

LEXICAL ACCESS OF KANA WORDS AND WORDS IN KANA

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Introduction

According to the standard process model of reading words<sup>5)</sup>, there are at least two alternative procedures for a word to access the internal lexicon: (1) direct access in terms of a visual orthographic code, and (2) indirect access in terms of non-lexical phonological recoding.

Written Japanese comprises two distinct orthographies: kanji and kana. Kanji are logographic characters of Chinese origin used in the Japanese writing system; they map onto lexical morphemes of spoken Japanese, such as nouns and the root forms of verbs and adjectives. Most kanji have several alternative readings, depending on different semantic/morphological contexts in which they are used. Thus, the orthography-phonology relationship for kanji is arbitrary and irregular; lexical access is normally achieved in terms of orthographic patterns, i.e. by use of the first procedure above.

Kana, on the other hand, are syllabic characters, each kana representing a speech unit roughly equivalent to a syllable. There are two forms of kana: hiragana and katakana. Hiragana are used for representing some content words of Japanese origin (e.g., nouns and adverbs) as well as most function words, while katakana are used primarily for representing loan words. Since kana characters cover all the sounds in Japanese, all Japanese speech sequences or words including those normally written in kanji can be transcribed in kana also. Script-sound correspondences for kana are highly regular; lexical access for kana words can always be made on the basis of nonlexical kana-to-sound correspondence rules, or by means of the second procedure above. However, there is no a priori reason why lexical access via the first procedure could not be made for kana words also, particularly for those that are normally printed in kana, and therefore orthographically familiar.

Literature on reading performance of Japanese neurological patients abounds with reports of those instances where various degrees and types of dissociations between kanji and kana processing are described and analyzed<sup>4,7)</sup>. There are some experimental data as well which are essentially in support of these differences in processing procedures between kanji and kana<sup>6)</sup>.

On the other hand, far less attention has been paid to the possible differences in the type of procedures required for lexical access among different types of kana strings, namely,

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between "kana words" which are normally written in kana and are therefore orthographically familiar, and "words in kana" which are not normally written in kana (e.g., kanji words transcribed in kana, or katakana loan words transcribed in hiragana) and are therefore orthographically unfamiliar. According to a Japanese version of the process model of reading kanji and kana, constructed on the basis of experimental as well as clinical data,<sup>9,10</sup>) orthographic familiarity of kana strings constitutes a major variable in determining the type of procedures used in achieving lexical access. That is, orthographically familiar kana words are predicted to achieve direct access to the lexicon on the basis of an orthographic code, while lexical access for orthographically unfamiliar words in kana is predicted to be made by means of phonological recoding. There are some clinical as well as experimental data supporting the predictions<sup>1-3,8</sup>). Sasanuma<sup>8</sup>) reported a case of an aphasic patient whose oral reading of orthographically familiar hiragana words was significantly more impaired than his ability to match these words to pictures. Since his kana-sound correspondence rules were severely impaired, making it unlikely for him to use a non-lexical phonological recoding procedure, there is a likelihood that he used a visual/orthographic procedure for accessing semantics for some of these words.

Some experimental data with normal readers also indicate the differential effects of orthographic familiarity on lexical access of kana words. Two studies by Hirose<sup>2,3</sup>) examined the effects of orthographic familiarity on semantic processing of kanji and kana words using a category decision task<sup>2</sup>), and on kana word recognition using a lexical classification task<sup>3</sup>), respectively. Mean decision latency for familiar kana words was shorter than that for unfamiliar kana words, while no difference was found in latency between familiar kana and kanji words. These results were interpreted by the author to indicate that orthographic familiarity played an important role in the speed of semantic access as well as in word recognition.

Besner and Hildebrandt<sup>1</sup>) designed an experiment in which they had Japanese readers read aloud orthographically familiar katakana loan words and unfamiliar words printed in katakana (words normally written in kanji). Orthographically familiar words were named faster than both nonwords and orthographically unfamiliar words printed in katakana. The authors interpreted these results as evidence that lexical access of words written in katakana can be achieved without reference to phonology at least some of the time.

In the present study, we used a lexical decision paradigm to investigate: (1) whether RTs for orthographically familiar kana words are faster than RTs for orthographically unfamiliar words and nonwords, and (2) whether RTs for orthographically unfamiliar words are faster than RTs for nonwords. Additionally, we investigated whether different categories of kana words (Japanese nouns, loan words, adverbs and function words) affect lexical access of these words.

