

TEMPORARY MEMORY FOR LINGUISTIC AND NONLINGUISTIC MATERIAL
IN RELATION TO THE ACQUISITION OF JAPANESE KANA AND KANJI

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Abstract

Two experiments employed the recurring recognition paradigm of Kimura to assess the relationship between temporary memory for linguistic and nonlinguistic material and Japanese children's reading ability in the second grade. The first examined temporary memory for spoken nonsense words, and revealed that, like good beginning readers of the English alphabet, good beginning readers of Japanese excel in temporary linguistic memory, presumably because they make more effective use of phonetic representation than poorer readers do. The second experiment explored the relationship between memory for nonlinguistic visual material and orthographic material including: 1) abstract designs, 2) faces, 3) Hiragana, and 4) Kanji. It revealed that good beginning readers of Japanese excel in memory for both Kana and Kanji, but in contrast to good readers of the alphabet, these children also excel in memory for abstract designs. In general, Japanese children's memory for Kana is significantly related to that for Kanji and spoken syllables, but not abstract designs or faces, whereas memory for Kanji is significantly related to that for nonsense designs and spoken syllables, but not faces. The implication is that the ability to retain linguistic material in temporary memory contributes to successful acquisition of alphabets, syllabaries and logographies, whereas the importance of nonlinguistic memory skills can depend on the nature of the orthography at hand.

Introduction

Temporary memory is important to the would-be reader of any orthography. Whether material is written in an alphabet, a syllabary or a logography, the reader who intends to comprehend its full meaning must be able to retain the information represented by individual characters until such larger units as words, sentences, or paragraphs can be apprehended. How beginning readers of syllabaries and logographies meet these temporary storage requirements is the issue at stake in this study, which examines the relation between temporary memory skills and success in learning to read Japanese. Several different types of material are to be considered, as an accumulating body of evidence from the psychological (Ellis, 1975; Woodhead and Baddeley, 1981) and neuropsychological literature (see, for example: Kimura, 1963; Milner and Taylor, 1972, Warrington and Shallice 1969) reveals that temporary memory can involve separable components. One such component employs

phonetic representation as a means of retaining linguistic material such as names of objects, spoken or printed words, etc., and is localized within the left, language dominant hemisphere. This stands in contrast to another component which employs nonlinguistic representations as a means of retaining such nonlinguistic materials as abstract designs and faces, and is localized within the right hemisphere. The question to be asked over the course of two experiments is whether the linguistic and nonlinguistic components of temporary memory make equivalent contributions to success in learning to read Kana and Kanji.

In recent years, studies in America and in Europe have asked whether success in learning to read alphabetic orthographies is related to the ability to remember certain types of information. These reveal that not all temporary memory abilities tend to distinguish good and poor beginning readers of the alphabet. For example, good and poor readers in the second-grade do not significantly differ in the ability to remember such nonlinguistic visual material as photographs of people's faces, or abstract visual designs (see, for example: Liberman, Mann, Shankweiler and Werfelman, 1982; Vellutino, Steger, Desetto and Phillips, 1975). Yet it quite evident that good readers surpass poor readers in temporary memory for syllables, words and sentences -- whether these are heard or read (see, for example: Byrne and Shea, 1979; Shankweiler, Liberman, Mark, Fowler and Fischer, 1979; Mark, Shankweiler, Liberman and Fowler, 1977; Mann, Liberman and Shankweiler, 1980; Mann, 1984) This has been accounted for by the view that superior readers make effective use of phonetic representation in temporary memory (Shankweiler et al, 1977).

