

[ CASE REPORT ]

## Revival of Historical *Kana* Orthography in a Patient with Allographic Agraphia

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### Abstract:

Japanese people born before World War II learned Japanese *kana* (Japanese syllabograms) writing in a style that is not currently used. These individuals had to learn the current style of *kana* orthography after the war. An 85-year-old man was taken to our hospital by his family who were surprised by his diary. It was written with *kanji* (Japanese ideograms) and *katakana* using the prewar style. A neuropsychological examination revealed impaired recall of *hiragana*. Neuroimaging studies revealed atrophy of the left fronto-parietal lobe and hypoperfusion of the left frontal lobe. His allographic agraphia might have resulted from the disturbance of the current style of *kana* orthography.

**Key words:** allographic agraphia, Japanese language, *hiragana*, *katakana*, dementia

(Intern Med 57: 745-750, 2018)

(DOI: 10.2169/internalmedicine.8834-17)

### Introduction

Japanese people use two types of writing: *kana* and *kanji*. *Kana* consists of syllabograms that represent sounds. *Kanji* consists of ideograms that simultaneously represent both sounds and meanings. *Kana* is divided into two groups: *hiragana* and other *katakana*; each of which contain 46 characters. A single sound can be written using either *hiragana* or *katakana* (Table 1). In current Japanese usage, *katakana* is mainly used for foreign words, onomatopoeic words, and the names of living things. *Hiragana* is more commonly used in combination with *kanji* for the construction of typical sentences. In the English and Japanese literature, numerous articles have discussed the differences in the pathways involved in the cognition or writing of *kana* and *kanji*. However, few reports have investigated the differences between *hiragana* and *katakana*.

With regard to writing systems, two processes have been proposed. “Central processes” include “sublexical” (or “phonological” routes) and “lexical” routes; these processes generate spelling, regardless of the modality of output (handwriting, oral spelling, typing, etc.). “Peripheral processes” are specific to one particular output modality. For handwrit-

ing, three successive stages are described. In the first stage, which is referred to as the “allographic system”, the allograph, the appropriate font, and the case of the letter to be written are selected. In the second stage, the graphic-motor pattern specifies the direction, relative size, position, and order of strokes. In the final stage, graphic coding takes place; this corresponds to the execution and control of neuromuscular commands (1, 2).

There are few reports on allographic agraphia. When the alphabetical scripts are used, allographic agraphia appears as the misuse of upper and lower cases (e.g., “mIXeD CasES”) (3, 4). In other cases patients have been observed to be unable to write in a single specific font or case (5-10). We herein describe the case of a man with dementia who used *kana* letters in an unusual manner, which differed from simple allographic agraphia.

### Case Report

An 85-year-old right-handed man presented with dementia. He was accompanied by his family. He had been educated until fourteen years of age. The patient kept a diary. His family was surprised to see that his diary was written in *kanji* and *katakana* instead of *kanji* and *hiragana*. His diary

