THE EFFECTS OF CONTEXT ON THE READING PROCESSES OF KANJI, KANA SCRIPT *) **)

FUMIHIKO MASUDA AND YUKIMASA NOMURA ***)

Department of Psychology, Kansai University

Writing systems may be divided broadly into two types. The first type, to which belong alphabetic and syllabic (Kana) scripts, uses a limited number of visual symbols to represent its phonetic units. In the particular case of Kana script, forty-six syllabics correspond respectively to forty-six phonetic units. The second type, ideographic script (Kanji), uses a very large number of visual symbols to represent semantic units. Therefore Kanji and Kana script must be processed differently with regard to their respective graphemic, phonemic, and semantic properties. Saito, Inoue and Nomura (1979) have explained these three properties within a framework of information processing in the light of their linguistic characteristics.

We here note that human processing systems have been divided into two major types (Norman, 1976): data-driven processing and conceptually-driven processing. Human processing systems, however, cannot be explained by either system alone: both processes are essential. Both data-driven and conceptually-driven processing must take place simultaneously, each assisting the other in the completion of the overall job of making sense of the world. Therefore, Kanji and Kana script must be processed by both data-driven and conceptually-driven processing. That is to say, the graphemic properties are processed by the former, while global visual configuration seems to cause the organism to expect the word to surrender some meaning, and then this expectation promotes individual analysis by data-driven processing. This type of processing by expectation must certainly be considered as part of conceptually-driven processing.

The effect of this expectation in the case of Kanji processing is more efficient

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*) The two Exps. in this paper were described briefly in Nomura (1981 b) which reviewed the information processing of Kanji and Kana script reading.

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than in that of processing Kana script, since the visual images of Kanji and Kana script are quite different, and Kanji are characterized by their pictorial aspect. It is possible to say that Kanji are more complicated than Kana script because Kanji show a two-dimentional structure composed from a semantic element called "the radical" and a "phonetic" element, while any sequence of Kana script is constructed on a one-dimensional arrangement of syllabics. Therefore it may be said that, as Kanji, in distinction from any sequence of alphabetic or Kana script, offer dual sources of information, both of which are extracted and then processed simultaneously, they are in some respects more efficient than the sequential signification of words in other writing systems.

It is therefore possible to say that the conceptually-driven processing of Kanji is more efficient than that of Kana script. With regard to the processing of Kana script, however, acts of graphemic processing of individual syllabics are directly related to acts of phonemic processing. In other words, graphemic processing in Kana script is always accompanied by simultaneous phonemic processing. In Kanji, however, phonemic processing is not inevitably related to the graphemic or semantic processing except in the special case of Phonetic-ideographic Characters (Keisei-Moji, see Nomura 1981 b).

The meaning of both Kanji and Kana script is extracted by both types of processing. In the reading of Kanji, however, their pronunciation seems to be generated on the basis of their meaning which is extracted by data-driven and conceptually-driven processing. On the other hand, while the reading of a sequence of Kana script seems to be generated on the basis of meaning as with Kanji, it is directly constructed from data-driven processing alone.

While the effects of data-driven and conceptually-driven processing on reading are very important, these effects seem to depend on various factors, namely, 1) the number of letters in the target, 2) the meaningfulness of the target, 3) the presence or absence of prior warning leading to expectation of meaningfulness or meaninglessness from the target.

With regard to the first two variables, it is possible to say that the degree of effect of both data-driven and conceptually-driven processing may be dependent on the difficulty of task requirement in Kana script processing, but not in Kanji processing.

Furthermore with regard to the presence or absence of prior warning variables, it is possible to say that this variable causes Ss to adopt different strategies from those adopted in the absence of any such warning concerning the target.

In order to teat these possibilities, Nomura (1981 a) performed three experiments, in which Ss were presented with a random series of Kanji and sequences of Kana script one at a time and were required to read aloud the presented word as fast as they could. The results obtained from these experiments seem to be adequately explained by the above possibilities.

EXP. I

We here note that while the effects of data-driven and conceptually-driven processing on reading may be also dependent on the existence of context, the relationship has not yet been verified. All the above three experiments (Nomura, 1981 a) were performed in such way that Ss were required to read Kanji singly or in pairs (forming compound semantic units) and meaningful or meaningless Kana sequences, each of which was presented alone. But when these semantic units are presented embedded in meaningful sentences, the results change, since Ss are then able to use in processing the context provided by the sentences. Therefore the contribution of conceptually-driven processing is greater when the target semantic unit is embedded in a meaningful sentence than when it is presented in isolation. The help provided by context, however, seems to be almost the same whether the target is a sequence of Kana, a single Kanji or a pair of Kanji.

On the other hand, presentation of the target embedded in a sentence also creates hindrances that are absent when the target is presented in isolation. One of these hindrances is that it becomes difficult for Ss to discriminate the target from the other words or letters in the sentence. This type of difficulty seems to arise from certain characteristics of the language and writing systems.