Attempts to clarify and explain the association between effective use of phonetic representation and early reading ability have tended to focus on beginning readers of English (see, for example: Brady, Shankweiler and Mann, 1983; Katz, Shankweiler and Liberman, 1981; Mann et al, 1980; Mann, Shankweiler and Smith, in press; Mann and Liberman, in press; Shankweiler Liberman, Mark, Fowler and Fischer, 1978; Mann, in press), or of other alphabetically-transcribed languages such as French (Alegria, Pignot and Morais et al, 1982), Swedish (Lundberg, Oloffson and Wall, et al, 1980) and Dutch (Mann, 1982). One possible explanation is that learning to decode a phonetic transcription of spoken language places certain demands on memory for phonetic material (see, for example, Shankweiler and Liberman, 1976). If so, the association between phonetic representation and reading skill could be restricted to readers of the alphabet, conceivably extending to readers of a syllabary, since a syllabary is a type of phonological transcription, but not to readers of a logography, since logographies do not transcribe the phonological structure of spoken words. Another possibility is that phonetic representation is critical to all language processing, spoken and written alike, because it meets the temporary storage requirements involved in recovering

phrases, sentences and paragraphs from sequences of individual words (see Liberman, Liberman, Mattingly and Shankweiler, 1980; or Mann, 1984). In this case, the relationship between phonetic representation and reading ability should extend to readers of any orthography -- alphabet, syllabary or logography -- because all of these require that readers recover phrases, sentences, etc. one way or another.

One straightforward means of determining why use of phonetic representation is associated with reading skill would be to examine the use of phonetic representation by good and poor readers of syllabaries and logographies. Japanese has the virtue of using both; however, relatively little attention has been devoted to the temporary memory skills associated with acquiring Japanese. As some type of temporary memory should be essential to readers of syllabaries and logographies, we would expect some relationship between temporary memory skills and success in learning to read Japanese. It is even possible that the relationship will involve linguistic memory, and phonetic memory in particular, given some evidence that for both Japanese children and American children memory for the meaning of spoken text, as well as serial memory for words and digits, is associated with reading ability in the fifth-grade (Stevenson, Stigler, Lucker, Hsu and Kitamura, 1982). Yet there is no direct evidence about the use of phonetic representation by children who are in the early grades in Japan.

Certainly it is possible that effective use of phonetic representation characterizes good readers of nonalphabetic orthographies just as it characterizes good readers of the alphabet. This follows from a consideration of the fundamental nature of all orthographies, and from an observation about a coding strategy that is common to skilled readers of Chinese and English. All orthographies function to transcribe spoken language, hence it would be parsimonious if reading drew upon some of the processes that otherwise support spoken language use. Skilled readers who are attempting to remember written words in order to comprehend written sentences and paragraphs might rely on phonetic representation, as phonetic representation fulfills the temporary memory requirements of comprehending spoken sentences and paragraphs. Confirmation that this is indeed the case has been provided by experimental studies which reveal that both the temporary memory for orthographic material (including isolated letters, printed nonsense words, and real words and sentences) and the comprehension of written text involve recoding print into a phonetic representation. Most importantly, phonetic representation is employed in the service of temporary memory and comprehension whether subjects are reading the English alphabet (see, for example: Daneman and Carpenter, 1980; Kleiman, 1975; Levy, 1977; Meyer, Schvaneveldt and Ruddy, 1974; Slowiaczek and Clifton, 1980) or the Chinese logography (Tzeng, Hung and Wang, 1977; Hung and Tzeng, 1981).

However, it is nonetheless possible that the acquisition of nonalphabetic writing systems places less severe of a demand on phonetic memory than the alphabet does. Before beginning readers can begin to comprehend phrases and sentences, they must learn to decode individual words. While all orthographies serve to transcribe the words of spoken language in one way or another, they differ in the nature of the units that they transcribe: alphabets transcribe phonemes, syllabaries such as the Japanese Kana transcribe syllables, and logographies such as Chinese and Japanese Kanji transcribe words. It could be argued that these distinctions have consequences on the importance of phonetic representation to children's initial acquisition of word decoding skills. The beginning reader of the alphabet, for example, who is attempting to recognize a written word like "kitten", must be able to integrate the phonemes that the letters represent, and this may require effective use of phonetic representation. For the reader of a syllabary, integrating a sequence of syllables like "neko" into a word may also involve phonetic representation, but the demand could be milder than that of the alphabet, insofar as syllables are less abstract phonological units than phonemes, and there are typically fewer of them in a word. Finally, for the reader of a logography, word decoding may place almost no demand on phonetic representation. Since the characters of logographies transcribe words on a one-to-one basis, recognizing a word could be an all-or-none process which does not require that phonemes or syllables be retained in temporary memory.