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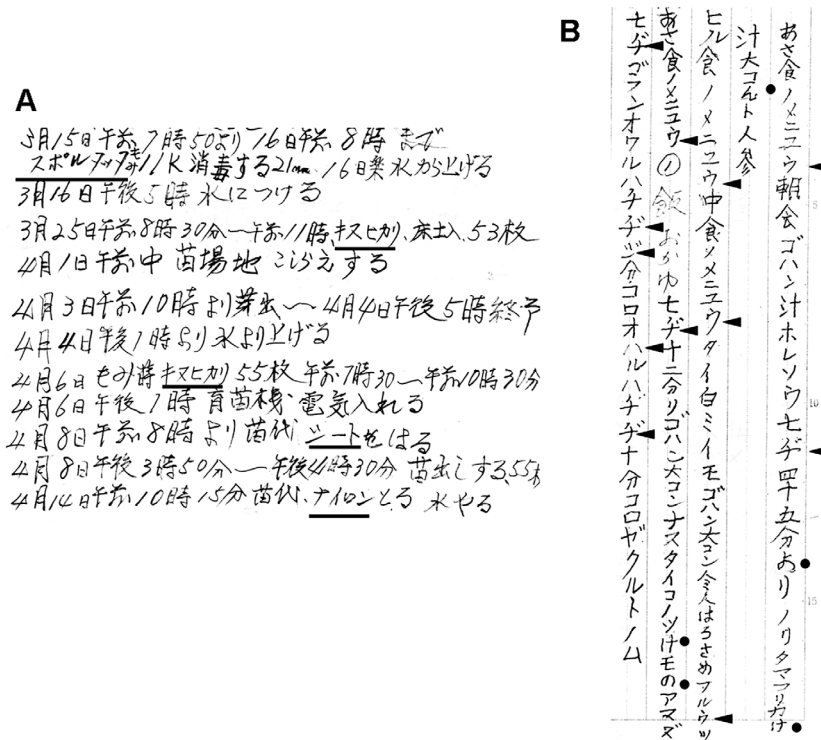
Received for publication January 9, 2017; Accepted for publication July 17, 2017

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**Table 1.** The Japanese *kana* characters (*hiragana*, *katakana*) and Their Pronunciation.

あ, ア, a	か, カ, ka	さ, サ, sa	た, タ, ta	な, ナ, na	は, ハ, ha	ま, マ, ma	や, ヤ, ya	ら, ラ, ra	わ, ワ, wa	ん, ン, n
い, イ, i	き, キ, ki	し, シ, shi	ち, チ, chi	に, ニ, ni	ひ, ヒ, hi	み, ミ, mi		り, リ, ri		
う, ウ, u	く, ク, ku	す, ス, su	つ, ツ, tsu	ぬ, ヌ, nu	ふ, フ, fu	む, ム, mu	ゆ, ユ, yu	る, ル, ru		
え, エ, e	け, ケ, ke	せ, セ, se	て, テ, te	ね, ネ, ne	へ, ヘ, he	め, メ, me		れ, レ, re		
お, オ, o	こ, コ, ko	そ, ソ, so	と, ト, to	の, ノ, no	ほ, ホ, ho	も, モ, mo	よ, ヨ, yo	ろ, ロ, ro	を, ヲ, wo	

