Comparison of the Remembering Ability by the Difference Between Handwriting and Typeface

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Abstract. When people study something, it is common to memorize textbooks, reference books, and notes that are handwritten or typed. Those memorization tasks are known to be effectively done with typefaces that are hard to read. Then, it is assumed that handwriting would help you memorize things better than typed letters as it is often difficult to read and the form of letters is not uniform. In this research, we conducted experiments on handwritten characters and typefaces that have different features from each other to verify whether they work differently for memorization. The result found that handwritten characters are more likely to be retained in memory than typefaces. Specifically, familiar handwritten characters are more likely to be retained in memory.

Keywords: Handwriting, Typeface, Memory, Character Shape, Memory Easiness.

1 INTRODUCTION

When people study something, they use textbooks, reference books, lecture slides, and notes in which the contents of the lectures and the textbooks are organized. These books, slides, and notes are written with various forms of characters. Usually, typefaces are used in textbooks and reference books. On the other hand, notes are handwritten or typed.

According to the study of Mueller et al. [1] concluded that students who took notes on a laptop performed worse on conceptual questions than students who took notes by hand. Mendizábal et al. [2] also concluded that students who took notes by hand performed better on memory tests than those who took notes by computer. These studies focused on the comparison of writing and typing, but it has not been clarified which form of characters, handwriting or typeface, is more effective for memorization.

Various studies have been conducted on the influence of the character style used when memorizing. For example, Diemand-Yauman et al. [3] have clarified that it is easy to remember the contents when they are written in a typeface that is difficult to read. In addition, Sungkhasettee et al. [4] showed that it is easier to memorize words that are rotated 180 degrees to make them difficult to read. These results suggest that

unrecognizable characters are more likely to be retained in memory. Then, since handwritten characters are often difficult to read and the form of letters is not uniform compared to characters in typefaces, it is expected that memorization would be easier with handwritten characters than characters in typefaces. However, it has not been clarified whether memorization can be done more easily with handwritten characters or typefaces. Given that typefaces are easier to read due to the uniform style of characters, it is expected that handwritten characters are more helpful for memorization.

In this research, in order to realize a style of note which makes it easy to memorize things, we examine what form of characters has high effect for memorization when learning. We hypothesize that handwriting is more effective for memorization than uniform, relatively readable typed characters. We also focus on features of handwriting and typed characters, and carry out a memory task experiment to verify which one helps memorization more.

2 Characteristic Memory Experiment

2.1 Outline of the Experiment

In order to verify the hypothesis that handwriting is more effective for memorization than uniform, relatively readable typed characters, we conducted a feature-memory experiment to see if memorization can be influenced by whether the information to memorize was handwritten or typed. The experiment was designed based on the study by Diemand-Yauman et al. [3], in which the participants were asked to memorize features of imaginary things. In the experiment, two types of typefaces, MS Gothic and MS Mincho, and two types of handwritten characters were compared. Though handwriting characters necessarily have various types of individual differences, two types of handwritten characters with different features were used for the current study. The features of the two kinds of handwritten characters (hereinafter referred to as handwritten A and handwritten B) are as follows (see Fig.1).

- handwriting A: Round, wide, and angular
- handwriting B: Angled, long, and chained

2.2 Experimental Procedure

In this experiment, participants were provided with a document in which three imaginary proper nouns and seven features for each noun were written, and were asked to memorize them in 90 seconds. The text was written in one of the four forms shown in Fig. 1 and Fig. 2. The order effect was considered for the presentation of the character style. After the memorization session, we asked the participants to watch a 15-minute-long video clip to take a rest. After that, the participants were asked to answer 10 questions about 21 items (3 nouns x 7 features). An example of the question is shown in Fig. 3 and Fig. 4.

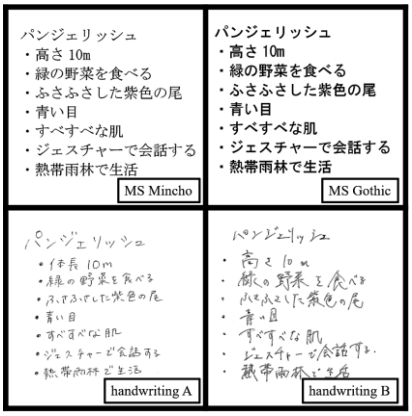

Fig. 1. The characters used in the experiment (in Japanese).

