Tsukuba Psychological Research
1994, **16**, 75-82

Priming on single-kanji fragments: Towards the study of different kinds of priming on the same memory test

Roberto Cabeza and Hideaki Takahashi

(Institute of Psychology, University of Tsukuba, Tsukuba 305, Japan)

Implicit memory tests measure retention as a facilitation to perform on a seemingly unrelated task. This facilitation is known *priming* and occurs at different levels (e.g., semantic, phonetic, graphemic). Single-kanji fragment completion could be used to investigate the semantic, phonetic, and graphemic components of priming, if two conditions are fulfilled: First, single-kanji fragment completion should exhibit significant priming; second, the amount of priming displayed by different kinds of fragments (e.g., semantic and phonetic fragments) should be similar. The study reported provided evidence fulfilling these two conditions.

Key words: priming, perceptual priming, conceptual priming, kanji fragments.

The standard experimental paradigm to study memory is to have a group of subjects study informational items, such as words, sentences, or pictures, and later measure their memory of these items by means of a memory test. There are two basic types of memory tests, implicit and explicit. Whereas *explicit tests*, such as recall and recognition, measure memory directly, by asking subjects to retrieve studied items (e.g., words), *implicit tests* measure memory indirectly, as a facilitation to perform on a seemingly unrelated task. For example, in the popular implicit test word fragment completion, subjects are asked to complete word fragments, such d__n__sa__r, with the first words that come to their minds, and memory for studied items is measured as an increase in the probability of completing those fragments corresponding to studied words (e.g., *dinosaur*). This facilitation is known as *priming*.

The present research was supported by a scholarship of the Ministry of Education of Japan to Roberto Cabeza. The experiment could have not been conducted without the assistance of Kazumi Kurokawa, Kyouko Kawaguchi, and Masayuki Hirasawa.

During the last decade, priming has become one of the most studied topics in the field of memory research. The main reason of this popularity is that priming behaves very differently than the traditional explicit measures of memory (for reviews, see Cabeza & Ohta, 1993a; Ohta, 1991; Richardson-Klavehn & Bjork, 1988). For instance, whereas amnesic patients are disastrously impaired on recall and recognition tests, they show normal levels of priming on implicit tests (see Shimamura, 1986, for a review). Also, it has been found that explicit memory and priming can be stochastically independent (Cabeza & Ohta, 1993b; Tulving, Schacter, & Stark, 1982). Moreover, whereas explicit memory is typically very sensitive to manipulations affecting conceptual elaboration, such as levels-of-processing, but almost immune to changes on perceptual format (e.g., modality, typography) between study and test, the converse occurs with priming (for a review, see Roediger, 1990).

This last kind of evidence has originated the notion that priming is a perceptual phenomenon. A system view has suggested that priming is based on a pre-semantic and hyperspecific Perceptual Representation System (Tulving & Schacter, 1990), and a processing view has proposed that it involves data-driven processing (e.g., Roediger, Weldon, & Challis, 1989).

However, there is now evidence that priming is not always a perceptual phenomenon. For example, priming can be also observed on implicit tests in which cues are not perceptual (e.g., d__n__sa__r), but conceptual, such as a question about the target (e.g., *What species of large reptile became extinct during prehistory?*), its category (e.g., *reptiles*:), or an associated word (e.g., *mammoth*:). Moreover, in contrast with priming in tests with perceptual cues, priming in tests with conceptual cues is usually sensitive to conceptual, but not to perceptual manipulations (e.g., Blaxton, 1989; Srinivas & Roediger, 1990). Also, contingent dissociations have been found between tests with perceptual cues and tests with conceptual cues (Cabeza & Ohta, 1993b).

In order to accommodate the existence of a non-perceptual form of priming, the systems view has distinguished two types of priming: perceptual and conceptual. Whereas perceptual priming is assumed to depend on a Perceptual Representation System, conceptual priming is supposed to depend on a Semantic Memory System (e.g., Tulving and Schacter, 1990). These two memory systems are hypothesized to involve different brain regions (posterior cortical areas and medial temporal lobes, respectively), and hence, the distinction between perceptual and conceptual priming is a sharp one. According to the processing view, priming on tests with conceptual cues emphasizes conceptually-driven processing (e.g., Blaxton, 1989).

