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How Best to Study for a Test: A Comparison of Practice Retrieval and Self-Explanation

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HOW BEST TO STUDY FOR A TEST:

A COMPARISON OF PRACTICE RETRIEVAL AND SELF-EXPLANATION

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By

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ABSTRACT

Students often struggle to prepare for their exams, perhaps as a result of using an unhelpful study method. This study compared the effects of using three study methods: rereading, practice retrieval, and self-explanation. 79 college students studied a short science text passage and were tested with both verbatim and inference questions one week later. Students who reread the information did not perform differently from those who practiced retrieving or self-explained the information. Students who self-explained the information performed better on verbatim test questions than those who practiced retrieving the information. Possible explanations for these findings and implications are discussed.

Keywords: Study method, rereading, practice retrieval, self-explanation, memory

Dedicated to all my loved ones

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I am thankful to God for the opportunity to be here today, and to Jesus for giving meaning to my being here. I am thankful to my family, mother, father, and brother, for their support in all that I do. I am also very grateful to have such wonderful friends who keep me focused while also giving me many reasons to laugh.

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VITA

September 15, 1993……………………………………Born – Bowling Green, Kentucky

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FIELDS OF STUDY

Major Field: Psychology

2nd Major Field: Philosophy

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It is no secret that college students often experience great amounts of stress and frustration in preparing to take examinations for their courses. These students may spend hours rereading their notes and using a variety of study methods the night before the big exam. However, information that once seemed perfectly coherent and available in memory may seem incoherent and difficult to retrieve when it comes time to take the test (Roediger & Karpicke, 2006). The question that these students may struggle to answer, then, is how they can effectively use their study time in order to "make it stick." Researchers have examined this phenomenon and have developed specific study methods of varying utility and effectiveness, two of which are the practice retrieval and self-explanation methods.

Rereading

Rereading is reported to be a very popular study method among college students (Carrier, 2003). However, the effects of reading a text several times in succession have been mixed. For example, Rawson and Kintsch (2005) found that students who reread materials immediately after the initial reading (massed rereading) performed better on an immediate performance measure of both verbatim recall and comprehension of information than students who read the materials once. However, there was no difference between the single reading and massed rereading conditions in performance after a two-day delay. Students in a third condition who reread materials one week after the initial reading (distributed reading) did not perform differently from students who read only once, but they did perform better than single readers when both groups were given a test after the two-day delay (Rawson & Kintsch, 2005). These results are consistent with other studies which have examined rereading (Roediger & Karpicke, 2006). Thus, students have been shown to use a popular study method with few long-term benefits on retention of information.

Practice Retrieval

The practice retrieval method has perhaps been unknowingly used by students for many years, in the form of rehearsal with flash cards. The method involves an initial study period in which information is encoded into short-term memory (and ideally transferred to long-term memory); after the rehearsal period, the student will attempt to recall the information, answering either a cued-recall or free-recall prompt on a test (Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013). Afterwards, the student takes a final memory test, in order to measure learning. The mere act of retrieving information from memory on a practice test functions as a method of storage, reinforcing the connection between the retrieval cue and the answer for the final test (Roediger & Karpicke, 2006).

Research has shown that rereading a text improves recall in the short-term more than practice testing, but the use of testing as a study method improves recall in the long-term more than rereading (Roediger & Karpicke, 2006). It has also been found that free-recall prompts are useful in helping students reinforce information through practice testing, although information that is not recalled during practice testing will not be recalled in the long-term (Roediger & Karpicke, 2006). The benefits of practice retrieval apply to several different test formats, and even across test formats, when the practice and final tests appear in different formats. Although most studies of practice retrieval have made use of paired-word and paired-phrase lists as materials for study, several have recently examined the effect of practice retrieval for more educationally-relevant materials, such as science and history text passages (Dunlosky et al., 2013). Furthermore, research has found practice retrieval to be effective even when performance feedback is not given (Roediger & Karpicke, 2006). Thus, the present study attempts to build on these findings and to compare the practice retrieval method with another lesser known study method, self-explanation.