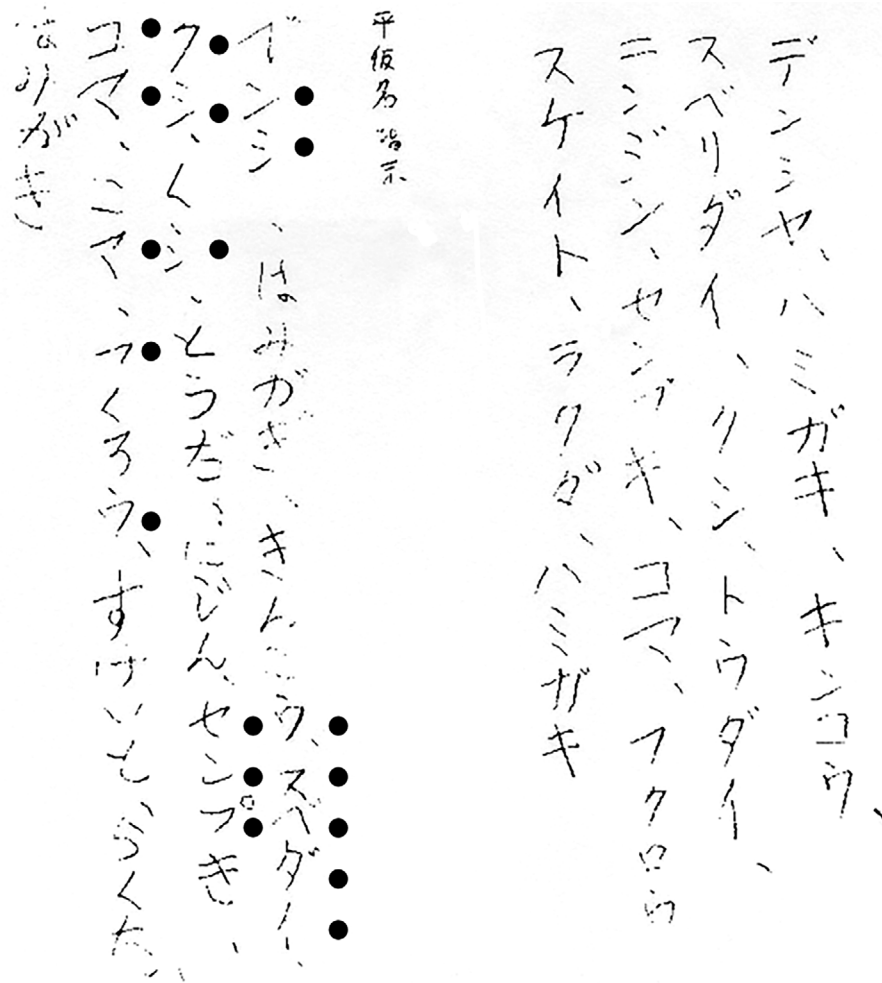
In addition to the standard letters described in Table 1, the addition of two dots on the upper right corner of letters in the ‘か,カ(ka)’, ‘さ,サ(sa)’, ‘た,タ(ta)’, and ‘は,ハ(ha)’ columns (e.g., か) modify the pronunciation to ‘ga’, ‘za’, ‘da’, and ‘ba’, respectively. The addition of a circle on the upper right corner of the ‘は,ハ(ha)’ column (e.g., ば) modifies the pronunciation to ‘pa’. A small ‘つ,ツ’ denotes a double consonant. The small ‘や,ヤ’, ‘ゆ,ユ’, and ‘よ,ヨ’ produce contracted sounds.



**Figure 1.** (A) A sample of the patient’s writing from March 15th to April 14th in 2013. The sentences are written horizontally from the left to the right with the current style of *kana* orthography. *Katakana* is only used for foreign words or for writing the type of rice (underlined). “March 16. From 7:50 AM on March 15 to 8:00 AM Disinfection of 11 kg unhulled rice with Sporutak®. On the 16th take them out of the fluid/March 16. Put them in water at 5:00 PM March 25. Prepare the soil in order to plant 53 cases of Kinuhikari (a type of rice) from 8:30 AM to 11:00 AM April 1. Prepare the ground in the morning. April 3. Sprout from 10:00 AM until 5:00 PM on April 4. April 4. Take the cases out of the water. April 6. Scatter 55 cases of unhulled Kinuhikari rice from 7:30 AM to 10:30 AM. April 6. Turn the electric nursery chamber on April 8. Cover the rice nursery with sheets from 8:00 AM. April 8. Take 55 seedlings out from 3:50 PM to 4:30 PM. April 14. Take the Nylon sheets off and spray with water at 10:15 AM”. (B) A sample of his writing dated May 3 of 2014. Here, the sentences are written vertically with *kanji* and *katakana* using the historical *kana* orthography (arrowheads). *Hiragana* is mixed into some words (dots). “Breakfast menu. Breakfast. Rice, soup, spinach. From 7:45. Noritama seasoning powder. Radish and carrot soup. Lunch menu. Lunch menu. A piece of sea bream, potatoes, rice, radish and carrot, Harusame, and fruits” (the first three columns).

had been written in *kanji* and *hiragana* until November of 2013. His usage of *katakana* was normal. He only used *katakana* for foreign words and to describe varieties of rice (Fig. 1A). After May 2014, the patient’s diary was written in *katakana* and *kanji* with a historical form of *kana* orthogra-

phy - as if it had been written before World War II (Fig. 1B). Neurologically, he was alert and his manner was polite. His spontaneous speech was fluent and paraphasia was not observed. His auditory comprehension was good. There was no external ocular palsy, facial palsy, masked