It is tempting to summarize the preceding ideas by saying that implicit tests with perceptual cues reflect perceptual priming (or data -driven processing), and implicit tests with conceptual cues reflect conceptual priming (or conceptually-driven processing). Unfortunately, priming data is not so simple. It has been found, for instance, that implicit tests with perceptual cues are sometimes sensitive to the conceptual manipulations, such as levels-of-processing manipulation (for a review, see Challis & Brodbeck, 1992). Moreover, there is evidence that implicit tests with perceptual cues can be simultaneously affected by both perceptual and conceptual manipulations. For instance, Cabeza (1993) found that a new kind of implicit test with perceptual cues, the kanji fragment completion test (e.g., Figure 1−b), was sensitive to both perceptual (script) and conceptual manipulations (levels-of-processing). This evidence suggests that implicit tests with perceptual cues can reflect not only perceptual priming, but also conceptual priming. In the particular case of the kanji fragment completion test, the role of conceptual priming can be related to the presence of some semantic elements in the cues. In the example in Figure 1−b, for instance, the kanji part cueing the second kanji (戸) is a kanji itself, and has a meaning (*door* or *house*) that is related to the meaning of the kanji it hints (*chamber*), and hence, it could become a conceptual cue for it.

The evidence that tests with perceptual cues can reflect not only perceptual, but also conceptual priming has both pessimistic and optimistic implications for priming research. The pessimistic implication is that if tests are not "pure", it is more difficult to investigate perceptual and conceptual priming by simply comparing implicit tests with perceptual and with conceptual cues. The optimistic implication is that perceptual and conceptual priming could be compared on the same memory test, eliminating in this way all the confounding factors that appear

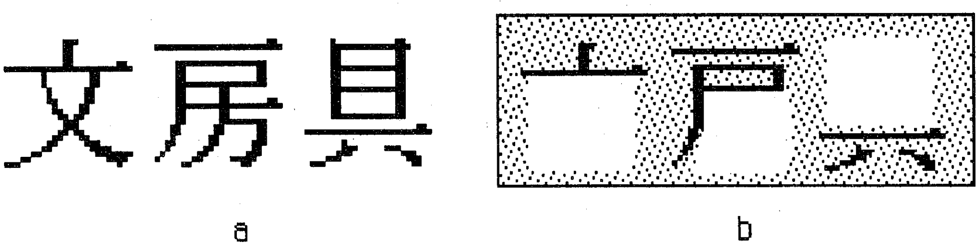

Figure 1. Examples of (a) a target word, and (b) a cue of the kanji fragment completion test.

when tests with different characteristics are compared. The main obstacle to implement this idea is to find a test in which the proportions of perceptual priming and conceptual priming can be manipulated. This is very difficult to achieve in most memory tests, but there is at least one test in which it is possible: the kanji fragment completion test.

Priming occurs when there is an overlap between study and test operations (Roediger et al., 1989). This overlap can occur at different levels. In visual tests with perceptual cues, for example, it can occur at three different levels: graphemic, phonetic, and semantic. A word like the one in Figure 1—a, for instance, can prime a fragment such as the one in Figure 1—b, because they are visually similar (graphemic overlap), because the (they) involve similar sounds (phonetic overlap), or because the meaning of the word and the final meaning of the fragment is the same (semantic overlap). It is possible to assume that the graphemic and phonetic overlaps mediate what has been called perceptual priming, and the semantic overlap mediates what is known as conceptual priming.