Thus it is an open question whether use of phonetic representation will distinguish good and poor beginning readers of Japanese. Likewise, it is unknown whether, like good and poor readers of the alphabet, good and poor readers of Kana and Kanji tend to possess equivalent nonlinguistic memory skills. Here it is conceivable that the acquisition of the Kana syllabaries and the Kanji logography could place a certain demand on visual memory systems. Syllabaries to some extent and logographies in particular involve considerably more orthographic units than the alphabet, thus would-be readers of Japanese must encode and remember more visual shapes. For mature readers of Japanese, the reading of Kana and Kanji, like that of the alphabet, tends to be associated with the linguistic faculties of the left hemisphere (Sasanuma, 1975; Sasanuma and Fujimura, 1971). Hence it appears unlikely that the visual memory demands of Kana and Kanji cause skilled readers of Japanese to place inordinate reliance on nonlinguistic memory skills. Nonetheless, for the beginning reader who is acquiring an initial knowledge about orthographic characters, it is possible that learning to remember more-or-less abstract patterns of lines and curves could demand effective use of nonlinguistic memory skills. If so, good beginning readers of Japanese may surpass poor readers in their ability to hold certain types of nonlinguistic material in temporary memory.

To summarize, a rationale has been offered that the type of temporary memory abilities that are crucial to success at

learning to read may depend on the type of orthography at hand. In the two experimental studies which follow, an attempt was made to discern whether phonetic representation and various types of nonlinguistic memory abilities distinguish good and poor beginning readers of Kana and Kanji. The design is prompted by a previous study of American children which used the recurring recognition paradigm of Kimura (1963) to assess good and poor readers' ability to remember alphabetically written material, visual nonsense designs, and photographs of unfamiliar faces. The first experiment extends this methodology to the use of spoken nonsense materials, in order to determine whether effective use of phonetic representation distinguishes good and poor readers in the second grade. The second experiment turns to comparing memory for the two types of orthographic material, Kana and Kanji, with that for two types of nonlinguistic visual material, abstract designs and faces.

Experiment I

Methods

Subjects

The subjects were second-grade children attending the primary school attached to Ochanomizu University in Tokyo, Japan. All available children participated, including 50 girls and 50 boys, of mean age 86.6 months (sd.=3.5 months). At the completion of the study, each child was rated by his or her classroom teacher as either good, average, or poor in reading ability.

Materials

The materials comprised 52 two-mora (i.e. disyllabic) utterances which were meaningless, but phonologically plausible according to the intuitions of five native speakers of Japanese (three members of the staff of the Institute for Logopedics and Phoniatics, a Japanese linguist, and a teacher of Japanese). The utterances were constructed so that all Japanese consonants and vowels were represented in a variety of combinations (with the exception of consonant-[y] clusters as in [kyo]). Both V and CV mora occurred with the restriction that no mora occur more than once in either initial or final position.

Memory for these materials was assessed according to the recurring recognition paradigm of Kimura (1963). This required that 80 test items be constructed, each item being one of the 52 basic utterances. Four of the utterances were repeated eight times each (the recurring stimuli) and the remaining 48 were used once each (the nonrecurring stimuli). For the purpose of testing, the items were divided into eight sets of ten items each, with each set containing the four recurring stimuli randomly interspersed with six of the nonrecurring stimuli. The

first set of ten items constituted the inspection set, the remaining seven constituted the recognition set of 70 test items. The test was administered by a male native speaker of Japanese who read each item aloud with a neutral intonation contour at a rate of one every five seconds.

