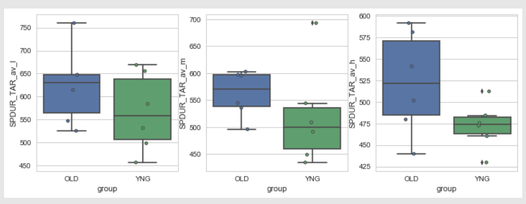

Fig6: Duration of smooth pursuits on the target images

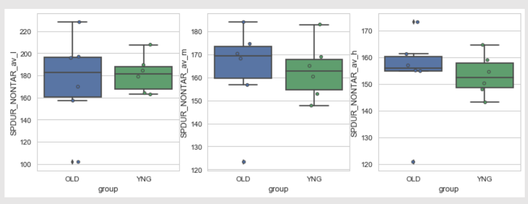

Fig7: Duration of smooth pursuits on non-target images

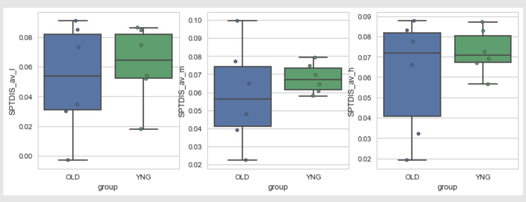

Fig8: Average deviation of the target-SP from the center of the target during each smooth pursuit

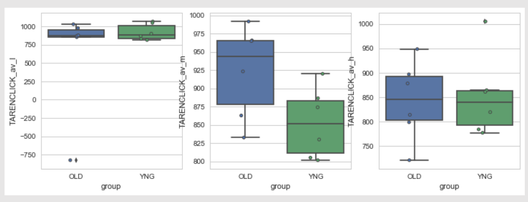

Fig9: The latency between the click event and the target enter

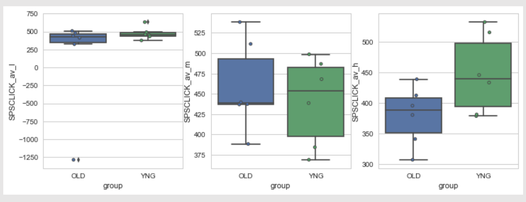

Fig10: The latency between the click event and the beginning of the target-SP

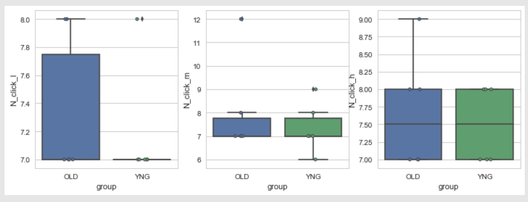

Fig11: Number of click events

Future work: In the future study, we will use the above metrics to monitor dementia patients. It is expected that the pattern of OKN eye movements (such as slow phase) to be disturbed and missed targets in dementia patients to be significantly increased compared to control subjects since dementia affects the top-down process of attention and memory.

References

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