The kanji fragment completion test provides a unique possibility for manipulating graphemic, phonetic, and semantic components of priming. By deleting different parts of a kanji, it is possible to create cues emphasizing one of these three components. For example, it is possible to use semasio-phonetic kanji characters (*keisei kanji*; e.g., Figure 2—a) as stimuli, and create fragment cues containing the semantic element (Figure 2—b), the phonetic element (Figure 2—c), or neither of them (Figure 2—d). These three types of fragments would emphasize, respectively, semantic, phonetic, and graphemic aspects of priming. Semantic, phonetic, and graphemic fragments would allow the comparison of semantic, phonetic, and graphemic aspects of priming on the same test, avoiding all the confounding factors associated with inter-test comparisons. However, this kind of research would be possible only if two conditions can be fulfilled:

1) It should be possible to obtain significant priming on single-kanji fragments. Priming is usually found with materials that have preexistent memory representations, such as words, but it is sometimes difficult to obtain it with materials that do not have them, like nonwords (e.g., Diamond & Rozin, 1984; for a review, see Richardson -Klavehn & Bjork, 1988). Does each kanji have an independent memory representation? Paradis, Hagiwara, and Hildebrant (1985) distinguished three views: (a) kanji are listed in a special graphemic lexicon with its own intrinsic meaning, and can be accessed directly; (b) kanji representations are added to word representations when the child learns to read, and consequently, kanji access is mediated by word access; finally, (c) kanji are a part of the word entries, like in the second view, but the knowledge about kanji learnt at school can be used to guess the meaning and pronunciation of kanji. The first model suggests that a single, brief presentation of an isolated kanji could produce a large amount of priming on the fast completion of a single-kanji fragment. The second and the third model cast doubts about this possibility.

Another reason to be skeptic about the possibility of obtaining priming on single-kanji fragments is that this kind of fragments could have too many possible completions. Whereas word fragments (e.g., Figure 1—b) usually have a single possible completion, single-kanji fragments, particularly if they are segmented according to their basic components (e.g., Figures 2—a and 2—b) can have many. Since the

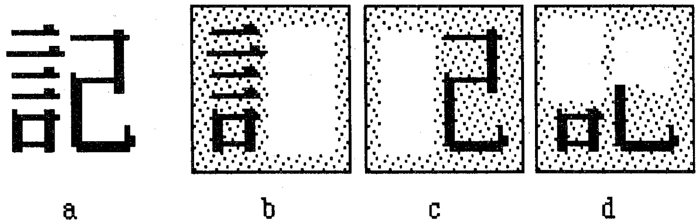

Figure 2. Examples of (a) a target kanji, (b) a semantic fragment, (c) a phonetic fragment, and (d) a graphemic fragment.

5robability of obtaining priming decreases when the number alternative answers to a cue is very high (e.g., d ____________), single-kanji cues might not be able to display priming.

2) The level of priming obtained by semantic, phonetic, and graphemic cues should be similar. If the amount of priming reflected by the different types of cue is too different, any difference that independent variables could produce between them would be difficult to interpret. One reason why different cues might involve different amounts of priming is that they could involve a very different number of possible completions. For example, the fragment in Figure 2–c has only a few possible completions and is likely to display more priming than the fragment in Figure 2–b, which has many alternative answers. It is possible that this kind of differences is neutralized in a kanji list, but it is also possible that one kind of fragment has consistently more possible completions than the others.

In sum, before using different versions of single-kanji fragments to investigate the different components of priming it is necessary to demonstrate that single-kanji fragments can display significant priming, and that the amount of priming reflected by different kinds of fragments is similar. The present article reports a preliminary study that tried to fulfill these two conditions on semantic and phonetic single-kanji fragments. Additionally, the experiment explored the effects of a semantic/phonetic study manipulation on the two types of cues. The transfer appropriate processing principle — memory is a function of study-test overlap — suggests that semantic study would yield more priming than phonetic study when the cues are semantic, but the converse would occur when the cues are phonetic.

Experiment

Method

Subjects and Design. Sixty-six undergraduates participated voluntarily in the experiment. The design had one between-subjects factor, cue type (semantic fragment, phonetic fragment), and one within-subjects factor, study history (semantic study, phonetic study, and nonstudied).

Materials. First, kanji were selected from the 2000 most frequently used kanji (Kuratani, Kobayashi, & Okunishi, 1982) according the following criteria: (1) they should contain one element with a meaning directly related to the meaning of the whole kanji; (2) they should contain one element with an associated sound corresponding to the main Chinese reading (*onyomi*) of the whole kanji; (3) the semantic and phonetic elements should be kanji in themselves, or their meanings or sounds should be well known by university undergraduate students; (4) the semantic and phonetic elements should be different and separable in a fragment. This first selection produced a list of 123 kanji, from which a second selection was made according the following criteria: (1) each semantic element should appear only once in the selection; (2) each phonetic element should appear only once in the selection. Additionally, kanji in which both the semantic and phonetic elements were kanji in themselves were preferred. This second selection produced a final list of 30 target kanji.