Procedure

All children were tested in their classrooms while seated with their classmates in their normal seating arrangement. Testing was completed during a single session conducted in the early afternoon after school hours. The instructor, who was a male native speaker of Japanese, began by telling the children that he would be reading them some words which they had never heard before (i.e. nonsense words). The words would be read one at a time and the first task was to listen to ten words and to try to remember each of them; afterwards they would be listening to a set of 70 more words and using a response sheet numbered from 1 to 70 with a single box next to each number. For the additional words, if the instructor had said a word before, they should put an "O" in the corresponding box, otherwise they should put an "X" in the box if the word had not been said before. At this point, presentation of the ten inspection items began, immediately followed by presentation of the 70 test items. To aid children in the correct use of the response sheet, the instructor said the number of each test item prior to reading the item aloud.

Results and Discussion

Following the methodology employed in the previous study of American children (Lieberman et al, 1982), the data were analyzed in terms of the total number of correct responses, summing over the seven sets of items, and including both the number of correct recognitions of recurring items and the number of correct rejections of nonrecurring items. To determine whether this data reduction procedure masked any critical findings, the data obtained from one of the three classrooms of children (n=33) were subjected to a more detailed analysis. That analysis indicates that a consideration of early vs. late sets, or of recognition vs. rejection would not alter the basic pattern of findings and the interpretation of them.

The main purpose of this experiment was to determine whether, like beginning readers of alphabetic orthographies, children who differ in the ability to read Japanese differ in memory for nonsense words. The basis from which I will attempt to answer this question is the teachers' rating of whether children were good, average, or poor in reading ability, a measure which does not separate skill in reading the Kana syllabaries from that in reading the Kanji logography. Attention

to the separate contribution of each skill will be a concern of Experiment II; for now, the analysis will focus on the question of whether reading ability, in general, is related to memory for spoken nonsense words.

The answer is affirmative, good readers surpassed poor readers in memory for the nonsense words, as the following analyses will show. On the average, performance was significantly better than the chance level of 50% correct, $t(99)=40.0$, $p<.001$, although children differed considerably in the accuracy of their responses. The highest score was 65 items correct (out of 70) the lowest was 36, and the mean was 57.0, or 81% correct. The 15 children whom their teachers deemed to be good readers achieved a mean score of 62.4 correct, which is significantly better than the mean score of 45 correct achieved by the 10 children who were deemed to be poor readers, $t(23)=6.18$, $p<.001$. When the scores of the good, below- and average readers are all considered, the relation between memory performance and reading ability is positive, and a modest, but significant correlation is apparent, $r(100)=.25$, $p<.006$.

The results of this experiment therefore suggest that children who are good beginning readers of Japanese, like those who are good beginning readers of English (Byrne and Shea, 1979), tend to excel in temporary memory for spoken nonsense words. The implication is that children who are particularly successful readers of nonalphabetic orthographies tend to make more effective use of phonetic representation than children who read less well. Whether use of phonetic representation is of equal importance to successful acquisition of the Kana syllabary and the Kanji logography remains to be explored in the second experiment, along with the question of whether memory for nonlinguistic material is related to successful acquisition of either Kana or Kanji.

Experiment II

Methods

Subjects

The subjects of Experiment II were the same 100 children who participated in Experiment I.

Materials

The materials included four different types of visual stimuli: abstract designs, photographs of faces, Hiragana, and Kanji. Memory for each type of stimulus was assessed separately, using tests modeled on Kimura's (1963) recurring recognition paradigm as employed by Liberman et al. (1982). As for the materials themselves, 1) The abstract designs were those employed by Liberman et al, 1982) and consisted of the irregular line

drawings of Kimura (1963). 2) The face materials were black and white photographs of male faces taken from a high school yearbook. Half were looking to the left, and half to the right. Preparation of the materials was as in Liberman et al (1982): To minimize distinguishing details that might lend themselves to verbal labeling, none of the photographs displayed teeth, facial hair, eyeglasses, or distinctive marks such as scars, etc. In addition, a uniform mask was applied to each picture to cover hair and background detail. 3) The Hiragana materials were meaningless, phonetically plausible digraphs which combined two characters, one above the other, which had been photographed from a set of flash cards. Each digraph was a transcription of one of the 52 basic utterances employed in Experiment I; in the test itself, different stimuli recurred a different order of presentation was employed. 4) The Kanji materials were drawn from the government-approved set of Kanji which children master in the first grade. They were photographed from a standard dictionary for foreigners which provided oversized characters.