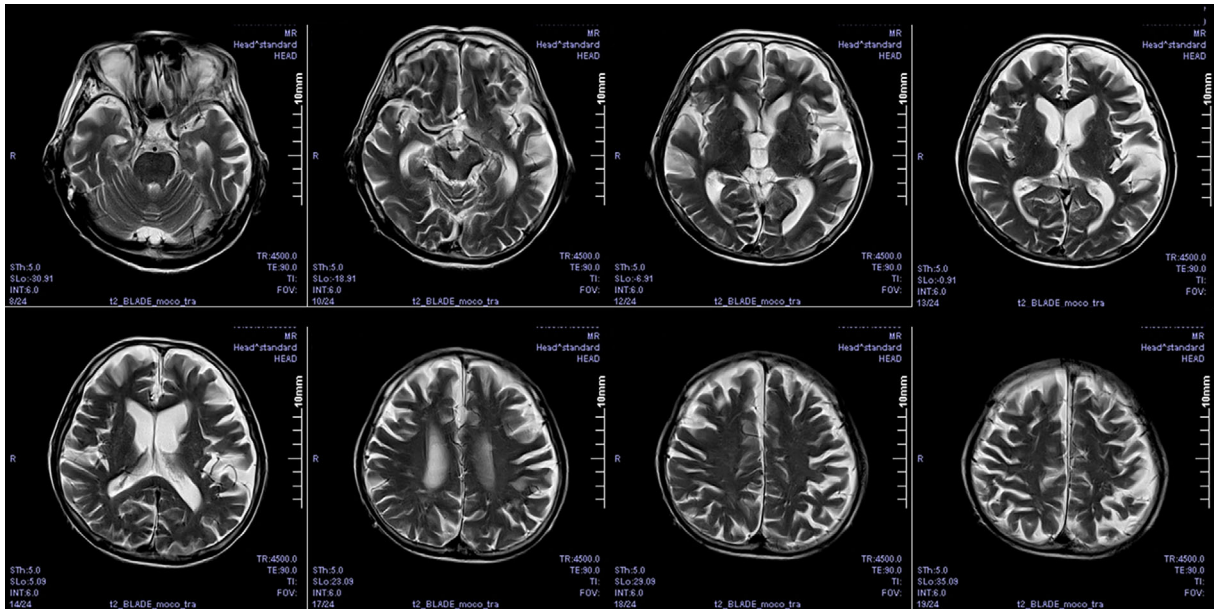
**Figure 2.** Writing the names of objects shown in pictures. The patient was asked to “Write the names of the objects shown in the pictures using *kana* (not indicating *hiragana* or *katakana*)” (right), and to “Write the names of the objects shown in pictures using *hiragana*” (left), “electric train”, “toothbrush”, “safe box”, “playground slide”, “comb”, “lighthouse”, “carrot”, “electric fan”, “top”, “owl”, “skate”, “camel”, and “toothbrush”. When the patient was asked to write in *hiragana* (left), he used *katakana* letters in some words (dots).

face, or bulbar palsy. He displayed no weakness, involuntary movement, sensory disturbance, ataxia, or parkinsonism. His deep tendon reflexes were all normal, and no pathological reflex was evoked. A neuropsychological examination revealed low Wechsler Adult Intelligence Scale (Third edition) scores: verbal intelligence quotient (VIQ), 67; performance IQ (PIQ), 58; and full IQ (FIQ), 60. Standard language tests for aphasia revealed decreased scores for “Following verbal commands”, “Word listing”, “Writing *kanji* words”, “Dictating *kanji* letters”, “Writing *kana* words”, “Dictating sentences”, and “Calculation”. In spontaneous written naming, he wrote all entries using *katakana*. When he was asked to write them using *hiragana*, he wrote some letters using *katakana* (Fig. 2). A standard performance test for apraxia (Japan Society for Higher Brain Dysfunction) revealed constructional disability. His visual perception test score for agnosia (Japan Society for Higher Brain Dysfunction) was normal. Brain magnetic resonance imaging revealed atrophy of the left frontoparietal lobe (Fig. 3). Single photon emis-