The 30 target kanji were divided into three sets of 10 kanji by the following method. The 30 kanji were ordered according the frequency order in Kuratani et al.'s (1982) dictionary, and each kanji in one of the ten consecutive sets of three kanji (kanji 1, 2, and 3; kanji 4, 5, and 6) was randomly assigned to one of three sets. Accordingly, the three sets had a similar frequency as indicated by the mean of the order in Kuratani et al.'s (1982) dictionary (1189,1189, and 1195). The three sets of target kanji and their corresponding semantic and phonetic fragments are presented in the Appendix. Additionally, 30 kanji were selected from the same source to be used as study (10 kanji) and test fillers (20 kanji). These kanji did not contain any semantic or phonetic element in the target kanji, neither have share any of their Chinese readings (*onyomi*).

Procedure. The experiment was introduced to the subjects as two surveys, the first concerned with the processing of the meaning and sound of kanji (study phase), and the second, with the writing of kanji (test phase). The instructions of the first survey (study phase) told subjects they would have to read a list of kanji and perform on each one of two possible tasks: indicate in 5–point scale how much they liked its meaning, or write its Chinese reading (*onyomi*). The two tasks varied randomly in the study list and which one should be performed on each kanji was indicated by a scale titled *dislike-*

like, or a blank titled *onyomi*, next to each kanji. The studied list contained 30 kanji, one set of target kanji studied under the semantic task (10 kanji), one set of target kanji studied under the phonetic task, and one set of filler kanji (4 primacy and 6 recency) that did not appear later in the test. The instructions of the second survey (test phase) told subjects that they had to complete kanji fragments with the first kanji that came to their mind. The test list contained 50 fragments: 30 fragments corresponding to target kanji (10 studied under the semantic task, 10 studied under the phonetic task, and 10 nonstudied), plus 20 fragments corresponding to nonstudied kanji —in order to discourage explicit retrieval (10 fragments at the beginning of the list and 10 fragments mixed with the fragments of the targets). The assignment of the three sets of target kanji to the semantic, phonetic, and nonstudied conditions was counterbalanced. The time allowed for each item was 4 sec at study and 5 sec at test, and pacing was indicated with a bell. At both study and test, subjects used a cover sheet to avoid looking following items, and were instructed not to go back to previous items.

Results

The results are presented in Figure 3. In the case of semantic fragments, the proportion of fragments completed in the semantic, phonetic and nonstudied conditions were .43, .42, and .15, respectively. In the case of phonetic fragments, the proportions were .58, .63, and .30. Figure 1 suggests that there was a considerable amount of priming (studied minus nonstudied) inboth types of fragments and in both study conditions. This observation was confirmed by separate ANOVAs comparing performance on studied and nonstudied items. Priming on semantic fragments was significant in both the semantic, $F(1, 30)=64.99$, $p<.0001$, and phonetic, $F(1, 30)=59.01$, $p<.0001$, encoding conditions. Priming on phonetic fragments too, was significant in both the semantic, $F(1, 34)=87.06$, $p<.0001$, and phonetic, $F(1, 34)=119.88$, $p<.0001$, encoding conditions.

Figure 3 suggests that, overall, completion performance was better on phonetic fragments than on semantic fragments. This idea was supported by a significant main effect of test, $F(1, 34)=40.96$, $p<$