If we obtained faster RTs for orthographically familiar kana words than for orthographically unfamiliar words in kana, then a most likely interpretation would be to ascribe the results to different types of processing procedures required in making lexical decisions for the two groups of kana strings. Since lexical decision of nonwords printed in kana or of orthographically unfamiliar words in kana (i.e., katakana transcription of hiragana words and vice versa) must be based on preliminary phonological recoding (because the kana orthographic lexicon has no word-level representations for nonwords and very weak representations if any for orthographically unfamiliar words in kana), RTs for these strings must be slower. Significantly faster RTs for orthographically familiar kana words, then, may be interpreted to suggest that lexical access for these words can be achieved directly on the basis of an orthographic code.

Further, if we obtained faster RTs for orthographically unfamiliar words in kana than for nonwords printed in kana, then three explanations would be possible: (1) Word-level phonological information in the lexicon for orthographically unfamiliar words may have exerted some facilitating effects on the phonological recoding of these words. (2) Even very weak word-level representations in the orthographic lexicon for some orthographically unfamiliar words may have invoked a processing procedure that is based on a visual/orthographic code, thus facilitating the lexical access of these words. (3) Combination of 1 and 2 above.

## Method

### Subjects

The subjects were 20 native speakers of Japanese, 20-32 years old (average of 26.6 years), with 12-16 years of education (average of 15 years). All had corrected eye-sight of 1.0 and above.

### Stimuli

Sixty-four high-frequency 3-character kana words were used to generate a total of 128 stimulus strings according to four experimental conditions: word/nonword x hiragana/katakana (Table 1). These 64 words comprised four categories of 16 words each: nouns (List 1), loan nouns (List 2), adverbs (List 3), and function words (List 4). Among these four categories of words, only those words in List 2 (loan nouns) are usually printed in katakana, all other words in other classes being normally printed in hiragana. To generate stimulus strings for word/hiragana and word/katakana conditions, one half of the 16 words in each category were printed in hiragana (Group A) and the other half in katakana (Group B), regardless of their normal orthographic form. Thus, Group A words (words printed in hiragana) from Categories 1, 3 and 4, as well as Group B words (words printed in katakana)

from Category 2, are orthographically familiar, while the rest of the words are orthographically unfamiliar. To generate stimulus strings for nonword/hiragana and nonword/katakana conditions, one character in each of the 16 words in each category was replaced by another character, producing 8 nonwords based on Group A words (Group D) and another 8 nonwords based on Group B (Group C) for each category. For the experiment, the words in Group C were presented in hiragana, and the words in Group D were presented in katakana.

Table 1. Stimuli: Examples of stimulus strings under each experimental conditions

List/Category	Words		Nonwords		Total
	Hiragana A	Katakana B	Hiragana C	Katakana D	
1. Nouns (Hiragana)	n=8 いとこ* こけし	n=8 コケシ** ミンナ	n=8 やけど けわか	n=8 コケソ ムンナ	32
2. Loan Nouns (Katakana)	n=8 てれび** れたす	n=8 テスト* ドラマ	n=8 つすと どらめ	n=8 テルビ ラタス	32
3. Adverbs (Hiragana)	n=8 かなり* すべて	n=8 セメテ** オヨソ	n=8 せみて えよそ	n=8 ケナリ スベツ	32
4. Functors (Hiragana)	n=8 しかし* どなた	n=8 ソチラ** アソコ	n=8 そちれ あさこ	n=8 サカシ ドニタ	32
	32	32	32	32	128

\* orthographically familiar  
\*\* orthographically unfamiliar

Each subject saw four lists of 32 stimuli. Each list, derived from one of the original 4 categories of words, consisted of 8 orthographically familiar words, 8 orthographically unfamiliar words, and 8 nonwords derived from each of these 2 sets of words by the procedure described above. Forty practice items (10 items x 4 conditions) were prepared also.

#### Procedure

Forty practice trials preceded the test trials. Kana strings were presented one at a time on a 2 cm x 4cm window in the middle of a 12 in. CRT screen of an NEC PC-9801 computer.