The preparation of the memory test for each type of material was as described in Experiment I. From each set of 52 stimuli, a set of 80 items was constructed, with four of the stimuli recurring eight times each, and 48 of the stimuli occurring once. The items were divided into eight sets of ten each; within each set, the four recurring items were interspersed with six nonrecurring ones. The first set of ten constituted the inspection set, and the remaining seven sets contained the 70 test items.

Procedure

Experiment I was run in conjunction with Experiment II, in two experimental sessions which were separated by one week. The Kana digraphs and the faces were presented in the first session; the Kanji, and the nonsense designs were presented in the second one. All stimuli were projected in black and white on a large screen at the front of the room by means of a Kodak carousel projector. The subtended angle was sufficiently great to permit all necessary details to be apparent to the children seated in the back of the room, as well as to those seated in the front.

The procedure was analogous to that in Experiment I and was the same for all four types of materials. The instructor began each test by telling the child that some Kana (or Kanji, etc.) would be shown on the screen at the front of the class. The task was to look carefully and to try to remember each item as it appeared. As in Experiment I, the children were given a response sheet which contained boxes numbered from 1-70, and were told that they would use the sheet to mark each new item with an "X" and each previously-seen item with an "O". The first ten items would be for looking at, the remaining 70 would be for responding to. The ten inspection items were then presented at a rate of

approximately one every five seconds, followed by the 70 test items at the same rate of presentation. The instructor said the number of each test item as it appeared on the screen, so that the children would not lose their place on the response sheet.

Results and Discussion

As was the case in Experiment I, the data were scored in terms of the total number of correct responses given to each type of material, and scores were considered in relation to children's designation as good, below- or average in reading ability. Although performance on the various types of material was always significantly better than chance (for nonsense designs, $t(99)=29.0$, for faces, $t(99)=20.4$, for Kanji, $t(99)=50.5$, for Kana, $t(99)=40.3$, all of which are significant at the $p<.001$ level), the level of performance varied among children and across the various types of items. Average scores were highest for Kanji (67.5 items, 96.5% correct) followed by Kana (62.7 items, 89.6%), abstract figures (59.0 items, 84.3% correct) and faces (57.0 items, 81%).

The main purpose of Experiment II was to determine the relation between reading ability, memory for nonlinguistic visual information and memory for Kana and Kanji. To that end, the first analysis concentrated on comparing the mean performance of the 15 good and the 10 poor readers. This has the virtue of permitting a direct comparison of the present results and those obtained in Liberman et al's (1982) study of American children. For convenience, the American data appear in Figure 1 so that they may be compared with the present results, which appear in Figure 2.

Let me first consider performance on the orthographic materials. It can be seen on the right side of Figure 2 that the good readers of Japanese achieved superior scores on both the Kana, $t(23)=18.7$ $p<.001$, and Kanji materials, $t(23)=6.12$, $p<.001$. Note also that, whereas the good readers had achieved equivalent scores on the two types of orthographic material ($p>.01$), the poor readers were markedly worse on the Kana digraphs than on the Kanji, $t(9)=7.18$, $p<.01$. Consequently, the extent of difference between children in the two reading groups is greater in the case of the Kana materials.

As for the two types of nonlinguistic material, the left side of Figure 2 reveals that, unlike the beginning readers of English whose data appear in Figure 1, the good readers of Japanese surpassed the poor readers in their performance on the abstract designs, $t(23)=4.76$, $p<.01$. Like beginning readers of English, however, the good readers of Japanese did not significantly differ from the poor ones in their memory for the faces (Although the good readers tended to achieve slightly higher scores, any difference failed to reach significance,

p>.1).