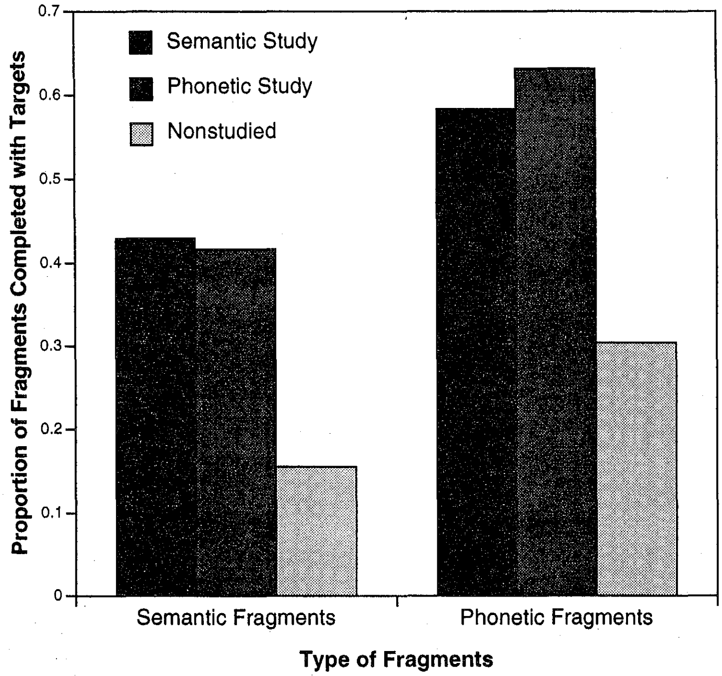

Figure 3. Proportion of single-kanji fragments completed with target kanji as a function of fragment type (semantic, phonetic) and item type (semantic study, phonetic study, or nonstudied).

.0001. However, this effect is a consequence of a difference on the nonstudied baseline, and when this baseline is subtracted from performance on studied items, the difference between the two tests disappears. In an ANOVA on priming scores (studied minus nonstudied) the main effect of test was nonsignificant, $F < 1$. In sum, the amount of priming was comparable on the two types of fragments.

Figure 3 indicates that the encoding manipulation produced an effect in the direction predicted by the transfer-appropriate processing principle, but that this effect was very small. Consistently with this idea, separate ANOVAs on priming scores (studied minus nonstudied) indicated that the effect of study task was nonsignificant on semantic fragments, $F < 1$, and only close to significance on phonetic fragments, $F(1, 34) = 3.027$, $p < .09$. The interaction between study task and fragment type was also nonsignificant, $F(1, 64) = 2.068$, $p > .155$.

Discussion

The experiment reported had two main objectives: First, prove that it is possible to obtain significant priming on single-kanji fragments; and second, demonstrate that semantic and phonetic fragments can reflect similar amounts of priming. Both objectives were accomplished.

First, priming was highly significant on the single-kanji fragments employed. This result indicates that single-kanji fragments can be used to investigate priming. Additionally, the finding that a single and brief (4 sec) presentation of isolated kanji generated a large amount of priming on single–kanji fragments is more consistent with the idea that kanji have individual entries in a special graphemic lexicon and can be accessed directly, than with the idea that they do not possess such entries and their access is mediated by word access (see Paradis, et al., 1985)

Second, priming on semantic and phonetic fragments was very similar. This result suggests that differences in amount of priming reflected by the semantic and phonetic fragments of each kanji can be neutralized by using several kanji in the list. This outcome is important because obtaining similar amounts of priming is a precondition to investigate the effects of independent variables on different kinds of fragments.

The finding that the semantic/phonetic encoding manipulation did not produce a significant effect indicates that a better method to manipulate semantic and phonetic processing during study should be developed. The most likely reason of this nonsignificant effect is that the effects of the semantic and phonetic study tasks were confounded due to the use of mixed lists. Since the two tasks alternated in a random fashion, they might have contaminated each other. Instead of thinking only about the meaning when performing the pleasantness-rating task, and thinking only about the sound when performing the pronunciation-writing task, subjects might have progressively tended to think both about the meaning and about the sound on all the kanji. One possible solution of this problem would be to use blocked lists, so that subjects perform the semantic task on all the items of one list, and the phonetic task on all the items of other list. However, this method could involve other kinds of complications. For example, when subjects think about the meaning of every kanji in a list, it is expectable that they would tend to make meaningful associations between them, generating a higher intra-list organization in the semantic study condition than in the phonetic study condition. Thus, more research is necessary in order to determine which is the best method to manipulate the amount of semantic and phonetic processing at study.

