Study on the Characteristic of Eye Movement for Visual Improvement of the Elderly

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Abstract: The purpose of this work is to identify the characteristic of eye movement for visual training of the elderly. This investigation is to examine the relationship between the head and the eye motor system for the localization of visual target direction in three-dimensional space. All experiments were performed in a soundproof chamber. Twenty-one red LEDs (Light-Emitting Diode, Brightness: 20cd/㎡) arrayed in three lines on a half circle-surrounding panel are used. LEDs are horizontally 30 degree apart and vertically 20 degree apart from each other. The condition of stimulation is random and anti-saccade. Physiological parameter such as EOG (Electro-Oculography) was measured by BIOPAC system. We measure the mean latency time, which is the time from the start of visual stimulation to the response of the human body. The result shows that the mean latency time is short in the case of the condition of anti-saccade, the fixed head and a quarter visual stimulation. This finding can be used in developing programs for various visual improvements for the elderly by analyzing the characteristic of eye movement.

Keywords: Eye movement, The elderly, Visual improvement

1. INTRODUCTION

The decline of sensory function reduces the activities and the enjoyment of the elderly. Specially, the decline of vision causes the reduction of social life and mental shrinkage of the elderly because the elderly cannot accept enough outside sensory information [1]. Until recently, the health system for the elderly gives much more weight to the treatment than the improvement of health or prevention of the sickness.

Park et. al found that '95% of near vision is a posteriori factor and 5% is a priority factor, and that near vision can be cured by eye movement' [2]. Kim et. al[3] also showed a theory suggesting eye movement training similar to that of Bates[4] as a healing method. Based on the finding from the previous researchers, vision improvement can be achieved through eye movement training but the study on the eye movement training method suitable to the condition of sensory function of the elderly is lacking.

In this paper, we conducted the eye movement by different age group to understand the characteristics of the elderly and the age groups for visual improvement of the elderly.

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2. METHOD

2.1 Subjects

Data were obtained from five subjects with normal visual motor function. Their age ranged from 24-69 years. All subjects had at least 20/20 of visual acuity in both eyes with correction. Subjects were asked to participate in these experiments with full knowledge that they could withdraw at any time.

2.2 Experimental instrument

Figure 1 shows the block diagram of the experimental system that we use to investigate spatial cognition for sensory-motor coordination. The eye and head movements of the subject were measured using EOG and then the data was transferred to a computer.

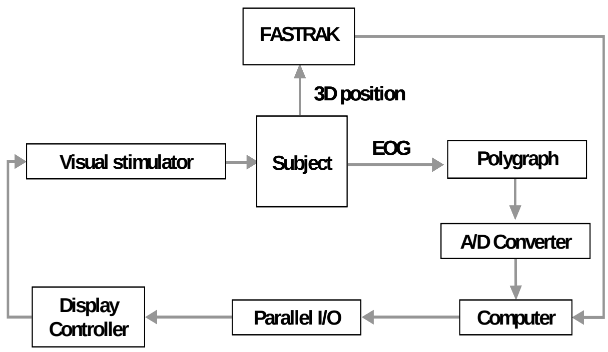
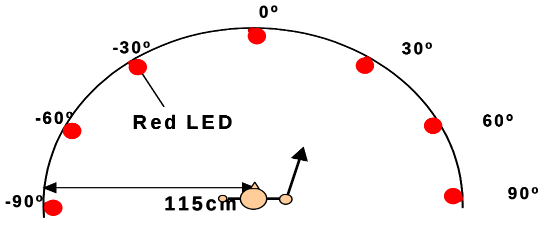
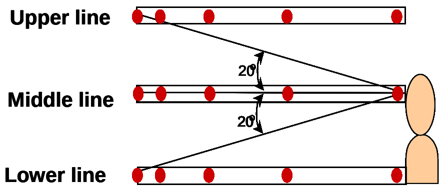


Fig. 1 Block diagram of the experimental system

The surrounding panel for visual stimulation (radius: 115cm) is shown in Fig. 2. The twenty one LED (Luminescent Diode, Brightness: 210cd/㎡) arrayed in three lines on the surrounding panel are used. Each LED is 10 degrees apart from each other. LEDs are controlled by LabVIEW (NI Co.) program. Each line is 20 degrees apart from the next one. The eye movement was measured with EOG by Biopac system INC. The EOG passed through a polygraph was sent to a computer through an A/D converter.



