Comparing Memory for Handwriting versus Typing

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This is an investigation into the possible links between psychomotor action, in the activities of handwriting, and memory. A comparison of recall and recognition for common words demonstrates that memory is better for words when they have been written down rather than when they are typed. This provides additional support for the hypothesis that the additional context provided by the complex task of writing results in better memory. With the recent trend towards electronic note taking, the educational and practical implications of these findings would suggest that performance may be improved by using traditional paper-and-pen notes.

INTRODUCTION

With the increased prevalence of technology in the classroom, students are more likely to be using laptops or computers for everything from self-guided instruction at home to taking notes in class. But, does this transfer to a more digitized world come with unintended consequences? Will the drive to have a computer for every student rob them of benefits of traditional pen-and-paper note-taking? Is there an aspect of handwriting that creates better context for memory, and what is the mechanism?

Longcamp, Zerbato-Poudou and Velay (2005) tested children's memory for letters after hand writing them and after using a computer program that emphasized typing. In this study, only children who were given letters to handwrite showed a significant increase in recognition performance. This suggests that the increased processing inherent in handwriting, due to a temporal and spatial component that is not found in typing, creates more context thereby increasing retention independent of semantic processing. This retention also extends to non-letters (Naka, 1998). Further extensions of this research looking at brain activity examined visual recognition of characters (both known and novel) following handwritten-based training and type-based training (Longcamp, et al., 2008). The researchers discovered that the motor knowledge acquired from handwriting during the training phase significantly contributes to the accuracy of recognition. This supports the argument that the physical act of writing or tracing provides an additional layer of memory that assists performance that is not found in typing (Hulme, 1979). While handwriting is a process that requires a great deal of complex movements, typing provides much less kinesthetic information. Handwriting has long been known to be a complex task with each letter or word requiring a series of unique movements (cf. Hylan, 1910). Alternatively, typing consists of a series of repetitive and unidentifiable movements. Without the additional information provided by the physical act of handwriting, memory for typed words would be comparatively poor.

The levels of processing framework initially developed by Craik and Lockhart (1972) would suggest that better memory results from taking handwritten notes because of increased semantic processing, not the addition of motor information. Because of the nature of the task, namely to copy down a potentially large amount of information in a short amount of time while also attending to a lecture, the note-taker must analyze the semantic content of the lecture into as few words as possible and into a meaningful organization. This additional processing would result in a deeper level of processing

and better memory for the material. But, this does not explain the learning effects described above, or from rote memorization through repeated rewriting, a common and effective method used in early education of learning new shapes (Naka, 1998).

This study extends previous findings by looking at the differences in memory for writing entire words, as opposed to individual characters. In addition to recognition, recall was also examined. We hypothesize that memory for handwritten words will be better than for typed words for both recall and recognition tasks. Similarly, we expect that the group handwriting words will make fewer errors when asked to recall and recognize the target words than the typing group.

METHODS

Participants

A total of 61 adults participated, ranging from the age of 18 to 24 (M = 19.33, SD = 1.38). Participants were recruited through an online announcement in exchange for undergraduate class credit. Seventy-two percent of participants were female and one participant did not report English as their first language. All participants were evenly assigned to either the typing or the handwriting condition. Technology usage was generally high with all participants reporting daily computer usage Mean usage was 4.99 hours per day (SD = 2.74) raging from 2 to 15 hours. Participants reported daily instant messaging (IM) averaging 1.58 (SD = 2.52) hours of IM per day and phone text messaging with a mean of 79.03 texts per day (SD = 154.90). It is notable that the majority of students reported that they prefer to take notes using pen and paper (72.1%) rather than using a word processor and laptop.

Measures

The words used were taken from the sixth grade Florida Comprehensive Assessment Test (FCAT; Florida Department of Education, 2007) tests of reading comprehension and vocabulary. The recall task asks participants to remember as many of the words that they were presented within five minutes by writing them down onto a blank sheet of paper. The total number of words correctly recalled and the number of falsely recalled words were recorded. The recognition task presents a mixed list of thirty-six words consisting of the stimuli words and new words from the same FCAT vocabulary. Participants are asked to indicate which words were in the stimuli. Correct words and incorrect words were measured and compared separately.

Procedure

Stimuli and measures were presented in a fixed order to individual participants. Participants were not explicitly informed that their memory would be tested, however no deception was used and the variables of interest could be determined from the title of the study. In the handwriting condition, participants were presented with a computer printout of the stimuli words. The stimuli were in alphabetical order and were listed down the left hand side of the page. Participants were then instructed to copy the words, one time each, on the right hand side of the page. Instructions were given to copy the words however they wished (e.g., in print or in cursive) and to take as long as needed to complete the task. Time to complete the task was recorded.