Self-Explanation

Self-explanation as a practical study method was first examined by Chi, Bassok, Lewis, Reimann, and Glaser (1989). In this study, researchers recorded the verbal reactions and explanations produced by students while they completed physics problems and paid special attention to those produced by students who were skilled or unskilled in solving the problems. They found that skilled students produced significantly more verbal responses during a given study period than did unskilled students, and skilled students also produced a greater proportion of physics explanations in their responses than did unskilled students. Thus, researchers began to investigate the possibility that self-explanation as a study method could be instructed and trained in students who do not normally use the method. Research has shown that it is indeed possible to teach the self-explanation method (Chi, De Leeuw, Chiu, & LaVancher, 1994).

The self-explanations that Wong, Lawson, and Keeves (2002) attempted to produce in their study follow a specific pattern. First, students were instructed in how to produce self-explanations based upon their observations and reactions to the material presented. Second, students were given three content-nonspecific, guiding questions to answer for each new piece of content presented. Third, students answered these questions explicitly, and their answers were recorded for further analysis. These basic principles were all followed in the current study. Though the effects of self-explanation have been demonstrated with a variety of study materials and final test formats, the durability of the learning effects has not been examined in great detail (Dunlosky et al., 2013).

In this study, we sought to compare the effectiveness of these study methods, rereading, practice retrieval, and self-explanation. Though rereading is a more popular study method than practice retrieval (Roediger & Karpicke, 2006), we hypothesized that the practice retrieval method would allow students to encode and retrieve more material in the long-term than rereading, based on the results found in previous research. However, our inquiry into the effectiveness of the self-explanation method in relation to the other study methods was exploratory, due to uncertainty about the durability of the effects of self-explanation.

Method

Participants

105 participants completed both sessions of the study. Participants received course credit and five dollars. Nine participants were removed from final data set because English was not their first language. Three participants were removed from the data set because they were biology majors, in order to control for previous knowledge of the

subject matter. One participant was removed due to a computer error, and one was removed for attempting to cheat during the final test period. Finally, twelve outliers were removed. This left 79 participants whose data could be used in analysis. Fifty-four participants were female. There were 61 Caucasians, 14 African Americans, one Asian or Pacific Islander, one Latino/Hispanic, and two participants who identified as multi-ethnic.

Materials

The Human Ear Passage. The science text passage used in the experiment, detailing the path of sound as it travels through the human ear to the brain, was used previously by Karpicke and Blunt (2011). Comprehension of the passage requires both simple memorization and a deeper conceptualization of the sound-transfer process, which is explained in detail at each stage of the process.

Self-Explanation Training. The self-explanation training materials were developed and adapted from Wong, Lawson, and Keeves (2002) in order to accommodate the time constraints of the current study. The materials consisted of a general overview of self-explanation and specific examples and practice problems for participants to work through. The examples and practice problems were developed from materials used by Karpicke and Blunt (2011). Three main differences from the materials used in Wong et al. were present in the current study’s materials. First, participants in the self-explanation condition received verbal and written instructions, rather than receiving instruction through an audiotape, to assure that participants listened to the instructions. Second, participants in the current study were required to present their practice answers to the experimenter for approval before moving on to the next study period, in order to give participants ample instruction in this session. Third, instead of self-explaining aloud, participants in the present study typed their self-explanations into a computer. As a result, participants could alter their self-explanations before submitting them. This was done to control for any possible verbal rehearsal memory effects not present in the other two conditions. Although the text used in this study does not explain mathematical principles or problem-solving procedures, as the materials used by Wong et al. did, we hypothesized that self-explanation procedures would still apply to the comprehension of a reading passage containing scientific principles, as Chi et al. (1989) originally demonstrated self-explanation using physics principles and problems.

Final Human Ear Test. The final test was also adapted from Karpicke and Blunt (2011). All of the original fourteen items were retained, and one additional inference-based item was added. Thus, there were ten items designed to measure verbatim knowledge of the passage, and five items designed to measure inference knowledge pertaining to the functions of the human ear.

