

## Case report

# Right-sided neglect influences the writing of Kanji: A case study

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## ABSTRACT

Neglect is the failure to report, respond, or orient to novel or meaningful stimuli presented to the side opposite a brain lesion. Here we describe the case of a 73-year-old woman who experienced a writing deficit in the right-sided component of Kanji letters (morphograms) of the Japanese language. Magnetic resonance imaging of the brain showed an infarction in the left middle temporal and occipital gyrus. The patient wrote recognizable, well-formed but parapraphic Kanji letters in both spontaneous and dictated writing. Most letters are composed of two elements: "hen" (left) and "tsukuri" (right). Neographism in tsukuri was her most frequent error. When she was instructed to answer orally hen and tsukuri, she made more mistakes related to tsukuri than to hen. Unilateral spatial neglect in memory or imagery was reported. We concluded that unilaterally disrupted processing of internal representations affected the writing of Kanji letters in this patient.

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## 1. Introduction

A characteristic feature of the Japanese writing system is that it is composed of two types of letters: Kana (phonograms) and Kanji (ideograms). Each Kana letter represents a spoken syllable and has one-to-one correspondence with sound. Kanji letters are used for expressing nouns, roots of verbs, adjectives, and adverbs.

About half of all Kanji letters consist of two elements: "hen" and "tsukuri". The hen element forms the left part of the letter and the tsukuri element forms the right part. For example, 明 (bright) consists of left and right radicals: 日 (day or the sun) and 月 (month or the moon).

Unilateral spatial neglect is a disorder clinically characterized by the inability to perceive or respond to stimuli presented to the side opposite a brain lesion, despite the absence of significant sensory or motor deficits [1]. Patients with left-sided spatial neglect and a lesion in the right hemisphere are more frequently seen than those with right-sided spatial neglect [1]. It is known that left-sided neglect often affects writing and spelling [2–7]. Omission, substitution, and duplication have also been reported in Kanji letters written by patients with left-sided neglect [3,4,6]. Since right-sided neglect resulting from a lesion in the left hemisphere is rare, its influence on writing and spelling has not been well examined.

We present a patient with a writing deficit in the right-sided component of Kanji, i.e., tsukuri. We assumed that the errors

involved processing the right part of a canonical orthographic representation in a word-centered coordinate system [8,9].

## 2. Case report

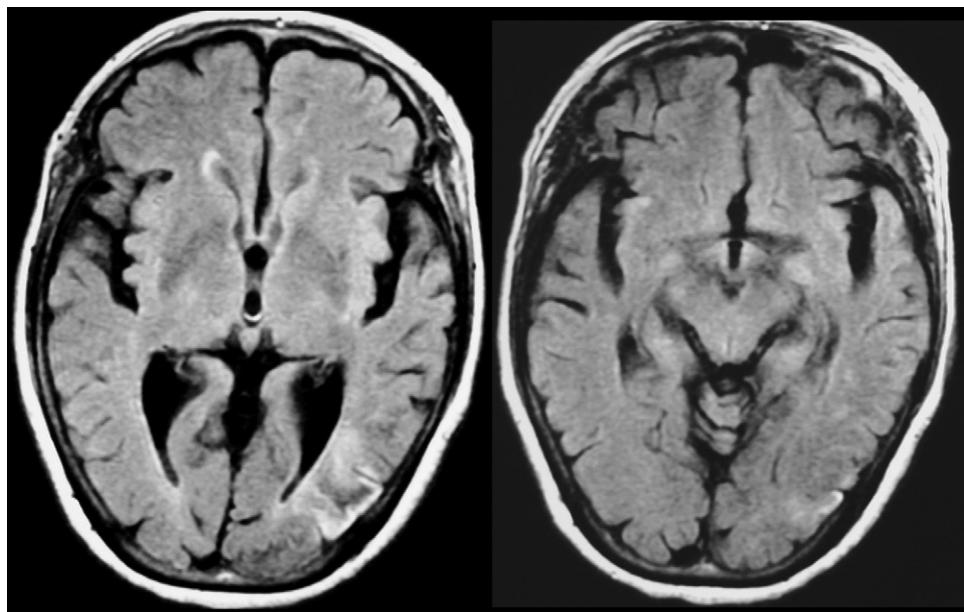
A 73-year-old right-handed Japanese woman with right homonymous hemianopia was admitted to our hospital. After she graduated from university, she worked as an English teacher at a senior high school. On admission, the patient was alert and her WAIS-R score was normal (total IQ 112, verbal IQ 116, performance IQ 105). She showed no signs of neglect in tests of line bisection, cancellation, and copying figures. Brain MRI showed a fresh infarction in the left middle temporal and occipital gyrus (Fig. 1).

The patient wrote recognizable, well-formed letters. She made a perfect score on the test for reading of Kana and Kanji letters, but the error rate was 1.0% (1/100) for the writing of Kana letters and 6.0% (6/100) for Kanji letters [10,11]. There was a significant difference in the number of errors between Kanji and Kana letters ( $P < 0.05$  by Fisher's exact method).

Of the 262 Kanji letters written spontaneously within 1 week after the onset of stroke symptoms, 46 letters were wrong (error rate 17.6%). For the 46 incorrect Kanji letters, the partial response rate (a component of a Kanji character was correct) was 73.9% (34/46), the unrelated response rate (substitution by a different Kanji response with no visual or phonological similarity to the correct answer) was 21.7% (10/46), and the nonresponse rate was 4.3% (2/46) [10,11]. To clarify the spatial position of the patient's errors, the 46 incorrect Kanji letters were assessed by dividing each error into left and right halves. Four letters had an error on the left side (8.7%), 20 letters had an error on the right side (43.5%), and 10 let-

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**Fig. 1.** Brain MRI showing high-signal intensity on fluid-attenuated inversion recovery (FLAIR) in the left middle temporal and occipital gyri.

ters had an error on both sides (21.7%). There were therefore more errors on the right side of Kanji letters than on the left. Of the 46 incorrect Kanji letters, only 15 consisted of hen and tsukuri, while 31 letters did not. The error rate associated with only tsukuri, both hen and tsukuri, and only hen was 80.0% (12/15), 13.3% (2/15), 6.7% (1/15), respectively (Fig. 2-1).