Further analysis involved a series of Pearson correlations computed to assess the interrelations between children's performance on the various types of materials employed in Experiments I and II, and the teachers' ratings of their reading ability. That analysis revealed that performance on the Kana materials was significantly correlated with performance on the Kanji materials, $r(100) = .19$, $p < .03$, with the teachers' ratings, $r(100) = .32$, $p < .001$, and with performance on the spoken utterances employed in Experiment I, $r(100) = .27$, $p < .01$. Performance on the Kanji materials was likewise correlated with the teachers' ratings, $r(100) = .36$, $p < .01$, and performance on the spoken utterances of Experiment I, $r(100) = .30$, $p < .01$. Neither the correlation between memory for Kanji and teacher ratings, nor that with memory for spoken utterances was significantly different from the correlations which obtained in the case of the Kana materials.

There was one difference, however, between memory for Kanji and that for Kana. Memory for Kanji significantly correlated with memory for the nonsense designs, $r(100) = .18$, $p < .03$, whereas memory for Kana did not ($p > .1$). Thus the differences between good, and poor readers' performance on the abstract designs would appear to be more closely associated with their differences in memory for Kanji than with that for Kana.

Further analyses of the data revealed that memory for the abstract designs was correlated with the teachers' ratings, $r(100) = .36$, $p < .01$. It was also with memory for the faces, $r(100) = .26$, $p < .01$. Neither memory for Kana nor memory for Kanji correlated with memory for faces ($p > .1$), and all other correlations failed to reach significance at the .05 level of confidence.

Discussion

Different components of memory may accomplish temporary memory for linguistic and nonlinguistic materials. As is evident from the present results, and those obtained in previous studies of American children (Liberman et al, 1982; Mann and Liberman, in press), children who possess superior skills in one domain need not possess superior skills in another. Skill in remembering faces, for example, may have little to do with skill in remembering printed or spoken words, which agrees with what is known about the memory skills of adults (Woodhead and Baddeley, 1981).

The present study concerned the types of temporary memory skills which are most pertinent to children's ability to learn to read Japanese, a language whose orthography comprises a syllabary (Hiragana) and a logography (Kanji) instead of an alphabet. The

possibility that different memory skills might make different contributions to early reading success follows from findings about American children learning to read an alphabetic orthography (Lieberman et al, 1982; Mann et al, 1980, Mann, 1984). Children who are good beginning readers of English, tend to surpass poor beginning readers in use of phonetic representation (see Mann, 1984 for a review). However, as documented in Figure 1, good beginning readers of English do not surpass poor beginning readers in memory for abstract visual designs or in memory for faces. The benefits of superior use of phonetic representation, and the relative neutrality of nonlinguistic memory skills, could reflect the narrow demands of learning to read a phonetic transcription, or the broader demands of learning to read any written representation of spoken language. It was to decide between these alternatives that the present study was conducted. It sought to gain the broader perspective on reading acquisition that is available through study of children learning to read a syllabary and a logography instead of the alphabet.

It has been claimed that all children learn to read Japanese (except those markedly deficient in intelligence), and that reading difficulty is a peculiar problem of Western children learning to read the alphabet (Makita, 1968; 1974). A recent study, however, provides evidence that reading disabilities occur as often in Japan as in America (Stevenson et al, 1982). Thus it would appear that early reading difficulty can occur in syllabaries and logographies as well as in the alphabet. With this finding in mind, the present study focused on a population of second-grade children whom their teachers rated as good, average or poor in reading ability.

Confirmation that the children rated as good readers were better readers than the children rated as poor readers can be had from the data which appears on the right side of Figure 2. The children who were good readers remembered both the Kana and Kanji materials significantly better than the poor readers, which would be consistent with the fact that they possess a superior ability to read each type of character. A further finding about the reading ability of children in each group is evident in Figure 2. The poor readers encountered more difficulty in remembering the Kana digraphs, whereas the good readers were equally accurate on the Kana and Kanji materials. The fact that the Kana digraphs were nonsense materials could be the source of the poor readers' problems with these materials. Alternatively, Kana may have been problematic because learning to decode an orthography which transcribes the abstract phonological subcomponents of words could be more demanding than acquiring one which transcribes language at the level of the word. Future research is necessary to clarify the basis of poor readers' difficulties with the Kana digraphs.