Procedure

The experiment was divided into two sessions. In Session One, participants signed informed consent forms and worked through a computerized study session in Media Lab. All participants were instructed to read through the science text passage for seven minutes and to continue reading for the whole time, even if they finished their initial reading of the text before the seven minutes ended. Participants were randomly assigned to one of three study conditions: rereading, practice retrieval, or self-explanation.

Rereading Condition

After the initial reading session, participants in the rereading condition completed a word search filler activity for ten minutes, then reread the science text passage from the first session, this time for ten minutes.

Practice Retrieval Condition

After the initial reading session, participants in the practice retrieval condition also completed the word search filler activity for ten minutes. Next, they were instructed to type as much of the information as they could remember, without concern for exact wording or ordering of the concepts, for ten minutes. This constituted a free-recall prompt and an opportunity to practice retrieving the previous information without feedback, as used in previous research (Roediger & Karpicke, 2006).

Self-Explanation Condition

After the initial reading session, participants in the self-explanation condition underwent a brief self-explanation training procedure, in order to demonstrate the concept of self-explanation and to allow them the opportunity to practice using it without time pressure. Participants had up to 15 minutes to finish their training. Participants then were exposed to distinct, consecutive segments of the original passage and were instructed to read and self-explain after reading each segment. They were provided space on the screen immediately following each idea segment in which to type their self-explanations. After each self-explanation was completed, a new idea segment was presented; there were a total of nine idea segments comprising the entire passage, to be self-explained within ten minutes. Once the time ran out, participants who were not finished self-explaining were allowed to finish only the current idea segment. Participants were then moved on to the next part.

After all participants completed this second study period, they all completed demographic information and were invited to return for Session Two.

Session Two took place exactly one week after Session One. Participants took a short-answer test measuring their knowledge of the human ear from the science text passage from Session One (Adapted from Karpicke & Blunt, 2011). Participants were given 20 minutes to complete the test. Participants were then compensated for their participation and dismissed.

Results

There were no differences in GPA, $F(2, 78) = .80$, $p = .453$, or in ACT score, $F(2, 78) = 1.76$, $p = .178$, across the conditions, indicating that the conditions were equivalent in academic ability prior to the experimental manipulations.

Final Test

Participants' responses were scored by assigning 1 point to each correctly answered item, for a total of 15 possible points. The mean number of points earned by participants in each condition, is displayed in Figure 1 on page 9. Participants in the self-explanation condition ($M = 4.67$, $SD = 2.18$) correctly answered more verbatim recall items than participants in either the practice retrieval ($M = 3.39$, $SD = 2.30$) or rereading condition ($M = 3.92$, $SD = 2.69$). A one-way ANOVA revealed a significant effect of condition on verbatim test performance, $F(2, 78) = 3.87$, $p = .025$, partial eta squared = .094. Bonferroni pairwise comparisons were conducted and indicated a significant difference between the self-explanation and practice retrieval conditions, p = .04. There was no significant difference found in the other verbatim score comparisons.

The rereading group (M = 2.46, SD = 1.41) scored slightly higher on the inference items than the practice retrieval group (M = 2.24, SD = 1.46), followed by the self-explanation group (M = 2.00, SD = 0.94). A one-way ANOVA revealed no significant effect of condition on inference item performance, $F(2, 78) = 0.30$, p = .745, partial eta squared = .008. The majority of the differences in total test scores between conditions, then, are explained by the differences in verbatim scores. No significant effect of condition was found among participants' total test scores, $F(2, 78) = 1.68$, p = .193, partial eta squared = .041.

