



## Original article

# Intelligence test at preschool-age predicts reading difficulty among school-aged very low birth weight infants in Japan

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## Abstract

**Objective:** To elucidate whether the results of an intelligence test at preschool age are predictive of reading difficulty (RD) at school age among very low birth weight infants (VLBWI).

**Methods:** Subjects were 48 Japanese children whose birth weight was <1500 g and who regularly visited a follow-up clinic. All subjects completed the Wechsler Intelligence Scale for Children-III (WISC-III) during the last grade of kindergarten, and four reading tasks during the second to fourth grade of elementary school. All participants had a full-scale intelligence quotient score of 85 or higher. Subjects with a standard deviation reading time score greater than 2.0 in two or more tasks were considered to have RD. We evaluated the associations between each WISC-III score and RD using logistic regression analyses. Furthermore, we performed receiver operating characteristic (ROC) analysis to determine a cutoff WISC-III score predictive of RD.

**Results:** In the mutually-adjusted model, the adjusted odds ratio per 1 score increase of freedom from distractibility (FD) was 0.832 (95% confidence interval: 0.720–0.962). In the ROC analysis, an FD score of <95.5 was chosen as the cutoff value for predicting RD (sensitivity, 0.77; specificity, 0.74).

**Conclusion:** The present study indicated that a lower FD score at preschool age, which was associated with deficits in verbal working memory and attention, is a risk factor for RD at school age among Japanese VLBWI. Further investigation is desired to clarify the cognitive deficits underlying RD in Japanese-speaking preterm children, and to establish appropriate interventions for these children.

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**Keywords:** Very low birth weight infant; VLBW; Preterm; Reading difficulty; Dyslexia; Japanese; Verbal working memory; Attention

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## 1. Introduction

In Japan, the survival rate of very low birth weight infants (VLBWI) has been reported to be higher than 90% [1], and about 85% of survivors have no obvious mental retardation [2]. However, Bowen and colleagues previously showed that many school-aged VLBWI without mental retardation had some educational difficulties [3]. Among various educational difficulties in preterm children, reading difficulty (RD) has been particularly well studied in many countries [4]. Although there were limited data on this issue for a long time in Japan, we recently reported the high prevalence (about 30%) of RD among Japanese-speaking, school-aged VLBWI with normal intelligence, using standardized Japanese *kana* reading tests [5].

It was previously shown that rates of social, emotional, and behavioral difficulties in children with RD were significantly higher than in the general population, and were correlated with self-esteem [6]. Furthermore, it was reported that children with learning disabilities were at high risk for maladaptation in early school life [7]. Therefore, early detection and early intervention for children with RD is thought to be important to avoid such secondary problems. Considering the high prevalence of RD among very low birth weight (VLBW) children, we should actively try to identify children with reading problems among VLBWI to provide early appropriate support for them. In the present study, we aimed to elucidate whether the results of an intelligence test at the preschool age, a test which has been widely accepted as part of the standard developmental follow-up protocol for VLBWI in Japan [8], are predictive of RD at school age among VLBWI.

## 2. Methods

### 2.1. Subjects

Japanese children with normal intelligence in the second to fourth grades of elementary school (approximate age range, 7–9 years of age) who had been born with VLBW and who regularly visited a follow-up clinic at one of the participating hospitals (Kyushu Medical Center, Fukuoka, Japan and Saga Hospital, Saga, Japan) were eligible for the study and were recruited prospectively between April 2013 and March 2015. Subjects had been scored according to the Wechsler Intelligence Scale for Children-III (WISC-III) at preschool age (during the last grade of kindergarten), and all participants had full-scale intelligence quotient (FIQ) scores of 85 or higher. Children with hearing difficulties, impaired visual acuity despite the use of eyeglasses, or articulatory disorders were excluded. Also, children in inappropriate educational settings were excluded. Written informed consent was obtained from all participants

and/or their parents at the time of the study. This study was approved by the Ethical Committee of the National Hospital Organization (H25-0213005).

### 2.2. WISC-III (preschool)

Each subject completed the WISC-III during the last year of kindergarten. All subjects were examined by certified clinical psychologists in quiet rooms. FIQ and four sub-scores including verbal comprehension (VC), perceptual organization (PO), freedom from distractibility (FD), and processing speed (PS) were calculated.

### 2.3. Reading tests (grades 2–4)

Each subject completed all four of the reading tasks described below, in accordance with methods previously reported [5,9]. All subjects were examined by neuropsychology experts in quiet rooms. During each of the four tasks, we recorded the subjects' voices with an integrated circuit (IC) recorder.

### 2.4. Monomoraic syllable reading task

Each subject completed a monomoraic syllable reading task [5,9–11]. A 'mora' was defined as the smallest rhythmic element into which a word can be divided. Subjects were instructed to read aloud 50 monomoraic syllables, including 20 contracted sounds (e.g., “*にゃ*” [pronounced *nya*]), as quickly and as accurately as possible. Syllables were printed in hiragana on 210 × 297 mm white cards, arranged into five rows and 10 columns of syllables on each card. Before the trial, subjects practiced with sample cards. The amount of time each subject required to read all 50 syllables was recorded.

### 2.5. Word reading task

All subject also completed a word reading task [5,9,10,12]. Subjects were instructed to read aloud 30 Japanese words of three to four moras each (e.g., “*げんかん*” [pronounced *genkan*, meaning *entrance* in Japanese]) as quickly and as accurately as possible. Words were printed in hiragana on 210 × 297 mm white cards, arranged into three columns and 10 rows of words on each card. Before the trial, subjects practiced with sample cards. The amount of time each subject required to read all 30 words was recorded.

### 2.6. Non-word reading task

In addition to the word reading task described above, all subjects completed non-word reading task [5,9,10,12]. Subjects were instructed to read aloud 30 non-words of three to four moras each (e.g., “*してぼう*” [pronounced *shitebou*, no meaning]) as quickly and as

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