The hypotheses upon which this Exp. was based are as follows: the reading latency of Kanji is not hindered when presented as a target embedded in a sentence, while the processing of a semantic unit in Kana script is considerably hindered by presentation within a sentence of otherwise made up of Kana script. This is because, as is evident from the following examples (私は山へ行く, 私はやまへ行く), the Kana syllabics constituting the target embedded in a sentence are inevitably surrounded by other Kana syllabics.

METHOD

Subjects

The Ss were 24 undergraduate students of Kansai University who chose to participate in this experiment voluntarily. Each S was tested individually. Each S was assigned at random to one of two different groups of 12. None of them had been previously employed in any experiment of this kind.

Material and Apparatus

Half of the Ss were required to read meaningful Kana sequences or single Kanji or a pair of Kanji, each of which was presented alone (word condition). All these semantic units were different: 24 Kanji singly (e.g., 山 : mountain) and 24 Kanji in pairs (e.g., 学校 : school). And then 48 Kanji were also represented by sequences of Kana script (e.g., やま : mountain, がっこう : school). The mean number of Kana syllabics was 1.9 in the case of single Kanji, whereas the number was 3.8 in the case of the pairs of Kanji. Single Kanji had been drawn from the word-pool of Kun dominant Kanji (Nomura, 1978). The pairs of Kanji were drawn from the word-pool of Japanese nouns (Ogawa and Inamura, 1973), each of which consists of two Chinese characters and has an ease of learning value of between 3.00 and 5.00. Furthermore, four practice semantic units were chosen in the same manner respectively.

The other half of the Ss (sentence condition) were required to read sentences, each of which was constructed using the same semantic units as in the word condition phase. These sentences were as follows: Subject (I) +noun (Kana script or Kanji) + verb, for example, 私はやまへ行く；私は山へ行く (I shall go to the mountains), 私はやまを写す；私は山を写す (I shall take a picture of a mountain), 私はがっこうへ行く；私は学校へ行く (I shall go to a school), 私はがっこうを写す；私は学校を写す (I shall take a picture of a school). Each set consisted of eight of the sentences, each of which had the same pattern of construction. 25 sets of these sentences were constructed, one of which was used as practice, and the other as the presentation under this condition.

Regarding word condition, four kinds of semantic unit were randomly divided into halves, giving groups of twelve semantic units each. One half of these was used as presentation material for half of the Ss, while the other half were used in the same manner for other groups of Ss. All these semantic units were different.

With regard to sentence condition, on the other hand, each set, consisting of eight sentences, was divided into four groups of two sentences, each of which included single Kanji or its pronunciation in Kana script and a pair of Kanji or its pronunciation in Kana script, each pair of sentences having differing verbs. 24 of these sets were assembled into one block. In this way 4 different blocks of 48 differing sentences were constructed, each of which was assigned as presentation material to a group of 3 Ss. Although the presentation order of the material within each block was constant, no two blocks had the same order of presentation.

All the materials were prepared in the form of slides which were presented using a Kodak Model 850 projector with an electric shutter (Ralf Gerbrands Co.) and timed by a regulator (Biomedica K.K.). The reaction as a dependent variable was recorded using a digital timer (Takei Kiki K.K.) and a voice key (Sanwa K.K.).

Procedure

In the 2x2x2 factorial design of this experiment, a between-subjects factor was the type of presentation form (whole sentence or semantic unit in isolation) and two within-subjects factor were the number of letters (one Kanji or two Kanji) and the type of writing system used for the target semantic unit (Kanji or Kana script). The Ss were presented with a series of 48 semantic units in isolation or embedded in sentences one at a time and then required to read them aloud as fast as they could.

In the word condition phase, the trial for each semantic unit was as follows: Ss were at the outset presented with a signal at 1 sec and after a 1 sec interval were presented with a semantic unit and required to read it as fast as they could. The latency of reading was then recorded. The target was presented for a maximum of 2 sec, and if a S's response was faster than this, it was removed from view simultaneously to his response. The signal for the next trial was presented in the same manner after an interval of ten seconds from his last response.

In the sentence condition phase, the procedure was the same as that for the word condition phase except for the following instruction: Ss were told to read the whole sentence except for the subject (私 : I). In each phase, Ss were given four practice trials.

Results and Discussion

The mean latency of all conditions obtained from this Exp. is shown in Fig. 1. Therein the latencies in cases of voice key failure and of misreading have been omitted; the probability of exception is less than 3% of the total responses, and these responses were not conspicuously frequent for any particular condition.