Let me now turn to the question of whether linguistic memory skills are related to success at learning to read Kana and Kanji.

The answer is affirmative: children who differ in reading ability tend to differ in the ability to remember spoken nonsense words as well as in the ability to remember Kana and Kanji. Moreover, their memory for the nonsense syllables was equally related to their memory for Kana and Kanji, which implies that the importance of phonetic representation is not limited to orthographies which involve some type of phonological transcription. Rather, effective use of phonetic representation characterizes superior beginning readers, whether they are learning to read an alphabet, a syllabary or a logography. The implication, then, is that reading success in all orthographies is influenced by the ability to recode orthographic material into a phonetic representation, which is consistent with findings that mature readers of all languages do so (see, for example: Conrad, 1964; Levy, 1977; Slowiaczek and Clifton, 1980; Tzeng et al, 1977).

With respect to the relation between memory for orthographic and nonlinguistic visual materials, there are commonalities between beginning readers of English and Japanese, but there is also an interesting difference. The commonality is that, like American children, Japanese children who differed in reading ability tend not to differ in memory for faces. Thus it cannot be concluded that good readers possess a superior memory, in general. The further implication is that at least one aspect of nonlinguistic memory skill is not particularly relevant to success in learning to read any orthography. The difference between beginning readers of Japanese and English is that the good readers of Japanese surpassed the poor ones in memory for the abstract designs.

Two observations suggest a plausible explanation of the orthography-specific relationship between reading ability and memory for abstract designs. The first is that, as can be seen from a comparison of Figures 1 and 2, Japanese children tended to surpass American children in memory for the nonsense designs (a mean score 58 items correct, as compared to 49 items correct, respectively). Putting aside a racial interpretation of this fact, it may be the case that the Japanese children employed a more effective strategy for remembering these materials. The second observation concerns the nature of this hypothetical strategy. During testing, I noted that, unlike American children, many Japanese children attempted to trace the designs with their fingers or even with a motion of their head. My hypothesis is that they were encoding the design into a graphomotor representation, in much the same way that they might encode an unfamiliar Kanji character when the teacher first presents it in class. A graphomotor coding strategy could be encouraged by the teacher's instructions in Kana and Kanji, which always involve presenting characters as a sequence of strokes which the children must copy and memorize. If applied to the abstract designs, a graphomotor coding strategy can explain why memory for the Kanji correlated with that for the designs.

(Although one would have to the absence of a correlation between memory for nonsense designs and that for Kana digraphs.) It could further account for the correlation between the teachers' ratings of reading ability and performance on the nonsense designs. Finally, it can account for the superior performance of the Japanese children, in general: the American children, by virtue of their education, would have been less likely to make systematic use of a graphomotor coding strategy as a means of remembering the nonsense designs, and therefore would have been less successful.

If these arguments are accepted, the implication is that good beginning readers of Japanese, in addition to making more effective use of phonetic representation, may also make more effective use of graphomotor representation. Further research is needed to confirm the use of a graphomotor strategy by the Japanese children, and whether graphomotor coding continues to characterize skilled readers of Japanese beyond the early elementary grades. Findings that the mature reading of Kanji and Kana is more disrupted by damage to the left, language dominant, hemisphere than by damage to the right (Sasanuma, 1975; Sasanuma and Fujimura, 1971), would seem inconsistent with a view that some nonlinguistic coding strategy is fundamental to skilled reading of Japanese. Perhaps coding strategies change with age and reading experience, or perhaps the Kimura figures are processed differently by all Japanese subjects.