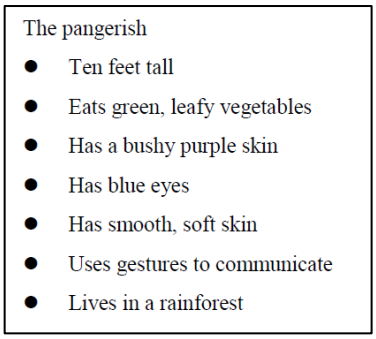

Fig. 2. English translation of the example in Fig. 1.

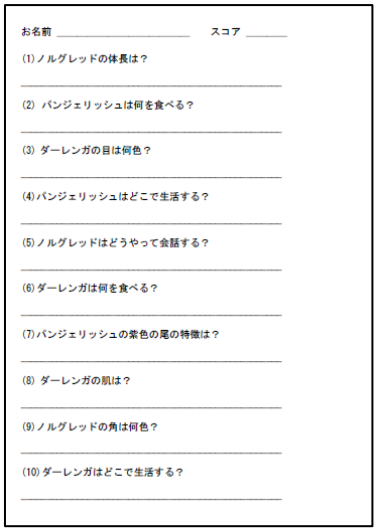

Fig. 3. An example of the original question in Japanese.

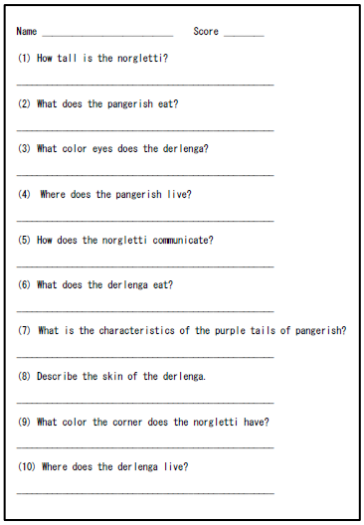

Fig. 4. English translation of the example of the question in the Fig. 3.

A total of 4 trials were conducted for each participant. After all the trials, the participants were asked to answer a questionnaire about whether they had confidence in their own handwriting, whether their handwriting resembled one of the two handwritten characters used in the experiment, readability of the four characters used in the experiment, how often they read typed letters, how often they look at handwritten characters, the experimental design, and impressions about the experiment.

The participants were 26 undergraduate students aged 18 to 23 (7 males and 12 females). The presentation order of the themes was unified for all members. The order was Alien, Cake, Country, and Animal.

2.3 Result

The participants' responses were evaluated as one correct answer counts as 10 points, so 100 points (10 points x 10 questions) was the full marks for each participant. The responses were regarded as correct as long as they mention a keyword of the item, even if they do not perfectly match the correct answer. Also, if the participants completely mistook an item for another when answering the questions, their responses were considered to be correct, since they were simple mistake and still show that the participants memorized the content.

A graph of the average scores for each character type is shown in Fig. 5. The results showed that the average score was the highest with handwriting B and the lowest with MS Gothic. Also, the results showed that the average scores of the handwritten characters were higher than those of the typefaces. In addition, the score of MS Gothic was found to be consistently low throughout the tests. The corresponding t-test revealed that there was a significant difference between MS Gothic and handwriting B ($p<0.05$). On the other hand, there were no significant differences among the other characters.

Tables 1 and 2 show the number of people who answered in the questionnaire that each style of characters was easy/hard to read and their average scores. As for handwriting B, it not only had the highest average score of the test, but also had the largest number of people (16 participants) who answered that the letter was illegible among the four types of characters. These results suggest that handwriting characters are more likely to be memorized than typefaces, and that, among handwriting characters, illegible handwriting is more likely to be memorized.

In addition, 9 participants answered in the questionnaire that their handwriting is similar to handwriting A. On the other hand, 16 participants answered that their handwriting is similar to handwriting B. Table 3 shows the average score of each handwriting character of the two groups divided by which handwriting is similar to their own.

