Writing over and over to remember? Does it work? Then why?

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It is well known that one writes down to-be-remembered materials over and over to memorize. Repeated writing is a good strategy to memorize names of people and places, spellings of foreign words, and Kanji characters. Infants start to learn Japanese letters by writing them (Onose, 1987, 1988), and children spontaneously use this strategy in memory tasks (Hashimoto & Hashimoto, 1986).

It is also known that one moves a finger in retrieval as if he/she tries to write down the materials (Sasaki & Watanabe, 1983). This writing-like-behavior in the air, on a desk, or on one's lap, is called Kusho behavior and commonly observed among Japanese and Chinese as a strategy of retrieval (Sasaki & Watanabe, 1984).

Although these observations can be expressed in several ways, such as an overlearning effect by motor modalitiy or an encoding specificity effect that motor movement serves as a retrieval cue, Sasaki (1986) suggested that there is more close relationship between motor movements and memory, that is, there is a certain kind of memory for which motor movement is essential, and which cannot be accessed but through the motor movement.

This study pursues the effect of writing on encoding. In exactly which condition and on what kind of information, does repeated writing facilitate the memory? If the motor movements have a close relationship with a certain kind of memory beyond the overlearning and contextual effect, then what is the rationale? This study wants to answer these questions.

Experiment 1

Method

Subjects. 10 undergraduate students of Chiba University.

Materials. Three lists, each of which consists of 10 paired associative learning items: word-word pairs for List A, word-nonsense syllable pairs for List B, and word-graphical character pairs for List C. Words were chosen from names of familiar objects, nonsense syllables were chosen from a nonsense syllable norm (Hayashi, 1976), and graphical characters were the combination of circles, triangles, squares, and straight and curved lines, which did not have specific meaning. See Appendix for examples.

Procedure. Subjects were asked to learn in either of writing or control conditions. Those in writing condition were instructed to memorize the lists by writing, and those in control condition were instructed to memorize them by watching. List A, B, C were presented orderly. Subjects studied lists 90 seconds for each, with 2 calculation tasks between lists, then were given a cued recall test that requires them to remember the items paired with word cues.

Results and discussion

Results are shown in Table 1. Subjects in control condition remembered more items in List A than those in writing condition although it remained to be a tendency ($t=2.11$, $df=8$, $p<0.10$). There were no other significant results.

Does this result suggest that writing inhibits learning against our experience and prediction? Before we conclude so, we have to look at several possibilities: first, subjects in control condition might finish the list faster than those who had to write down each item, and made the most of the spare time to rehearse items, which might cause better memory; second, the effect of writing may appear later rather than immediately after learning. In Experiment 2, we control these two points and examine the writing effect again.

Anyhow, the finding that writing does not necessarily promote learning suggests at least that the facilitation of memory by motor movements, if exists, is not simply attributed to the additional motor information that makes memory trace more tolerant and easier to be retrieved by cues, which is suggested by simple applications of overlearning or encoding specificity explanation.

Table 1. **Results of Experiment 1: Mean correct recalled items out of ten items**

Conditions	Words	Syllables	Graphical characters
Writing	5.6(0.83)†	1.8(2.16)	5.0(2.28)
Control	8.2(1.48)	1.8(2.19)	6.2(2.54)

†( ) indicates standard deviation.

Experiment 2-1 and 2-2

Method (Exp. 2-1)

Subjects. 10 undergraduate students of Chiba University, none of them attended in Exp. 1.

Materials. Revised version of List A in Exp. 1 in which each pair was printed on a sheet of paper and lists were made in a booklet style to control the learning time for each pair. Every second pair was underlined to mark it was the item of experimental condition.

Procedure. Subjects were instructed to memorize underlined items by writing, and the rest by watching. They were given 5 seconds for each pair, and learned the list twice. Then, they were given an immediate cued recall. In succession, half of subjects did a nonverbal intermediate task for 5 minutes then took a delayed cued recall test, while the rest did the nonverbal task for 20 minutes then took the delayed cued recall test.

Method (Exp. 2-2)

Subjects. 22 undergraduate students of Chiba University, none of them attended in Exp. 1 or 2-1.

Materials. Revised version of List B and C in Exp. 1 in which each pair was printed on a sheet of paper and every second pair was underlined.

Procedure. Subjects studied List B and C on different days, with 20 days of interval to prevent interference. On the first day, subjects were given List B or C, which was for writing or control condition, then after 20 days, they were given other list for other condition. As Exp. 2-1, all subjects were asked for cued recall, then half of them did nonverbal interval task for 5 minutes and took the delayed cued recall test, while the rest did 20 minutes' nonverbal interval task then took the delayed cued recall test.

Results and discussion

Results of immediate recall for List A, B, and C in Exp. 2-1 and 2-2 are shown in Table 2. As for the numbers of recalled items, there was no difference between writing and control conditions, nor between immediate and delayed recall. However, recalled items with their right associates of List A was 6 for writing condition and 0 for control condition, and this difference was significant ($\chi^2=6.11$, $df=1$, $p<0.02$). Impairment of association suggests that writing inhibits the inter-item processing. In Exp. 3, we use simple word lists instead of paired word lists, which do not require inter-item processing.

