Factors affecting saccadic latency in persons with mental retardation

Koichi Haishi1,*, Hideyuki Okuzumi2, Mitsuru Kokubun2, Shigeji Ohba1, and Kazuhito Noguchi3

1 Joetsu University of Education, 1 Yamayashiki-machi, Joetsu, Niigata 943-8512, Japan
2 Tokyo Gakugei University, 4-1-1 Nukuikita-machi, Koganei, Tokyo 184-8501, Japan
3 Miyagi University of Education, 149 Aramaki-aza-Aoba, Aobaku, Sendai, Miyagi 980-0845, Japan

The goals of the present study were to determine the factors affecting saccadic latency in persons with mental retardation from the viewpoints of intellectual function and ability of behavioral regulation, and to clarify the relationship among the factors. Participants were 44 persons with mental retardation aged between 13 and 57 years whose IQ was between 14 and 70. The ability of behavioral regulation was evaluated by the test of sustained simple motor action. A predictive visually-guided saccade paradigm was used. The mean value and coefficient of variance (CV) of saccadic latency were calculated. Multiple regression analysis was conducted to clarify the factors affecting the mean value and CV of saccadic latency. The independent variables used were age, IQ and presence/absence of disability of behavioral regulation. The mean value was significantly related to the IQ, and the CV had significant relevance to the ability of behavioral regulation. Accordingly, participants were divided into three groups. The participants whose IQ was 55 and more without disability of behavioral regulation consisted of group A. Group B was made up of the participants whose IQ was 55 and below without disability of behavioral regulation. Group C was composed by participants whose IQ was 55 and below with disability of behavioral regulation. Analysis of variance was conducted to examine the intergroup differences in the mean value and CV. The results were as follows. (1) There was no statistically significant difference in both mean value and CV between group A and B. (2) Saccadic latency in group C was significantly longer than group A. (3) The difference in CV between group B and C were significant. These results suggest that the intactness of the ability of behavioral regulation may attenuate the effect of lower IQ on saccadic latency.

Introduction

Saccadic eye movements are one of the substantial components of the visual exploration. Past works have suggested a qualitative difference in visual exploration between persons with mental retardation and their peers. However, little work has focused on the characteristics of saccades in persons with mental retardation. Moreover, there is no agreement among the outcomes. Although Takahashi, Ozaki & Suzuki (1987) pointed out the longer latency in persons with mental retardation, Lasker, Mazzocco & Zee (2007) put forward a view that there is not enough evidence to support that IQ is associated with eye movement latency. The goal of the present study was to determine the factors affecting saccadic latency in persons with mental retardation from the viewpoints of intellectual function and ability of behavioral regulation. The term “behavioral regulation” is used to refer to the ability underlying goal-directed behavior.

Methods

Participants

Participants were 44 persons with mental retardation aged between 13 and 57 years (mean age 28.39, SD=11.51) whose IQ was between 14 and 70 (mean IQ 35.52, SD=14.91).

* Corresponding author. Tel. & Fax: +81 25 5213386. E-mail address: haishi@juen.ac.jp (K. Haishi).
Measurement of the ability of behavioral regulation

The ability of behavioral regulation was evaluated by the test of sustained simple motor action. The test was composed of three tasks from Garfield’s motor impersistence test (Garfield, 1964; Garfield, Benton, & MacQueen, 1966) such as keeping eyes closed, protruding tongue with eyes open and keeping mouth open.

Measurement of eye movements

To elicit saccadic eye movements, a predictive visually-guided saccade paradigm was used. Participants were instructed to pursue the visual target movements as quickly as possible. The target was moved on the horizontal plane rectangularly at a frequency of 0.5 Hz. Eye movements were recorded using bitemporal direct-current electrooculography.

Data processing and Analyses

Except for the initial five saccades and those which preceded the target movements, five saccadic eye movements were extracted and the mean value and coefficient of variance (CV) of saccadic latency were calculated. A multiple regression analysis was conducted to clarify the factors affecting the saccadic latency. To compare with the properties of saccades among the subgroups which were classified on the basis of the relationship between the factors affecting the saccadic latency, ANOVA was performed.

Results

Multiple regression analysis was conducted to clarify the factors affecting the mean value and CV of saccadic latency. The independent variables used were age, IQ and presence/absence of disability of behavioral regulation. The results were summarized in Table 1. (1) The mean value of saccadic latency was significantly related to the IQ, that is, higher IQ was associated with shorter saccadic latency. (2) The CV of saccadic latency had significant relevance to the ability of behavioral regulation, that is, smaller CV of saccadic latency depended on the absence of disability of behavioral regulation.