(a) Top view of surrounding panel

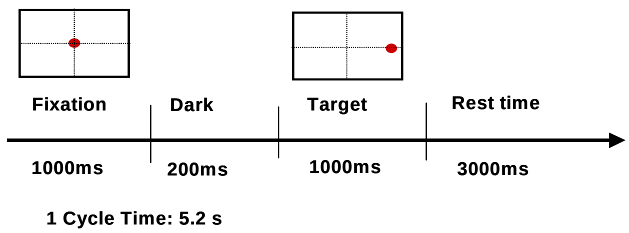


(b) Side view of surrounding panel

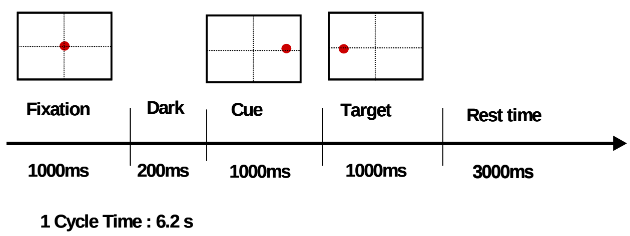
Fig. 2 Panel adhered LED for the visual stimulator

2.3 Experimental condition

The experiment consists of two types of experimental methods. Figure 3 shows the experimental procedure. After an experiment of one cycle ends the subject takes a rest for three seconds. The same pattern of procedure is repeated twice. Two different experimental sequences studied. One is random condition of eye movement. The other is anti-saccade. In the random condition, a subject looks at a fixation (center) LED that remained visible for 1000ms. A target LED is presented for 1000ms above, below, left or right side of the fixation LED after fixation LED goes off. In the anti-saccade condition, the subject looks at a fixation (center) LED that remains visible for 1000ms. Next, cue LED is presented for 200ms above, below, left or right side of the fixation LED after fixation LED offset. Then, the Target LED is presented to the opposite side of the cue LED after the cue LED goes off.



(a) Random condition



(b) Anti-saccade condition

Fig. 3 Experimental procedure of eye movement

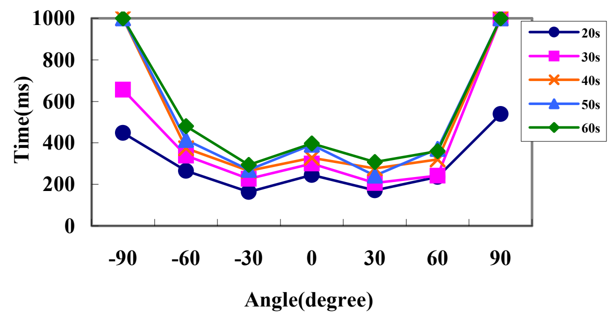
3. RESULTS

Here, the mean latency time is defined as the interval time from the visual stimulation to the onset of eye movements. In results, 1000ms means if subjects can't find target LED as visual stimulation or find over 100ms. The LED at 0 degree in the middle line can't obtain the mean latency time because we use 0 degree of LED as fixation LED.

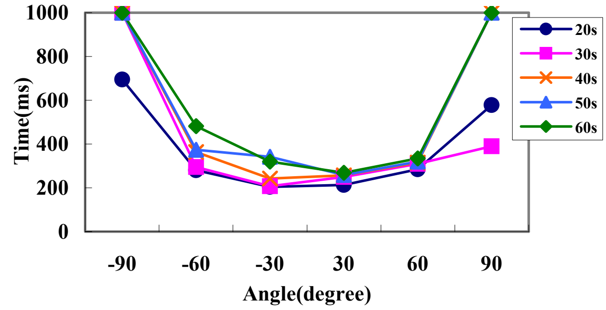
3.1. Random vs. Anti-saccade

We compare eye movement in random condition with that in anti-saccade condition by five age group ranges from 20s to 60s. Figure 4 and 5 show the mean latency time of random and anti-saccade condition by the age group.