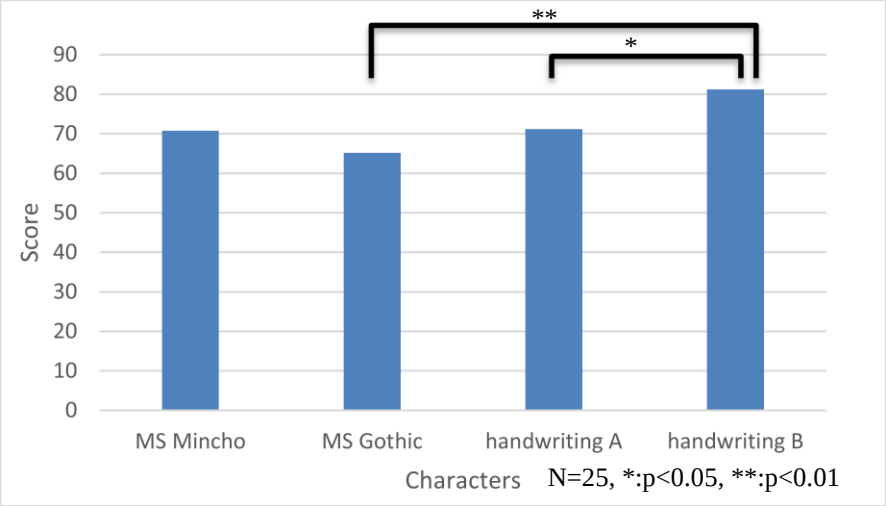

Fig. 5 The average remembering scores for each character type**.**

Table 1. The number of participants who found each character easy to read and their averaged scores.

	MS Mincho	MS Gothic	handwriting A	handwriting B
The number of people	24	22	18	9
Score	70.0	61.8	77.2	77.8

Table 2. The number of participants who found each character hard to read and their averaged scores.

	MS Mincho	MS Gothic	handwriting A	handwriting B
The number of people	1	3	7	16
Score	50.0	73.3	68.6	73.1

Table 3. The relationship between the similarity of handwriting and its score.

	handwriting A	handwriting B
Participant's handwriting is similar to the handwriting A	**80.0**	72.2
Participant's handwriting is similar to the handwriting B	71.3	**77.5**

All the participants who found handwriting A similar to their own handwriting answered that handwriting A was easy to read or slightly easy to read, and seven of them answered that handwriting B was hard to read or slightly difficult to read. The averaged test score of these 9 participants was the highest for handwriting A. For the participants who answered that their handwriting is similar to handwriting B, their answers about the readability of handwriting A and handwriting B did not show any tendency on which one was easier to read, but the averaged test score was highest for handwriting B. In other words, both groups of participants had the highest test scores for handwriting characters that are similar to their own handwriting. In addition, there were 12 participants whose scores were higher than average for the characters that they answered were difficult to read. Moreover, the difference in the average test scores of MS Mincho and MS Gothic of the participants who found handwriting A similar to their own was 6.7, while the difference of the participants who answered their handwriting resembles handwriting B was 10.0.

2.4 Additional Experiment

A graph of the average test scores for each character type is shown in Fig. 6.

In order to confirm the result that handwriting B is easy to be retained in the memory and MS Gothic is difficult to be retained in the memory, an additional experiment was carried out. The participants were 14 undergraduate students aged 18 to 22 (8 males and 6 females). The additional experiment was conducted with the same procedure as the previous experiment, but the contents to be memorized were changed. The themes used for the additional experiment were "Animal," "Amusement park," "Clothing," and "Cuisine," and they were presented in a fixed order. Table 4 shows the results of the additional experiment. Since there was one participant in this experiment whose score

Table 4. The average score of the additional experiment for each character type.

	MS Mincho	MS Gothic	handwriting A	handwriting B
Additional Experiment	86.2	64.6	77.7	84.6

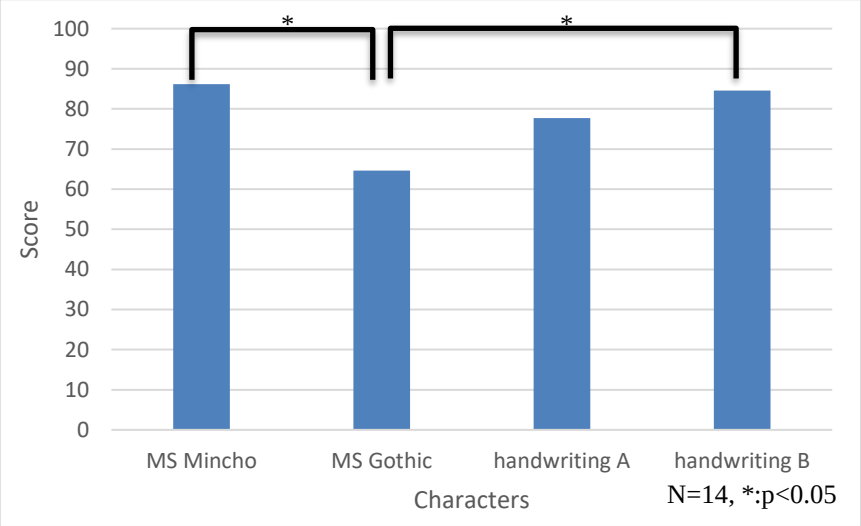

Fig 6. A graph of the average scores for each character type.

was considered as outlier (mean ± 2 SD), the scores for the other 13 participants were considered. The result showed that the average point of MS Gothic was the lowest, which was the same result as the main experiment.