Table 1. The Results of Multiple Regression Analysis on Mean and CV

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Mean</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>β</td>
<td>t</td>
<td>β</td>
<td>t</td>
<td>β</td>
<td>t</td>
</tr>
<tr>
<td>Age</td>
<td>-.22</td>
<td>-1.65</td>
<td>.04</td>
<td>.27</td>
<td>.04</td>
<td>.27</td>
</tr>
<tr>
<td>IQ</td>
<td>-.47**</td>
<td>-3.15**</td>
<td>.27</td>
<td>1.68</td>
<td>.27</td>
<td>.81</td>
</tr>
<tr>
<td>Behavior Regulation</td>
<td>.12</td>
<td>.81</td>
<td>.52**</td>
<td>3.17**</td>
<td>.52**</td>
<td>3.17**</td>
</tr>
<tr>
<td>F(3, 40)</td>
<td>6.41**</td>
<td>3.37*</td>
<td>3.37*</td>
<td>3.37*</td>
<td>3.37*</td>
<td>3.37*</td>
</tr>
</tbody>
</table>

Note: β=standard partial regression coefficient. Adjusted R²=squared multiple correlation coefficient adjusted for the degrees of freedom. *p<.05. **p<.01.
According to the results which suggested that saccadic latency may be affected by IQ and the ability of behavioral regulation, participants were divided into three groups in terms of these two factors, and the characteristics of saccadic latency of these three groups were analyzed. The participants whose IQ was 55 and more without disability of behavioral regulation consisted of group A. Group B was made up of the participants whose IQ was 55 and below without disability of behavioral regulation. Group C was composed by participants whose IQ was 55 and below with disability of behavioral regulation. The mean and CV of saccadic latency of each group were provided in Table 2.

Table 2. Mean and CV of Saccadic Latency by Group

<table>
<thead>
<tr>
<th>Group</th>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>157.08</td>
<td>25.20</td>
<td>194.40</td>
<td>47.85</td>
<td>224.28</td>
<td>54.45</td>
</tr>
<tr>
<td>Group B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Group A=participants with higher IQ (>55) and without disability of behavioral regulation. Group B=participants with lower IQ (<55) and without disability of behavioral regulation. Group C=participants with lower IQ and with disability of behavioral regulation.

Analysis of variance was conducted to examine the intergroup differences in the mean value and CV of saccadic latency. The main effects of groups for both the mean ($F_{2,41}=4.69$, $p=.015$) and CV ($F_{2,41}=3.75$, $p=.032$) were significant. The results of multiple comparison were as follows. (1) There was no statistically significant difference in both mean value and CV of saccadic latency between group A and B. (2) Saccadic latency in group C was significantly longer than group A. (3) The difference in CV of saccadic latency between group B and C were significant.

Discussion

As mentioned above, there is no agreement among the previous outcomes on the relationship between IQ and saccadic latency. However, the results of multiple regression analysis in the current research indicated that the mean value of saccadic latency was significantly related to the IQ. This result may be supported the empirically well established fact that reaction time correlates with IQ (Jensen, 1993).

On the other hand, the CV of saccadic latency had significant relevance to the ability of behavioral regulation. Sustained attention is required to regulate our behaviors to comply with the goals. There may be validity in our result given the findings that the CV of saccadic latency in persons with attention-deficit hyperactivity disorder (ADHD) who have difficulty in sustained attention is larger than typically developing controls (Mostofsky, Lasker, Cutting, Denkla & Zee, 2001).

The participants were divided into three groups on the basis of the relationship between IQ
and the ability of behavioral regulation to clarify their mutual interaction. Both the mean and CV of saccadic latency of Group B were not significantly different from those of Group A. The IQ of Group B was lower than that of Group A, but there was no difference between the ability of behavioral regulation. These outcomes suggest that lower IQ does not have an independent effect on saccadic latency. The intactness of the ability of behavioral regulation may attenuate the effect of lower IQ on saccadic latency.

Mostofsky, Lasker, Cutting, Denkla & Zee (2001) indicated that the CV of persons with ADHD was larger than typically developing peers, although there was no difference in the mean of saccadic latency. These findings suggest that higher IQ may not weaken the influence of the disability of behavioral regulation on the variability of saccadic latency given that persons with ADHD suffer from disability of behavioral regulation without intellectual disability. However, there is no evidence suggests that this inference is valid for the properties of saccades in persons with mental retardation. Further researches are needed.

Acknowledgement

This work has been supported by the Grant-in-Aid for Scientific Research (c) No.21531014 of Japan Society for the Promotion of Science. We are grateful for their support.

References