In the typing condition, participants were presented the stimuli words in the same order as the handwriting condition, on the left hand side of a computer screen. They were then asked to type the words into a word processing program, opened on the right hand side of the screen. Participants were asked to type as they would normally, with no concern for spelling or formatting. Though time to complete the task was recorded, participants

were informed that they could take as long as they needed to complete the task.

After being presented with the stimuli, participants were given a distracter task of eight complex multiplication problems. They were allowed as much time as needed to complete the task, though time to complete was recorded. Once they completed the distracter task, they were given the recall task. For the purposes of the recall task, participants were limited to five minutes to remember as many of the words that they had been presented with earlier by writing them down onto a blank sheet of paper. After the five minutes were over, participants were then given the recognition task where previously seen words were mixed with new words. The recognition task was also limited to five minutes.

RESULTS

A one-way ANOVA was used to test if memory was better for handwriting the stimuli words versus typing them using measures of correct recall and recognition and errors on these measures. Memory on the recall task approached significance for handwritten words, $F(1, 59) = 3.34$, $p = .065$; and was significant on the recognition task, $F(1, 59) = 4.63$, $p = .036$. The number of errors in the recall task was significantly higher for the typing condition, $F(1, 59) = 4.803$, $p = .032$. The number of errors for the recognition task was not significant. Means and standard deviations for the experimental conditions are presented in Table 1.

Table 1: Means and SD for Experimental Conditions

Measures	Condition	*Mean*	*SD*
Correct Recall	Handwriting	5.07	2.02
	Typing	4.10	2.01
Incorrect	Handwriting	.83	1.18
Recall	Typing	1.87	2.32
Correct	Handwriting	11.73	2.95
Recognition	Typing	10.19	2.64
Incorrect	Handwriting	1.03	1.25
Recognition	Typing	1.26	1.50

DISCUSSION

This experiment was designed to explore if memory was better for handwritten words than for typed words. Recent imaging and memory performance studies support the hypothesis that due to the additional context provided by handwriting, we remember target words more accurately when we take the time and effort to write them out than to type them. This hypothesis was supported, but with some caveats. While the number of words correctly recalled was not significant at $p < .05$, it did approach significance and would likely be significant with a larger sample size or if more experimental control was exerted (e.g., if performance was compared with-in subjects rather than between-subjects). The conclusion, even though not statistically significant, is supported by the fact that the number of words incorrectly recalled (i.e., words that were not part of the stimuli) was higher for the typing condition than for the handwritten condition. Further, performance on the recognition task is significantly better for the handwriting condition than for the typing condition.

These findings support our hypothesis that the increased kinesthetic information from handwriting creates a more complex memory trace than created by typing. By not prompting participants to remember the words and having a distracting task before the recall and recognition tasks, reduced the attempts by participants to rehearse or actively remember the words. The task was designed this way to expose the potential effects of motor memory. Additionally, by using simple words that were not semantically related, participants were not able to easily group the stimuli or add meaning that would aid their memory.

Further research in this area is necessary to completely understand the influence typing may have on our cognitive performance. After millennia of the time

consuming process of hand writing, our ability to generate text quickly now appears to be at the risk of learning what we have written down. This conclusion is by no means conclusive. Future research is necessary to investigate the effect typing has on remember more complex stimuli, for example, phrases rather than just words. In addition, this research was limited by being a between subjects research design, future investigations would likely benefit from using a within-subjects design.

The process of taking notes is not a simple process of transcription. Effective note taking is characterized by a semantic processing that emphasizes summarization, highlighting and organization. This study does not address the effect this may have on memory performance. The results do suggest that the process of "jotting down a quick line" is a more complex process than we previously appreciated.

Practical applications of this research would be the recommendation to encourage students to take notes by traditional pen-and-paper to aid their memory and retrieval for notes. This is very important as the use of the computer technology in the classroom becomes ever more prevalent. This research attempts to explain the importance of maintaining practices that are being abandoned for new technologies. Future developments in the area of touch-screen computing and direct input from a stylus may be ways to mitigate the loss of memory from typing on a traditional QWERTY keyboard, and may result in potential areas for future research. Advances in handwriting recognition and encoding software would have the additional benefit of maximizing the user's recall and recognition for what they have written down. This blending of pen/paper and modern technologies leverages the strengths of manual encoding and the efficiency of modern computing.

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