3 Consideration

The result of the experiments and the questionnaire showed that the test score tended to be higher when the information to memorize was written in a type of character that the participants felt was difficult to read. On the other hand, there was no correlation between the test score and readability of the characters that the participants found easy to read or slightly easy to read.

The reason for the high score for the handwriting characters would be that they are often deformed and difficult to read, so they are more likely to be memorized than typefaces. The results also revealed that the participants got higher test scores when the information to memorize was written in a character type that is similar to their own handwriting. This may be because characters that are relatively similar to one's own handwriting are easier to understand.

It is assumed as a reason why illegible characters led to the high scores that illegible characters are read so slowly that the readers would not miss the content while reading. One of the participants actually commented in the questionnaire that typefaces were easier to read but they sometimes just went over the sentences without understanding their contents.

Table 5. The degree of cosine similarity for each character.

	Cosine similarity
MS Mincho and MS Gothic	0.69
MS Mincho and handwriting A	0.67
MS Mincho and handwriting B	0.63
MS Gothic and handwriting A	0.57
MS Gothic and handwriting B	0.52
handwriting A and handwriting B	0.72

It was found in the results that there was a difference between MS Mincho and MS Gothic in the test scores of the participants who answered that their handwriting is similar to handwriting B. Given that the result of the study by Diemand-Yauman et al. [3] can be applied to Japanese characters, the difference would be due to the fact that the lines of MS Mincho were thinner and harder to read than MS Gothic. However, many participants answered in the questionnaire that MS Mincho was easier to read or a little easier to read than MS Gothic, so this consideration needs to be reexamined.

Table 5 shows the degree of cosine similarity for each character with 50 points as a default value. They were calculated to clarify the types of characters whose results were similar and to examine features of the characters that affect memory.

It can be seen in Table 5 that the cosine similarity was high between handwritten characters and between typefaces, and that there is a relationship between the character shapes and the test score. The cosine similarity between the two handwritten characters (handwriting A and handwriting B) and MS Mincho was high, but the cosine similarity between the handwritten characters and MS Gothic was low. MS Mincho has features of Japanese characters such as *Tome* (stop), *Hane* (upward stroke ending), *Harai* (sweeping stroke ending) while MS Gothic does not, which led to the difference in the cosine similarities. Also, since the test score of MS Gothic was drastically lower than other characters in both the main experiment and the additional experiment, it can be said that MS Gothic is not suitable as a character to be used for memorization.

4 Conclusion

In this study, we conducted memory task experiments using handwritten characters and typefaces with different characteristics under the hypothesis that handwriting characters are more memorable than typefaces. The experimental results showed that angular handwriting, which is relatively difficult to read, was the easiest to remember and that MS Gothic, which is relatively easy to read, was the most difficult to remember. The results partially support the hypothesis in that handwriting was easier to remember than MS Gothic, but the hypothesis was not fully verified in terms of comparison between handwriting and typefaces. The difference in memorability between handwritten characters and MS Gothic characters was considered to be due to the facts that handwritten characters are often out of shape compared to typefaces and that they are similar to the handwriting of the participants themselves.

The present study only examined four types of characters (handwriting A, handwriting B, MS Mincho, and MS Gothic), so future study will conduct experiments with characters with other features and see whether the difference in the memorability can be observed. Also, the experiments of the present study used handwriting characters that were written by a person who was not a participant of the experiment, so it was possible that both handwriting A and handwriting B were not similar to the participants' handwriting. Thus, experiments with the same procedure but using the handwriting of each participant would be considered as a future study.

In addition, as there are features of character shapes that work as a factor to be easily retained in memory, it is assumed that typeface that is both easy to read and memorize can be realized by fusing one's own handwriting and illegible typefaces using the method proposed by [5] Saito et al. Also, our future study will look at factors to improve memorization, and aim to realize notebook that helps memorization.

Acknowledgements

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