The mean latency was analysed by 2x2x2 ANOVA (Lindquist, 1953) on the basis of the reciprocal converted score of each raw latency. The analysis of latency data revealed significant main effect of the type of presentation form ($F=15.471$, $df=1/22$, $p<.001$), and furthermore three significant first order interactions, between respectively the presentation form and the number of letters ($F=20.411$, $df=1/22$, $p<.001$), the number of letters and the type of writing system ($F=5.554$, $df=1/22$, $p<.05$), the type of writing system and presentation form ($F=27.564$, $df=1/22$, $p<.001$).

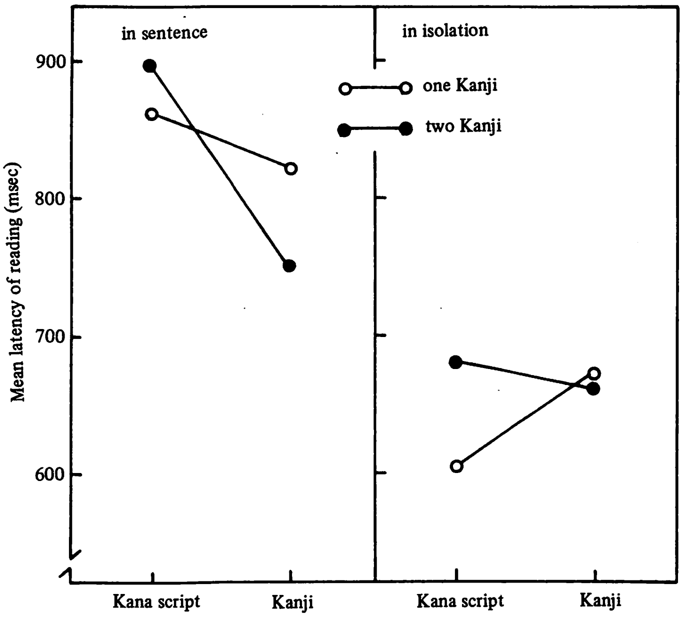

Fig. 1 Mean latency of reading a sentence or the target semantic unit in isolation. Data shown with filled circles are based on two Kanji condition, and those with open circles are based on one Kanji condition.

The first interaction may be due to the fact that the latency of the two letter condition is faster than that of the one letter in cases where the target was embedded in a sentence, but with regard to the word condition phase, single letter showed faster latency than pairs of letter. The second interaction may also be due to the fact that the latency of 2-syllabics is fater than that of 4-syllabics in Kana script, but the latency of a pair of Kanji is faster than that of single Kanji. Furthermore the third interaction may be due to the fact that the difference between Kanji and Kana script embedded in a sentence is larger than that between the two when each is presented in isolation.

The results gained from the presentation of the semantic unit in isolation are almost the same as those of Nomura (1981 a) but we observed some differences between the results for targets embedded in meaningful sentences and those for targets presented in isolation.

First, the reading latency of Kana script targets embedded in sentences is slower than that of Kanji, whereas the reading latency of Kana script targets presented in isolation is faster than that of Kanji. This fact may be due to the low discrimination potential of targets embedded in sentences which renders data-driven processing ineffective.

Second, with regard to Kanji targets embedded in sentences, there is a difference in latency between targets composed of single Kanji and those composed of a pair. Althought this difference has not been adequately explained for the present, as there is, however, no difference between the two kinds of target in word condition, this difference may be due to either the context effect caused by the semantic unit embedded in meaningful sentences or to the fact that Kanji, in general, are used in pairs (compound words) and that a pair of Kanji in the sentence appears as visually well-balanced.

Third, there is a difference in latency between 1.9 letter and 3.8 letter sequences of Kana script in targets presented in isolation, but there is no difference between them in targets embedded in sentences. This is because, with regard to the former, the fewer the number of the letters, the faster the target can be read, due to data-driven processing constructed from the individual reading of Kana syllabics; but in the case of the latter the target must be distinguished from the other words in the sentece, so from the outset it is difficult for Ss to process Kana script sequences by data-driven processing alone. Furthermore conceptually-driven processing seem to be more effective in this case than in that of word condition, so the number of Kana syllabics may not be a critical factor affecting the latency of Kana script.

EXP. II

As Kanji are a different script, when embedded as a target in a sentence, where they are surrounded by Kana, they show immediate high discrimination potential, whereas a Kana script target, being homogeneous with the surrounding Kana syllabics, shows low discrimination potential without further aids to discrimination. This is because a Japanese clause or clause group is written as an unbroken sequence of letters. Therefore if the degree of discrimination potential of targets embedded in sentences is manipulated by other aids to discrimination, that is, if a line frame around the target semantic unit is added to heighten discrimination potential, the following hypotheses suggest themselves. We assumed that the results obtained would be similar to those obtained for semantic units presented with the high discrimination potential afforded by isolation, but that without this heightening of discrimination potential, the results obtained would not differ from those of Exp. I.