To return to the major findings of this study, two experiments have revealed that, for second graders who are learning to read Japanese, use of phonetic representation in temporary memory is pertinent to the ability to read well, and to the ability to remember Kana and Kanji materials for a brief period of time. Memory for Kana is related to memory for spoken nonsense words, but not to memory for nonlinguistic materials such as faces and abstract designs. In contrast, memory for Kanji is related not only to memory for spoken nonsense words, but also to memory for nonsense designs, which would seem to involve reliance on a graphomotor coding strategy. It can be concluded that acquisition of both Kana and Kanji, like that of the alphabet, makes demands on the linguistic component of temporary memory. Acquisition of Kanji, however, contrasts with that of other orthographies, insofar as it makes an additional demand on a nonlinguistic component. The outcome is having to master both Kana and Kanji is that, for the beginning reader in Japan, both phonetic and graphomotor memory abilities associate with early reading success.

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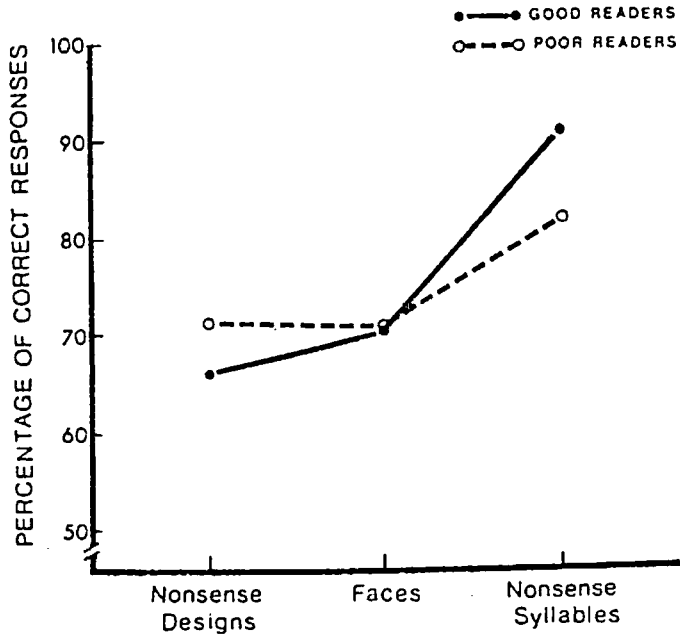


Figure 1: Mean percentage of correct responses made by good and poor readers of English on nonsense designs, American faces and printed nonsense syllables.

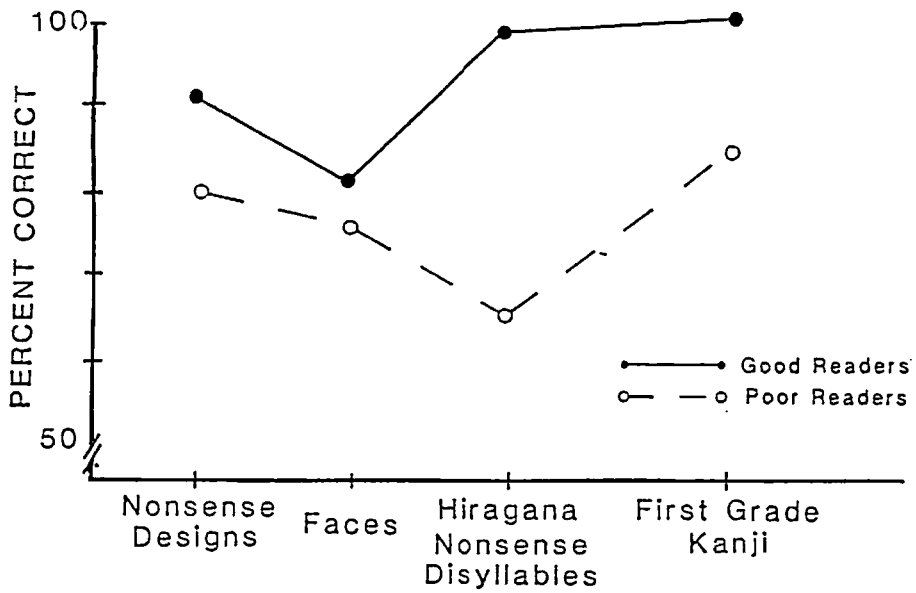


Figure 2: Mean percentage of correct responses made by good and poor readers of Japanese on nonsense designs, Japanese faces, Kana digraphs and Kanji.