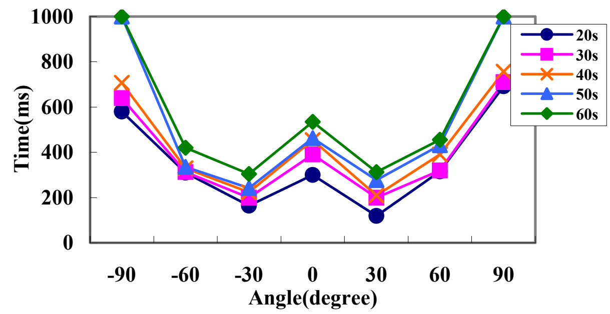
The first finding is that the mean latency time of 50s and 60s is similar to each other but it is remarkably different from the others groups. The secondly is that the shape of curves is similar to the shape of letter "W". The subjects respond to LED at 0° takes longer than the latency time than +30° and –30°. Because external ocular muscle in charge of horizontal axis of eye movement activate less than external ocular muscle in charge of vertical axis of eye movement.



(a) Upper line



(b) Middle line

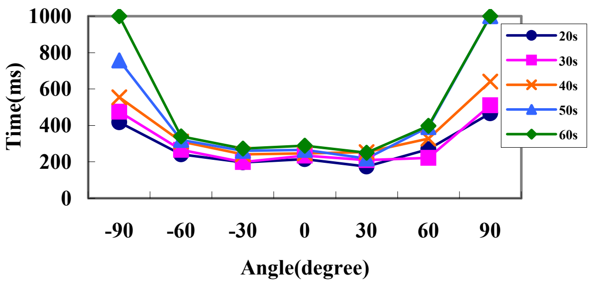


(c) Lower line

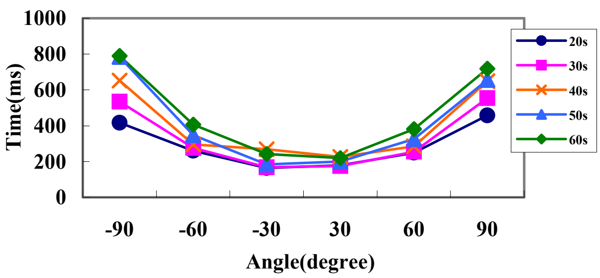
Fig. 4 The mean latency time on random condition

Thirdly, in anti-saccade condition, the mean latency time is shorter than that for the visual stimulation at the same location in random condition at though a subject responds to the target LED without dark interval following cue LED. The reason is IOR (Inhibition of Return). One behavioral consequence of the removal of attention is the phenomenon of inhibition of return (IOR), where target detection at previously attended locations has been shown to be delayed [5-7].

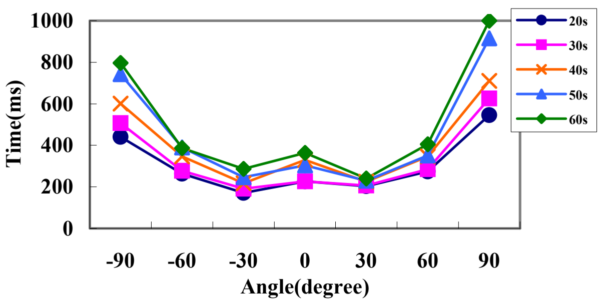
As a result of eye movement, in condition of visual stimulation, the mean latency time of anti-saccade condition is shorter than that of random condition. So, anti-saccade condition is better adjusted with condition for visual improvement than random condition.