Table 2 Results of Experiment 2-1 and 2-2: Mean correct recalled items out of ten items

Conditions	Words	Syllables	Graphical characters
Writing	3.5(1.11)†	2.5(1.80)	6.2(1.88)
Control	3.7(1.47)	3.7(2.28)	5.1(1.81)

†( ) indicates standard deviation.

Experiment 3

Method

Subjects. 20 undergraduate students of Chiba University, none of them attended in other experiments of this study.

Materials. Three lists, each of which consist of 10 items: 10 words for List A′, 10 nonsense syllables for List B′, and 10 graphical characters for List C′. Each item was printed on a sheet of paper and every second item was underlined. For recognition test, additional 10 words, 10 nonsense syllables and 10 graphical characters were prepaired.

Procedure. Subjects learned underlined items by writing and the rest by watching, then they were instructed to count alphabets backward for 30 seconds, and were given a free recall test and a recognition test.

Results and discussion

Results of free recall are shown in Table 3. Subjects showed significantly higher free recall for List B′ and C′ in writing condition than in control condition ($t=2.86$, $df=18$, $p<0.05$; $t=3.09$, $df=18$, $p<0.01$). There was no difference in recognition test.

Now in this condition where inter-item processing was not required, writing did promote the memory. This result supports the idea that writing affects intra-item processing rather than inter-item processing.

Second point of this result is that faciliation was seen only for nonsense syllables and graphical characters which did not have meanings. It suggests that processing is rather visual and non-semantic than verbal and semantic.

Table 3 Results of Experiment 3: Mean correct recalled items out of ten items

Conditions	Words	Syllables	Graphical characters
Writing	4.2(0.6)†	2.2(1.80)	3.4(0.66)
Control	3.7(0.37)	0.9(1.20)	2.0(1.18)

†( ) indicates standard deviation.

General discussion

Repeated writing is effective in intra-item processing rather than inter-item processing. And it is effective to remember nonsense syllables and graphical characters which do not have meanings.

It seems like repeated writing is a visual rehearsal suggested by Klatzky (1980) which brings good visual representation of the material. Takahashi (1987, 1988) reported the elaborated rehearsal facilitates inter-item processing, while the rote rehearsal facilitates intra-list processing. Repeated writing is more like a visual rote rehearsal to retain the exact image of materials than an elaborated rehearsal which developes deep meaningful codes.

Then what is the rationale of the writing effect on intra-item processing of visual and non-semantic materials? Let's think of this strategy again. This strategy is supposed to be effective to memorize names of people and places, spellings of foreign words, and Kanji characters, but may not so effective to remember meaningful texts, events, conversations, and so on. This strategy seems to be more effective to memorize exact letters, wording and surface structures such as visual representation.

Rubin (1977) discussed that a rote memory played an important role in everyday memory, and nonverbal rules such as rhymes, metrics, poetic ties and the like supported the rote memory (Wallace & Rubin, 1988). Naka and Uno (1989) showed that when verbal and semantic structure failed to organize information, as the case of words of a song which did not have a text-like-structure, a nonverbal structure such as a tune took place to organize the words into a structure.

Considering these studies, the rationale could be that motor movemets took the place of semantic constrains and supported the meaningless rote menory. This hypothesis is also supported by studies on Kanji retrieval. Sasaki (1983, 1984) observed writing-like-behaviors by subjects, who tried to retrieve Kanji characters with graphical, non-semantic cues while Murakami (1984) found no such behaviors by subjects who did the same task but with semantic cues.

Names of people and places, spellings of foreign words, and Kanji characters are arbitrary and do not have semantic constrains, though it might have had in their origins. They need to be organized by other structure than semantics, and that structure is what the consecutive movements in writing do offer. The conventional writing orders (left to right, top to bottom, and specific order to put down components of Kanji characters) organize materials into an integrated representation, which makes materials retain longer and be easily retrieved. This may be the rationale which accounts for the writing effect.

In summary, this study pursued the conditions in which writing affected on memory and its rationale. Findings are that writing promotes intra-processing of nonsense syllables and graphical characters which do not have meanings. These results were interpreted as motor movements did work as a visual rehearsal which allowed to develope an exact image of the material, and as a constrain which organized a representation of meaningless materials into an integrated one with conventional order of movements.

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Appendix. Examples of materials.

Words	Nonsense Syllables	Graphical Characters
アヤメ (iris)†	ムヘ (muhe)††	
レンゲ (vetch)	ネメ (neme)	
ユ　リ (lily)	ヌソ (nuso)	
ヘ　ビ (snake)	ナテ (nate)	
サ　ル (monkey)	スヨ (suyo)	
ウサギ (rabbit)	ロヘ (rohe)	
ウ　マ (horse)	ムヌ (munu)	
技術科 (art)	ツセ (tuse)	
理　科 (science)	レユ (reyu)	
英　語 (English)	ルオ (ruo)	

† (　) indicates meanings of the words.
†† (　) indicates pronounciations of the syllables.