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Pure alexia for kana. Characterization of alexia with lesions of the inferior occipital cortex

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Abstract

Objective: To characterize reading impairments caused by lesions in the posterior occipital cortices.
Methods: We gave six patients with these lesions reading and writing tests and located a critical site for alexia using MRI and SPECT.
Results: The patients read three-character kana (Japanese syllabograms) nonwords, and five-character kana nonwords significantly or at a near significant level more poorly and slowly than normal subjects, whereas they read kanji (Japanese morphograms) almost correctly but more slowly. Letter-by-letter reading with a single-kana character identification impairment (in five patients), a word-length effect, kinesthetic facilitation, a lexicality effect, and minor to mild agraphia for kanji (in three patients) were observed. These deficits were characteristic of pure alexia. Alexia disappeared within a few months except in one patient who had extensive hypoperfusion in the left occipital lobe. A shared lesion was located in the left posterior fusiform/inferior occipital gyri (Area 18/19) on MRI, and there was blood flow reduction around this area on SPECT. This area coincided with the activation site for kana word covert reading in our previous study.
Conclusions: These results suggest that pure alexia particularly for kana, or more generally pure alexia for letters, is caused by a lesion in the posterior inferior occipital cortex, characterized primarily by impaired kana character or letter identification, with relatively preserved kanji or word recognition.

Keywords: Letter-by-letter reading; Kanji; Kana; Inferior occipital gyrus; Fusiform gyrus

1. Introduction

Pure alexia is an acquired reading disorder for words and letters, characterized by letter-by-letter reading, a word-length effect (longer words are read much more laboriously than shorter words), kinesthetic facilitation (tracing letters with the fingers helps reading) and inability to read even what the patient just wrote [1]. Minor agraphia caused by impaired character recall accompanies alexia [2]. In Japan, kanji (Japanese morphograms) reading and kana (Japanese phonetic writing or syllabograms) reading are impaired to various degrees: some patients read kanji better than kana, whereas other patients read kana better than kanji [3]. Anatomically, pure alexia is divided into a classical type that includes a splenium lesion and a non-classical type without a splenium lesion [4].

Pure alexia for kana is a largely selective reading impairment of kana words and kana nonwords, with relatively preserved reading of kanji words. We successively reported two patients with pure alexia for kana from lesions of the posterior inferior

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occipital gyri [5,6]. Pure alexia for kana challenges the conventional view of pure alexia for the following reasons.

Firstly, the lesion is located more posteriorly in the occipital gyri compared to that in conventional pure alexia. That is, the anatomic substrate of pure alexia has been considered to be in the paraventricular white matter of the left occipital lobe [7], or the ventral occipitotemporal area [8,9]. Pure alexia for kana is not included in any of these areas, although many reported cases of typical pure alexia had lesions in both the ventral occipitotemporal area and posterior inferior occipital cortex [9–11].

Secondly, the patients also failed to recognize single kana characters. Since letter identification is included in the early visual analysis in a cognitive neuropsychological model of reading [12], their reading impairment was thought to lay in the early visual analysis stage. However, the fact that their kanji reading was preserved implies that there is hardly any sequential information processing from kana identification (early visual analysis) to kanji recognition [13]. If there were, reading of kanji, which requires both whole-word recognition and individual component discrimination, would also be impaired. The patients contradict the traditional cognitive model that reading proceeds in parallel, as well as in sequence, from letter identification to word recognition [14] or that the so-called word form system parses letter strings multiply and in parallel into graphemes, syllables and words [15]. Instead, pure alexia for kana suggests that letter identification and word recognition constitute a dissociable dual route separate from nonlinguistic fundamental visual analysis [13].

As there have been few reports on pure alexia for kana since our reports, it is controversial whether this type of alexia generally exists and, if it does, where the responsible lesion is located. In this study, we examined six patients with focal lesions in the left occipital gyri, characterized the neuropsychological deficits and located the common affected site using MRI and SPECT.

2. Materials and methods

Six patients with damage to the left posterior occipital region, two of whom were previously reported [5,6], were recruited and underwent the following reading and writing tests within 4 months of onset. They were all right-handed men, with age between 67 and 79, mean 75 years old (Table 1). All the patients gave informed consent and the protocol was approved by the Ethics Committee at our hospital.

2.1. Test (1)

Patients read aloud 100 single-character kanji and the kana transcription of kanji characters, and wrote the same 100 dictated kanji and kana [16], all of which are taught in the first 3 years of primary school in Japan. Correct answers and time for reading and writing were measured. Overall reading and writing errors were counted and classified into non-response, phonological, semantic, etc.

Table 1
Patients with focal lesions in the left posterior occipital gyri

Patient	1	2	3	4	5	6
Age, sex	77M	78M	75M	76M	67M	79M
Cause	H	I	HI	H	H	HI
Visual field defect	RL	(LH)*	RH	RH	(−)	(−)
Duration of alexia	>5 yr	4 mo	4 mo	2 mo	1 mo	<1 mo
Preceding stroke	(−)	rt Li, Cu	rt Fu	(−)	rt inf P	(−)
Lesion	mid,inf O	mid,inf O	mid,inf O	Fu, inf O	Fu	Fu
WAB						
Comprehension (/10)	9.85	10	9.15	n.d.	9.75	9.75
Reading (/10)	5.58	10	10	n.d.	10	8.36
Writing (/10)	8.85	9.9	10	n.d.	10	9.3
*Reading and writing test***						
Kanji reading (/100)	99	97	100	100	99	99
Kana reading (/100)	83	100	100	96	100	91
Kanji writing (/100)	79	95	97	85	99	64
Kana writing (/100)	96	98	100	98	99	92

∗Caused by the previous stroke.

∗∗ Test (1) in the text.

Abbreviations. M, man; H, hemorrhage; I, infarction; HI, hemorrhagic infarction; RL, right lower quadrantanopsia; RH, right hemianopsia; LH, left hemianopsia; rt Li, right lingual gyrus; Cu, cuneus; Fu, posterior fusiform gyrus (Area 18/19); inf P, inferior parietal lobule; mid, inf O, middle and inferior occipital gyri; n.d., not done.

2.2. Test (2)

Next, patients were given a reading test, consisting of 100 two-character kanji words, the corresponding 100 three-character hiragana (a cursive form of kana that is used for grammatical formatives) words (high familiarity; hf) that were transcribed from the above kanji words, another set of 100 three-character hiragana words (low familiarity; lf), and 100 three-character hiragana nonwords (a and b) [13]. The kana words were chosen from those with higher or lower familiarity based on how often the subject had seen, heard or used the word (above 3.50 or between 1.50 and 1.99, assessed by a five-point rating scale, range from 0.00 to 4.96) [17]. Mean familiarity values in auditory presentation assessed in a more recent study [18] were 5.98 for high familiarity words and 4.20 for low familiarity words on a seven-point rating scale. Actually, high-familiarity words (hf) were also high-frequency words and low-familiarity words (lf) were low-frequency words [18]. The kana nonwords were provided in two sets: (a) those combining kana symbols that had nearly no association with each other [19] and (b) those changing the sequential order of characters in the above higher familiarity kana words [6]. In fact, kana nonwords (a) were more difficult