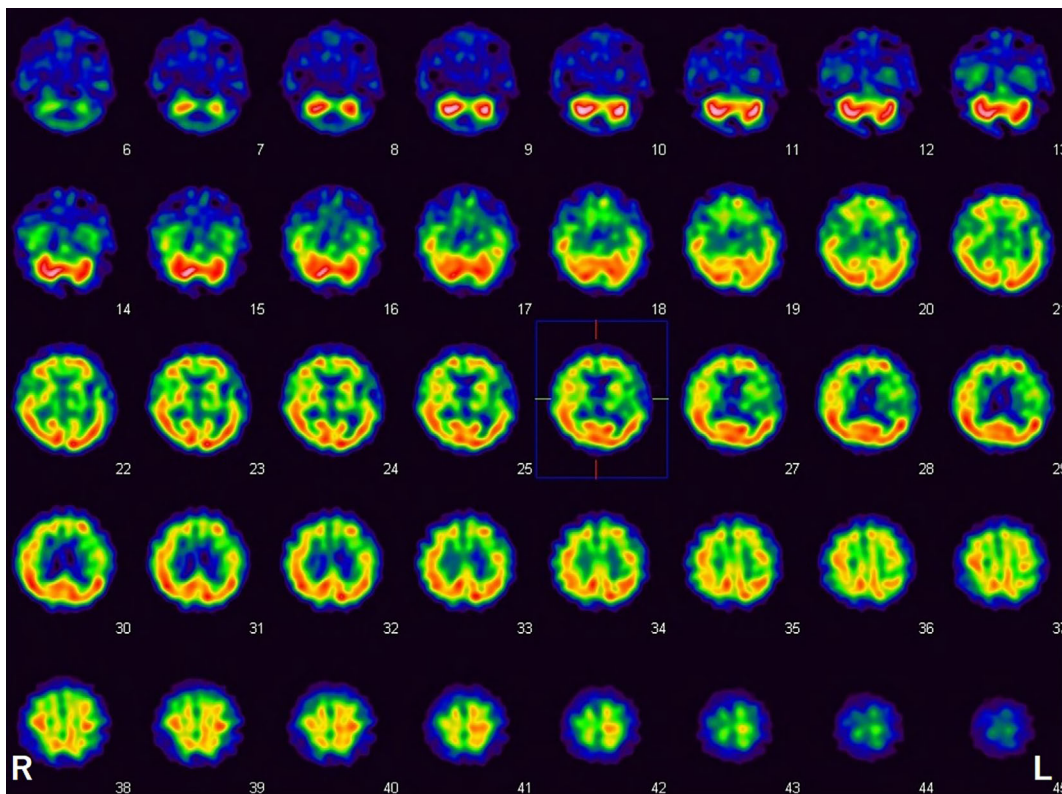
sion computed tomography using  $^{99m}\text{Tc}$ -ethyl cysteinate dimer revealed hypoperfusion at the left middle and inferior frontal gyrus and the anterior area of the left Sylvian fissure (Fig. 4). Treatment with donepezil chloride (5 mg/day) improved his handwriting. He was able to write sentences with *kanji* and *hiragana* as he had previously written them. However, with regard to the dictation of *kana* words that were spelled differently in the prewar style, he used the prewar style for 11 of 52 cases. He wrote words with a mixture of *hiragana* and *katakana* in 4 of 52 cases.

