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# Age-related change of the mean level and intraindividual variability of saccadic reaction time performance in persons with intellectual disabilities

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ABSTRACT

The current study examined age-related change of saccadic reaction time (SRT) in persons with intellectual disabilities (ID). Participants were 29 persons with intellectual disabilities aged between 14 and 34 years whose IQs were between 14 and 70. Participants were divided into Group I (IQ $\geqq$ 35) and Group II (IQ $\leqq$ 34). The mean and the standard deviation of SRT (SRTM and SRTSD, respectively) reduced through adolescence in both groups. This result suggests that the speed and stability of information processing develops during adolescence irrespective of the level of ID. Although SRTM and SRTSD of Group I stabilized after adolescence, those of Group II increased after their thirties. This outcome indicates that persons with severe ID may show signs of the aging process. The results of multiple regression analyses and path analyses indicated that SRTM was influenced by both the speed of information processing and the variability of the response. However, given that the extent of increase of SRTSD in Group II was smaller as compared with that of SRTM, this increase of SRTM after the thirties in Group II appears to be mainly affected by the slowness of information processing.



## 1. Introduction

Saccades are the rapid eye movements to shift our gaze from one object of interest in the visual environment to another. The principal purpose of saccades is to bring the image of an object of interest to the fovea, which is the retinal region with the highest resolution, in order to gather visual information. We control gaze shifts and fixations proactively for guiding movements (Johansson, Westling, Bäckström, & Flanagan, 2001). That is, saccades lead a wide range of daily activities.

Saccadic reaction time (SRT) is one of the primary variables that reflect the properties of saccades. To date, only a few studies have focused on the properties of SRT in persons with intellectual disabilities (ID). Although Haishi, Okuzumi, and Kokubun (2011) indicated that intelligence and executive control function have influence on SRT in persons with ID, the relationship between age and SRT remains an open question.

In the typical development, SRT conspicuously reduces through childhood and early adolescence, followed by a period of relative stability up to the latter period of middle age (Fukushima, Hatta, & Fukushima, 2000; Irving, Steinbach, Lillakas, Babu, & Hutchings, 2006; Yang, Bucci, & Kapoula, 2002). Although there is no direct evidence indicating that SRT of persons with ID shows the same reduction as typically developing persons, the findings of Takahashi, Ozaki, and Suzuki (1987) and

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Kawakubo et al. (2007) would suggest the existence of an age-related decrease of SRT during adolescence in persons with ID. Takahashi et al. (1987) revealed that the SRT of early adolescent children with ID were significantly longer than those of typically developing children. On the other hand, Kawakubo et al. (2007) indicated that the difference in SRT between adults with and without ID was not statistically significant. A possible explanation for these findings is that the SRT of persons with ID decreases through adolescence and early adulthood. The current study tests this assumption through clarifying age-related changes of SRT during adolescence and early adulthood in persons with ID. In addition, considering that one of the factors affecting SRT in persons with ID is intelligence (Haishi et al., 2011), the present study examines whether age-related change of SRT varies across intelligence level or not.

The current research focused attention not only on the mean level of SRT performance but also on the intraindividual variability of SRT. Past research has indicated that one of the properties of reaction time (RT) in persons with ID is characterized by large intraindividual variability (Baumeister, 1968; Baumeister & Kellas, 1968a, 1968b; Berkson & Baumeister, 1967; Caffrey, Jones, & Hinkle, 1971; Kellas, 1969). This is regarded as a difficulty in maintaining the optimal performance in persons with ID (e.g., Baumeister & Kellas, 1968c; Haishi et al., 2011). Nevertheless, insufficient attention has been directed toward age-related change in the intraindividual variability of RT because instability of performance has been typically regarded as a manifestation of noise or error. Recent research on the typical development of RT (Williams, Hultsch, Strauss, Hunter, & Tannock, 2005) shows that the intraindividual variability reduces during adolescence characterized by a decrease in the mean RT (e.g., Jensen, 2006), indicating that there is an age-related covariate relation between the intraindividual variability and the mean of RT. Moreover, it is suggested that the intraindividual variability of RT influences the mean RT (Haishi et al., 2011; Walhovd & Fjell, 2007). Considering these findings, it is necessary to examine the relationship between age-related changes of the mean and the intraindividual variability of SRT to better understand the properties of age-related change of SRT in persons with ID.

The goal of the present study is to clarify the properties of age-related change of SRT in persons with ID taking into account (1) the effect of intelligence on SRT and (2) the relationship between the mean and the intraindividual variability of SRT.

## 2. Method

### 2.1. Participants

Participants were 29 persons with intellectual disabilities (20 males, 9 females) aged between 14 and 34 years (mean age = 24.3 years, SD = 7.7) whose IQs ranged between 14 and 70 (mean IQ = 34.5, SD = 15.7). All participants were Japanese. IQ was assessed through the administration of the Tanaka-Binet intelligence scale, which is a standardized and widely used intelligence test in Japan that has been sufficiently validated against the Wechsler Scale. The Tanaka-Binet intelligence scale is suitable for assessing the intelligence of persons with ID because it is applicable to a wider range of IQ than the Wechsler Scale. IQ test was administered by trained psychologists. Participants did not suffer from any other serious disabilities (e.g., sensory deficits, motor disorders such as cerebral palsy, or degenerative disease) and did not have comorbid diagnoses. Participant characteristics were obtained from medical files. Persons on medication at the time of experiments were excluded from participation. Seven of these participants lived at home, while the others lived in a residential care facility for persons with intellectual disabilities. Informed consent was obtained from all participants' guardians before the assessment session. In addition, prior to the experiments, the experimenter described the details of the measurements. Persons who were reluctant to take part in the experiments were also excluded from participation.

As mentioned above, Haishi et al. (2011) recently revealed that SRT in persons with ID negatively correlated with IQ. In order to examine the possibility that age-related changes in SRT vary across IQ level, participants were divided into two groups according to their IQ scores. Group I consisted of participants whose IQ was 35 and more, and Group II was made up of participants whose IQ was 34 and below. An IQ of 35 is a boundary value that differentiates between moderate and severe mental retardation in ICD-10 (World Health Organization, 1992). Group I included 12 persons (7 males, 5 females; mean age = 22.83 years, SD = 8.13; mean IQ = 49.83, SD = 11.06). Group II consisted of 17 persons (13 males, 4 females; mean age = 25.29 years, SD = 7.41; mean IQ = 23.64, SD = 6.81). Gender distribution ($\chi^2(1) = 0.40$) and the difference in mean age ($F(1,27) = 0.72$) between two groups was not statistically significant.

### 2.2. Saccadic eye movements

#### 2.2.1. Eye movement recording

Horizontal and vertical eye movements were measured using electro-oculography (EOG). Ag–AgCl electrodes were attached to the lateral canthus of each eye to record horizontal eye position and attached above and below the right eye to measure vertical eye position. A ground electrode was placed in the center of the forehead. Horizontal and vertical EOG signals were amplified and low-pass filtered with 20-Hz cut off frequency. Signals of EOG and target movement were stored simultaneously with a data recorder for later analysis.

#### 2.2.2. Experimental set-up

The participant was seated in a chair which could be adjusted for height. Head movements were restricted with a chinrest equipped with a head support. In addition, an experimenter continuously checked head stability during the experiment. The