

Original article

# Predicting the reading skill of Japanese children

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Received 3 April 2016; received in revised form 20 July 2016; accepted 23 August 2016

## Abstract

**Objective:** To clarify cognitive processes underlining the development of reading in children speaking Japanese as their first language, we examined relationships between performances of cognitive tasks in the preschool period and later reading abilities.

**Methods:** Ninety-one normally developing preschoolers (41 girls and 50 boys; 5 years 4 months to 6 years 4 months, mean 5 years 10 months) participated as subjects. We conducted seven cognitive tasks including phonological awareness tasks, naming tasks, and working memory tasks in the preschool period. In terms of reading tasks, the *hiragana* naming task was administered in the preschool period; the reading times, which is a composite score of the monomoraic syllable reading task, the word and the non-word reading tasks, and the single sentence reading task, was evaluated in first and second grade; and the *kanji* reading task (naming task) was tested in second grade. Raven's colored progressive matrices and picture vocabulary test revised were also conducted in first grade. Correlation analyses between task scores and stepwise multiple regression analyses were implemented.

**Results:** Tasks tapping phonological awareness, lexical access, and verbal working memory showed significant correlations with reading tasks. In the multiple regression analyses the performances in the verbal working memory task played a key role in predicting character naming task scores (the *hiragana* naming task and the *kanji* reading task) while the digit naming task was an important predictor of reading times. Unexpectedly, the role of phonological (mora) awareness was modest among children speaking Japanese.

**Conclusion:** Cognitive functions including phonological awareness, digit naming, and verbal working memory (especially the latter two) were involved in the development of reading skills of children speaking Japanese.

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**Keywords:** Reading development; Japanese; Phonological awareness; Digit naming; Verbal working memory

## 1. Introduction

Written languages support almost all fields in modern society, such as learning, business, leisure, and social

systems. Hence, mastering reading and writing during early childhood should have a significant impact on one's life. Unfortunately, there are great differences in literacy among individuals. Some people have difficulty in reading and writing to the degree that they fail in learning or work, namely through developmental dyslexia [1].

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Developmental dyslexia, which is a subset of specific learning disorder [2], is a developmental disability of literacy. It is characterized by difficulties with accurate and fluent word recognition and by poor spelling and decoding abilities despite normal intelligence and an appropriate provision of education [1]. Developmental dyslexia is understood to be a long-lasting chronic disorder affecting between 5 and 17.5% of children [3].

Various factors have been purported to play a role in the occurrence of dyslexia. For example, the phonological theory [3], the involvement of attentional mechanism [4], the visual magnocellular deficit [5], deficits in detecting rapidly presented or rapidly changing sensory stimuli [6], and cerebellar impairment [7] have been proposed as the pathophysiology of dyslexia. We believe, however, that the occurrence of dyslexia cannot be explained by a single mechanism. Nevertheless, disorders within phonological processing has been repeatedly indicated among most patients with dyslexia [3].

Phonological processing refers to the use of phonological information in the processes of written and oral languages, and comprises three components, namely phonological awareness, phonological recoding in lexical access, and phonetic recoding to maintain information in working memory [8].

Phonological awareness represents the insight that spoken words can be broken down into the elemental particles of speech [3], and it can be evaluated by administering tasks such as tapping out the number of sounds in a word or putting together sounds presented in isolation to form a word [8]. If phonological awareness is disturbed, one cannot understand that acoustically perceived words consist of multiple phonemes and syllables. This leads to a disturbance of the development of the decoding ability that converts letters into speech sounds.

Phonological recoding in lexical access refers to relating a written word to its lexical referent by recoding the written symbols into a sound-based representational system [8]. The disturbance of phonological recoding in lexical access is reflected in the low scores of naming tasks and the failure to decide whether a string represents a real word or a non-word.

Phonetic recoding to maintain information in working memory means recoding written symbols into a sound-based representational system that enables them to be maintained efficiently in working memory during ongoing phonological processing [8]. Disturbances of the access to the phonological working memory result in poor performance of span memory tasks such as the digit span of Wechsler Intelligence Scales.

The Japanese writing system is significantly different from those of languages that use alphabets. There are two types of writing systems in Japanese: the phonogrammatic *kana*, which consists of *hiragana* and *katakana*, and the logogrammatic *kanji*. Basic phonological

units of Japanese are morae. A mora is the smallest rhythmic element into which a word can be divided, and it plays the same role in a Japanese word as a syllable does in an English word. Many of the morae are CV or V syllables. Exceptions include several special syllables, such as a nasal coda (CVN or VN), a geminate stop consonant (CVQ or VQ), a long vowel (CV: or V:), and a contracted sound (CjV). Unlike alphabets that represent phonemes, one *kana* represents a mora as a rule. One exception involves CjV syllables, which are represented by two *kana* characters. *Kanji* have complex structures, and one *kanji* can represent a word with/without subsequent *kana* (known as *okurigana*).

Since the Japanese writing system differs from those that use alphabetic languages, there is the possibility that cognitive processes underlying reading ability differ between Japanese and alphabetic languages. However, disturbances of phonological awareness and phonological working memory have been identified repeatedly among dyslexics who speak Japanese as their first language [9–12]. Regarding phonological recoding in lexical access, correlations between performance of naming tasks and reading ability were indicated among children in general [13].

In research aimed at clarifying cognitive process underlying the development of the reading skills or cognitive disturbances involved in dyslexia, it is common for correlation analyses between scores of cognitive tasks and those of reading tasks to be undertaken simultaneously at the same point of the developmental course. However, there are several problems in studies using correlation analysis between scores of tasks that are obtained simultaneously. If a score of a given neuropsychological task is proven to be low among subjects whose reading abilities are low, the disturbance of the cognitive process that is evaluated with that neuropsychological task is not necessarily the etiology of the impeded reading abilities. For example, it has been reported that while performance of phonological awareness affects the development of the reading ability, the reading ability itself has an impact on the development of the phonological awareness [8,14,15].

To clarify the causal association between a given cognitive function and reading abilities, a developmental study exploring correlations between scores of tasks tapping some cognitive function in the preschool period and the reading abilities in school age would be valuable. Such a developmental study also has the high possibility of establishing efficient methods for early identification of dyslexics. There have been several developmental studies in the alphabetical linguistic area, and it has been indicated that the reading abilities of grade-school children could be predicted with letter knowledge, phonological awareness, naming abilities, and short-term memory during the preschool period (ex. Jorm et al. [16], Vellutino et al. [17], Plaza and

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