METHOD

Subject

The Ss were 24 undergraduate students of Kansai University who chose to participate in this experiment voluntarily. Those Ss were divided into two groups in the same manner used in Exp. I.

Material and Apparatus

The sentence used in this Exp. were the same as those used in Exp. I but this time a line frame around the target semantic unit was added to heighten discrimination potential: 私は やま へ行く，私は 山 へ行く , that is both 25 sets of sentences used in Exp. I and the other 25 sets of sentences with line frame were used in this Exp. II. All this material was presented as in Exp. I.

Procedure

The design was the same as in Exp. I except for another between-subjects factors: the presence or absence of a line frame around the target in each sentence. The other procedures were the same as those employed in Exp. I except for the instruction; in this experiment, while Ss were told to read only the target embedded in the sentence, they were also instructed to comprehend the total meaning.

Results and Discussion

The mean latency of all conditions obtained from this Exp. is shown in Fig. 2. Therein the latencies in cases of voice key failure and of misreading have been omitted; the probability of exception is less than 4.6% of the total responses, and these responses were not conspicuously frequent for any particular condition.

The mean latency was analysed as in Exp. I. The analysis of latency data revealed significant main effect of the number of letters in target ($F=4.773$, $df=1/22$, $p<.05$), and furthermore significant first order interactions between the number of letters and the writing system ($F=5.219$, $df=1/22$, $p<.05$), and the writing system and the degree of discrimination potential ($F=17.653$, $df=1/22$,

$p < .001$). The former may be due to the fact that the reading of a pair of Kanji is faster than that of a single Kanji, but there is no difference for Kana script. The latency result may be due to the fact that the reading of Kanji is faster than that of Kana script in the low discrimination potential condition, but that the reading of Kana script is faster than that of Kanji in the high discrimination potential condition.

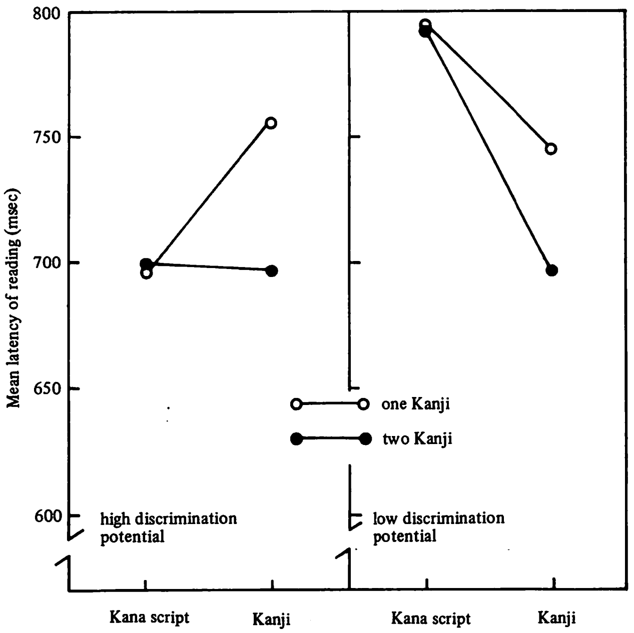

Fig. 2 Mean latency of reading the target semantic unit embedded in a meaningful sentence. Data shown with filled circles are based on two Kanji condition, and those with open circles are based on one Kanji condition.

The type of results obtained from the low discrimination potential condition are almost the same as those for the sentence condition phase in Exp. I except for the following fact: the mean latency of this Exp. is about 100 msec faster than that of Exp. I. This is because the Ss in Exp. I were instructed to read the whole sentence, whereas in this Exp. the Ss were instructed to read only semantic unit embedded in sentences. This result may be due to the fact that the Ss read semantic units in the light of the other words in the sentence.

The most interesting results obtained from this Exp. were that, with regard to the Kana script, the latency of reading in the high discrimination potential is faster than that of reading in the low discrimination potential, whereas there was no difference between them regarding the Kanji reading. Furthermore the type of reading of Kanji is just same as those of the sentence condition phase of Exp. I regardless of the high or low degree of discrimination potential. These results may be due to the fact that the latency of reading of Kana script varies according to the presence or absence of a line frame around the semantic unit, whereas the reading of Kanji is not influenced by these line frames. This is because, with regard to the reading of Kana script, the high discrimination potential may promote data-driven processing, while low discrimination potential may not. In the latter case, the Ss must first of all distinguish the semantic unit from the other words in the sentences, and then read the target by both data-driven processing and conceptually-driven processing. On the other hand, as Kanji are clearly distinguishable from the other words in the sentence regardless of the presence or absence of a line frame around the target, no effort is need to distinguish the target from the other words in the sentence. Therefore the pronunciation of Kanji, from the outset, seems to be generated on the basis of their meaning which is extracted by both data-driven and conceptually-driven processing.

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