## Discussion

The most striking feature of the patient’s presentation was the change in the script in his diary. Currently, Japanese people use *kanji* and *hiragana* in normal sentences. The use of *katakana* is limited to foreign words, onomatopoeic words, and the names of living things. In his diary, most of the letters that would normally be written *hiragana* were



**Figure 3.** T2-weighted magnetic resonance imaging of the patient's brain. The left frontoparietal lobe is atrophic.



**Figure 4.** Single photon emission computed tomography using  $^{99m}\text{Tc}$ -ethyl cysteinyl dimer.

written in *katakana*. Although he also used *kanji* and *hiragana* in his diary, he wrote some words using both *hiragana* and *katakana*. Similarly to the use of upper case and lower case letters in countries where alphabetical scripts are used, one single sound can be written using either *hiragana* or *katakana*; however, the use of a mixture of *hiragana* and *katakana* in a single word is grammatically incorrect in the Japanese language. We concluded that the patient's use of

script was a form of allographic agraphia. There were also errors in the configurations of both *kanji* and *katakana* characters. In the present case, impaired character recall for *kana*, especially *hiragana*, might have been responsible for the patient's allographic agraphia.

However, in addition to the patient's allographic agraphia, the patient also used historical *kana* orthography. The current style of *kana* orthography was established after the end



**Table 2. The Reported Cases of Allographic Agraphia.**

Reference	Age (years)	Aetiology	Imaging	Location	Complicating focal signs
5	54	CVA	CT	L-P	R hemianopia, R monoparesis
3	48	Tumor	CT	L-T, P, O	R hemianopia, Gerstmann's syndrome
6	67	?	CT	Normal	Global intellectual impairment
7	72	Infarct	CT	L-P, O	R hemianopia, R monoparesis
8	20	Injury	CT	L-P, R-F, O	Memory deficit, alexia, L hemiparesis
9	70	Stroke		L-hemisphere	R hemianopia, R paresthesia, alexia
10	52	AD	CT	Diffuse atrophy	
4	70	Infarct	MRI	Multiple lacuna	
1	81	FTD	CT, MRI	Diffuse atrophy	
12	62	Hemorrhage	CT, MRI, SPECT	L-P, O	R quadrantanopia, Gerstmann's syndrome
2	68	Encephalitis	CT, MRI, SPECT	L-T, O	Amnesic aphasia, R hemianopia, R hemiparesis

CVA: cerebrovascular attack, AD: Alzheimer's disease, FTD: frontotemporal dementia, CT: computed tomography, MRI: magnetic resonance imaging, SPECT: single photon emission computed tomography, L: left, R: right, P: parietal, T: temporal, O: occipital

**Figure 5.** An example of the difference of historical (upper line) and current (lower line) kana orthography. The indicated word is pronounced as 'ju-gatsu' meaning October.

of World War II (in 1946). In some words, although the pronunciation is the same, the spelling differs between the two styles (Fig. 5). Our patient first learned the prewar style in elementary school. At that time, students learned *katakana* before *hiragana*. Sentences in official documents, such as legal documents, were written in *kanji* and *katakana*. In our patient's brain, the two different Japanese language systems might have been input separately, with one system being the historical style of *kana* orthography consisting of *kanji* and *katakana*; and the other being the current style of *kana* orthography consisting of *kanji* and *hiragana*. A similar situation might be discovered in areas in which English language is used. The use of British-American (or *vice versa*) spelling is a good example. Some words are spelled differently in British English and American English, for example "centre" and "center". In the dementia process, the spelling that the patient learned first might appear in his/her handwritten sentences. A similar phenomenon has been discussed in bilingual patients with aphasia (11).

In the Japanese people, only one case of allographic agraphia has been reported in a patient with lesions of the left angular gyrus and the adjacent lateral occipital gyri (12).

In countries where alphabetical scripts are used, allographic agraphia was also observed in patients with lesions of the left temporo-parieto-occipital region. There were four cases (1, 4, 6, 10) in which the lesion responsible for allographic agraphia was unclear (Table 2). Although it was impossible to determine, the lesion responsible for allographic agraphia in our patient seemed to be located in the left middle and inferior frontal gyrus and the anterior area of the left Sylvian fissure. The writing of our patient improved after the administration of donepezil chloride. This fact suggests that his writing disorder might have been due to attention disturbance rather than a focal sign of the cerebral cortex (13).

The authors state that they have no Conflict of Interest (COI).

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*Intern Med* 57: 745-750, 2018