(a) Upper → lower line



(b) Middle line



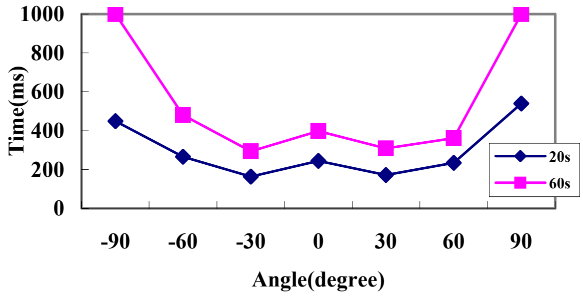
(c) Lower → upper line

Fig. 5 The mean latency time on random condition

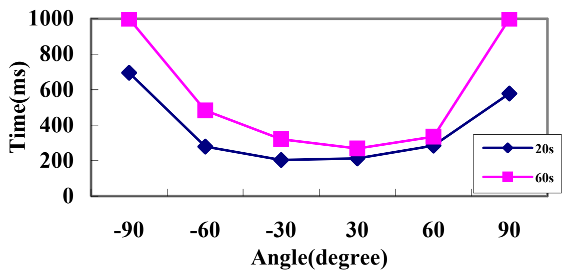
3.2 20s vs. 60s

Figure 6 and 7 illustrated the mean latency time of EOG in random and anti-saccade condition with 20s and 60s group.

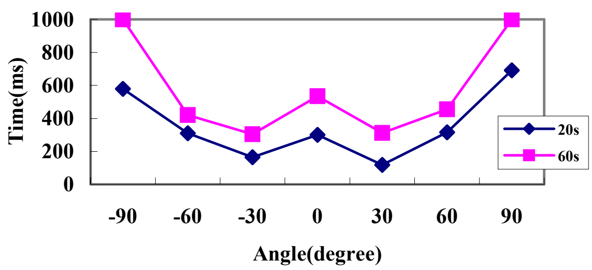
The mean latency time of 20s is faster than that of 60s as expected. There is a large difference between the two in random condition. In random condition, the mean latency different time is 253.3ms in upper line, 191.7ms in middle line, 222.6ms in lower line. And in anti-saccade condition, the mean latency different time is 223.8ms in upper line, 171.7ms in middle line, 193.3ms in lower line.



(a) Upper line

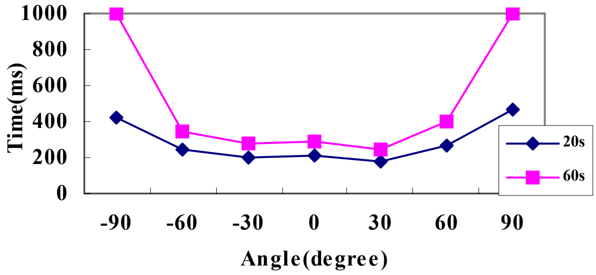


(b) Middle line

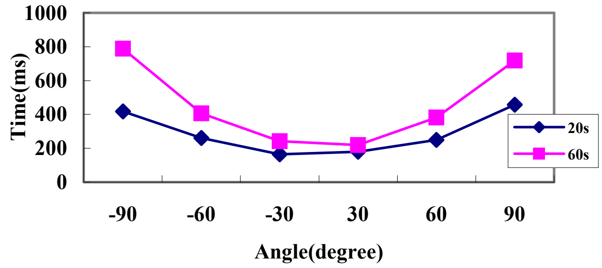


(c) Lower line

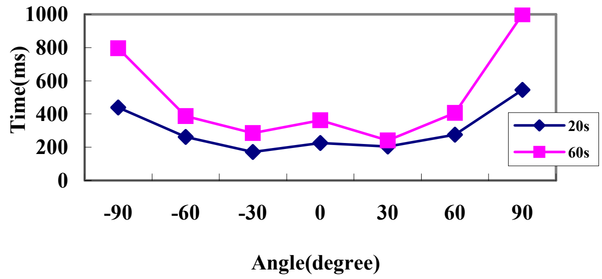
Fig. 6 The mean latency time on random condition
- 20s vs. 60s



(a) Upper → lower line



(b) Middle line



(c) Lower → upper line

Fig. 7 The mean latency time on anti-saccade condition - 20s vs. 60s

4. CONCLUSION

In this paper, we conducted studies on eye movement to understand the characteristic of the elderly for visual improvement of the elderly and different age groups. For this purpose, we investigated the mean latency time on eye movement using visual stimulation and reached following conclusion:

1. As a result of eye movement of the elderly, in condition of visual stimulation, anti-saccade condition is shorter than random condition. So, anti-saccade condition is better adjusted with condition for visual improvement than random condition.
2. In a result of eye movement by location of visual stimulation, stimulus presentation to activate six external eye muscles is better adjusted with visual improvement.

These results can be used in the field of visual improvement technology according to age.

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