Subjects initiated each trial by pressing a key on the key board; a second later a stimulus appeared and remained on the window until the subject responded by pressing a "yes" or "no" key. RT was recorded by a millisecond timer which started at presentation of the stimulus and stopped at the "yes" or "no" key press.

In the test session, the thirty-two strings in each List were randomized and presented to each subject in the same fashion as in the practice session.

To eliminate a possible effect of the presentation order of the four Lists, 20 subjects were divided into four groups of five subjects and assigned to each cell of a Latin square.

### Results

The results are summarized in Table 2. Trials on which word and nonword response errors occurred were eliminated from analysis of the reaction-time (RT) data. These eliminated trials accounted for a maximum of 17 responses (10.6%) and a minimum of 1 response (0.6%) across the 4x4=16 conditions, averaging 3.4%. It is interesting to note that the largest number of response errors occurred on katakana loan words transcribed in hiragana, although no immediate explanation is available at this moment.

Table 2. Reaction times (in milliseconds) as a function of stimulus category and stimulus type

Type Category	Words		Nonwords	
	Hiragana	Katakana	Hiragana	Katakana
Nouns (Hiragana)	588.7 ( 4.4)*	622.6 ( 4.4)	680.4 ( 1.3)	724.8 ( 4.4)
Loan Nouns (Katakana)	733.2 (10.6)	589.2 ( 1.3)	774.3 ( 1.3)	743.6 ( 1.9)
Adverbs (Hiragana)	579.6 ( 0.6)	644.6 ( 3.8)	674.9 ( 1.9)	676.7 ( 1.3)
Funcctors (Hiragana)	569.1 ( 0.7)	702.8 ( 3.2)	703.8 ( 3.1)	763.0 ( 9.4)

\* Figures in parentheses are percentages of errors.

Mean RTs for 20 subjects were submitted to a three-way analysis of variance (Word Categories x Orthographic Types x Words/Nonwords). Significance levels were set at .05.

Word Categories yielded no effect ( $F(3.96)=2.37$ ,  $p=.076$ ), while Orthographic Types yielded a main effect ( $F(1.96)=14.49$ ,  $p=.000$ ), as did the Word/Nonword condition ( $F(1.96)=170.16$ ,  $p=.000$ ). The interactions among these three factors were not significant. No main effect for the Word Categories indicates that this variable does not exert differential effects on response latencies for the stimulus strings. On the other hand, the significant main effects obtained for the Orthographic Types and Word/Nonword conditions indicate faster responses to orthographically familiar than unfamiliar strings, and to words than to nonwords.

To identify the source of the main effects, the Newman-Keuls multiple comparison test was used to compare differences between pairs of the Orthographic Types x Word/Nonword conditions for each List.

For List 1 (derived from hiragana nouns), significant difference in RTs was observed between words and nonwords, but not between orthographic types (hiragana and katakana). For List 2 (derived from katakana nouns) only those words written in katakana (orthographically familiar words) were significantly different in RTs from all other strings in the rest of conditions. In the case of Lists 3 and 4 (derived from adverbs and function words normally written in hiragana), RTs for only those words written in hiragana (orthographically familiar words) were significantly faster than RTs for other strings in the other three conditions.

To summarize, RTs for orthographically unfamiliar words are not significantly different from RTs for nonwords in Lists 2, 3, and 4. For List 1, on the other hand, RTs even for orthographically unfamiliar words (i.e., katakana transcriptions of hiragana nouns) are significantly faster than RTs for nonwords, and there is no significant RT difference between orthographically familiar and unfamiliar words.

#### Comments

The major findings of the present experiment were: (1) significantly faster RTs to orthographically familiar words than to nonwords, as well as to orthographically unfamiliar words in Lists 2 - 4; and (2) significantly faster RTs to orthographically familiar words than to nonwords, but nonsignificant difference in RTs between orthographically familiar and unfamiliar words in List 1.

The first finding suggests, as we proposed in the introduction, that orthographically familiar kana words can achieve lexical access on the basis of orthographic code without recourse to phonological recoding. The second finding may reflect the current states of fluctuation in the orthographic system for this group of words in Japanese. Katakana transcriptions of these words are being used in recent years

among some readers of the younger generation, from which our subjects have been drawn. Thus, "unfamiliar" words in fact may have had their word-level orthographic representations in the lexicon to the extent similar to that for "familiar" words.

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