In conclusion, the present experiment demonstrated that it is possible to obtain significant and similar priming on single-kanji semantic and phonetic fragments. This preliminary evidence is important because it supports the idea that different types of single-kanji fragments could be used to investigate the semantic, graphemic, and phonetic components of priming on the same test, avoiding the confounding factors that occur when tests with very different characteristics are compared.

References

Blaxton, T. A. 1989 Investigating dissociations among memory measures: Support for a transfer-appropriate processing framework. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, **15**, 657.

Cabeza, R. 1993 *Implicit perceptual, implicit conceptual, and explicit memory tests: Investigating the empirical and theoretical foundations of the distinction.* Ph. D. Thesis, University of Tsukuba.

Cabeza, R., & Ohta, N. 1993a Comparisons between explicit, implicit perceptual, and implicit conceptual memory tests: A selective review. *Tsukuba Psychological Research*, **15**, 71–100.

Cabeza, R., & Ohta, N. 1993b Dissociating conceptual priming, perceptual priming, and explicit memory. *European Journal of Cognitive Psychology*, **5**, 35–53.

Challis, B. H., & Brodbeck, D. R. 1992 Level of processing affects priming in word fragment completion. *Journal of Experimental Psychology: Learning, Memory, and Cognition.*, **18**, 595–607.

Diamond, R., & Rozin, P. 1984 Activation of existing memories in anterograde amnesia. *Journal of Abnormal Psychology*, **93**, 98–105.

Kuratani, N., Kobayashi, A., & Okunishi, S. 1982 *A new dictionary of kanji usage*. Tokyo: Gakken.

Ohta, N. 1991 Direct Priming. *Japanese Psychological Research*, **62**, 119–135.

Paradis, M., Hagiwara, H., & Hildebrant, N. 1985 *Neurolinguistic aspects of the Japanese writing system*. Orlando: Academic Press.

Richardson-Klavehn, A., & Bjork, R. A. 1988 Measures of memory. *Annual Review of Psychology*, **30**, 519–523.

Roediger, H. L. 1990 Implicit memory: A commentary. *Bulletin of the Psychonomic Society*, **15**, 379–388.

Roediger, H. L., Weldon, M. S., & Challis, B. H. 1989 Explaining dissociations between implicit and explicit measures of retention: A processing account. In H. L. Roediger & F. I. M. Craik (Eds.), *Varieties of memory and consciousness: Essays in honour of Endel Tulving*. (pp. 3–41). Hillsdale, NJ: Erlbaum.

Shimamura, A. P. 1986 Priming effects in amnesia: Evidence for a dissociable memory function. *Quarterly Journal of Experimental Psychology*, **38A**, 619–644.

Srinivas, K., & Roediger, H. L. 1990 Classifying implicit memory tests: Category association and anagram solution. *Journal of Memory and Language*, **29**, 389–412.

Tulving, E., & Schacter, D. L. 1990 Priming and human memory systems. *Science*, **247**, 301–305.

Tulving, E., Schacter, D. L., & Stark, H. 1982 Priming effects in word-fragment completion are independent of recognition memory. *Journal of Experimental Psychology: Learning, Memory, & Cognition*, **8**, 336–342.

– Received Sept. 30, 1993 –

Appendix

52	議	ぎ	言	義	262	聞	もん	耳	門	462	張	ちょう	弓	長
705	草	そう	艹	早	739	晴	せい	日	青	519	管	かん	⺮	官
941	堀	くつ	土	屈	795	努	ど	力	奴	852	被	ひ	衤	皮
1029	鉱	こう	金	広	1083	飯	はん	食	反	1113	紡	ほう	糸	方
1149	硬	こう	石	更	1154	枝	し	木	支	1133	吸	きゅう	口	及
1326	魔	ま	鬼	麻	1229	抱	ほう	扌	包	1274	凍	とう	冫	東
1400	腐	ふ	肉	府	1456	舶	はく	舟	白	1506	漂	ひょう	氵	票
1542	惜	せき	忄	昔	1630	霜	そう	雨	相	1525	粒	りゅう	米	立
1772	娠	しん	女	辰	1724	睡	すい	目	垂	1763	猫	びょう	犭	苗
1980	跳	ちょう	足	兆	1823	侍	じ	亻	寺	1804	畔	はん	田	半