To evaluate whether the patient made more errors on the right side than on the left, we conducted a special dictation test for her 2 weeks after the stroke. All Kanji letters are taught in the lower grades of elementary school in Japan, and they are generally frequent, familiar, and of low complexity. The patient's error rate was 7.5% (7/93). Of the seven letters with an error, six had an error only in tsukuri (85.7%) and one had an error only in hen (14.3%). There were no letters with errors in both hen and tsukuri (0%). Thus, most errors were in tsukuri (Fig. 2-2). The rate of neologism was 71.4% (5/7) and the partial response rate was 28.6% (2/7) [10,11]. Tsukuri was often substituted for a part of another Kanji letter or an unreal character. Because all Japanese who complete manda-

tory education can perform this test without error, the patient's performance was poor with regard to her age and academic background.

To evaluate the patient's manipulative task ability for Kanji letters, we developed another original test. The examiner pronounced a Kanji letter and then the patient was instructed to identify orally its hen and tsukuri. The total error rate was 17.4% (16/92), and the error rate for tsukuri was 93.8% (15/16). Almost all errors were for tsukuri. For example, although 相 (dimension) consists of 木 (wood) and 目 (eye), the patient replied that it consisted of 木 (wood) and 手 (hand). Again, the patient's performance was considered poor with regard to the above parameters.

### 3. Discussion

The patient showed a writing deficit that was more prominent in Kanji letters (morphograms) than Kana letters (phonograms). The patient wrote recognizable, well-formed but paragraphic Kanji let-

1-A	静→ <del>靜</del> 撃→ <del>搥</del> 同→ <del>𠂇</del>	誤→ <del>誤</del> 絶→ <del>絶</del>
	眼→ <del>眠</del> 液→ <del>液</del> 部→ <del>部</del>	縦→ <del>縦</del> 緒→ <del>緒</del>
	神→ <del>徑</del> 階→ <del>陥</del> 歸→ <del>帰</del>	綱→ <del>網</del> 姑→ <del>姑</del>
	経→ <del>経</del> 話→ <del>許</del> 頃→ <del>頃</del>	
1-B	初→ <del>礼</del> 梗→ <del>梗</del> 使→ <del>使</del>	2-A
1-C	敢→ <del>敢</del>	誤→ <del>誤</del> 絶→ <del>絶</del>
		縦→ <del>縦</del> 緒→ <del>緒</del>
		綱→ <del>網</del> 姑→ <del>姑</del>
		腰→ <del>腰</del>
		腰→ <del>腰</del>

**Fig. 2.** (Left) Examples of errors in the patient's spontaneous writing samples. (1-A) Errors in the right-sided component of Kanji (tsukuri). (1-B) Errors in both components of Kanji (hen and tsukuri). (1-C) Errors in the left-sided component of Kanji (hen). Many neographisms were noted in the right-sided component of Kanji (tsukuri). (Right) Examples of errors in the patient's dictation. (2-A) Errors in the right-sided component of Kanji (tsukuri). (2-B) Errors in the left-sided component of Kanji (hen). Many neographisms were noted in the right-sided component of Kanji (tsukuri).

ters. She made errors in the right-sided component of Kanji letters (tsukuri), in both spontaneous and dictated writing. She also made the same errors in the oral test with Kanji letters.

In the handwriting control, learned spellings are stored in the orthographic output lexicon, encoded in an abstract fashion and specifying a particular set of letters [12]. This process is called a word-centered coordinate system [8,9]. The information is transmitted to an output code, which is a physical code for handwriting and a name letter code for oral spelling. In our patient, not only handwriting but also oral spelling was involved. Hence, it was assumed that the word-centered coordinate system was affected.

Caramazza and Hillis [9] reported the case of a patient who was asked to write a word presented by auditory input (blame) but it was mistakenly written as bland. When asked to spell orally a word (normal) presented by auditory input, it was mistakenly spelled as “n-o-r-m-e-n-t.” In both dictation and spelling, errors occurred only on the right side of the words. The fact that their patient's writing and spelling processing deficit was restricted to the right side of words, regardless of the form of input or output, suggests that her difficulty involved processing the right part of a canonical orthographic representation in a word-centered coordinate system [8,9].

There are three differences between the case presented by Caramazza and Hillis [9] and our case. First, their patient showed right-sided neglect in copying figures, line bisection, and reading following an infarction in the left hemisphere, whereas our patient performed these tests without error. There have been reports of patients who have presented with representational neglect without unilateral spatial neglect in the visual modality [13,14]. In our patient, we suggest that unilateral spatial neglect affected only the internal representation of Kanji letters. Second, in contrast to our patient who was right-handed, the patient of Caramazza and Hillis was left-handed; therefore, it is possible that lateralization in that case was exceptional. Third, Caramazza and Hillis gave only a vague description of the site of the lesion. However in our patient, brain MRI showed a fresh infarction in the left occipital gyrus—nearly in the same region as that reported in a case of right-sided neglect [15,16].

As Caramazza and Hillis [9] pointed out, this writing deficit showed that one form of unilateral neglect resulted from a selective deficit in processing the right half of abstract orientation-invariant internal representations. This indicates that the errors involved processing the right part of a canonical orthographic representation in a word-centered coordinate system.

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