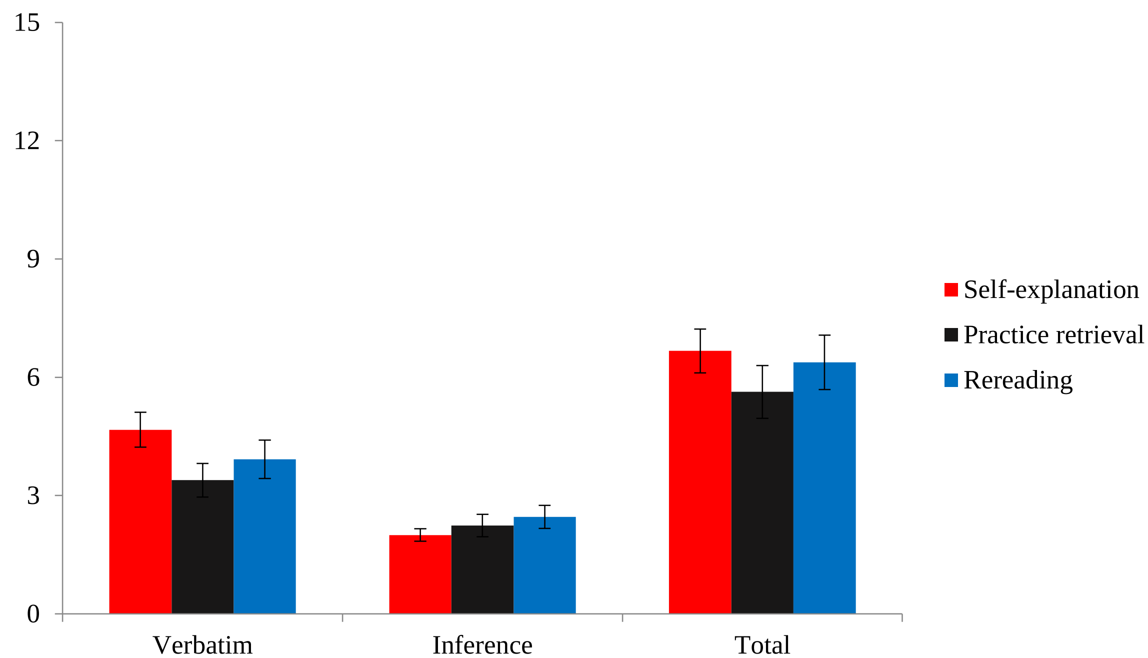

Figure 1. Mean number of items correctly answered on each portion of the test as a function of study condition. Error bars represent standard errors of the means. (n = 27, 28, & 24, respectively)

Discussion

Contrary to our hypothesis, students who practiced retrieving information from a science passage did not perform any better on a final test than did the students who merely read the passage and reread it. Students who self-explained the information, however, did perform better on verbatim recall questions than did students who practiced retrieving the information on a free recall practice test.

This result is noteworthy, because it highlights some interesting implications for practice retrieval as a study method. In our study, participants were allotted ten minutes of filler activity between the initial study period and the study method period. Students in the practice retrieval group waited ten minutes after their exposure to the information before they could ever begin to practice retrieving it. It is quite possible that much of the information gleaned from the initial reading was lost during this ten-minute filler period, which is a longer filler period than the two minutes employed by previous studies involving the practice retrieval method (Roediger & Karpicke, 2006). The difference between two versus ten minutes of filler appears to play a role in how practice retrieval affects the storage and retrieval of information. Indeed, many of the participants who practiced retrieving the information initially typed a great amount of information into the computer, but after a few minutes, they would slow down considerably, seemingly unable to remember anything else that they had read. As previously mentioned, studies have found that any information not recalled on the practice test will most likely not be recalled on any future tests (Roediger & Karpicke, 2006). This should be taken into account in future research that employs the practice retrieval method, so that waiting periods between encoding and retrieval can be optimized.

The finding that self-explanation improved recall for verbatim questions but not inference questions is interesting, as it suggests that there may be a difference in how college students self-explain verbatim information versus information constructed through inference-making. Inferences generally require a deeper level of processing from the student, which may not be necessary when students create self-explanations from the information presented. When a student recalls the information relevant to answering an inference question, s/he may remember the self-explanation constructed during the previous activity and not the exact wording or order of the information as it was presented in the passage. If self-explanation does not hinder inference-making during study, our data suggest that it at least does not aid students with inference generation after a substantial delay.

It is also possible that college students can use self-explanation to construct inferences effectively, but not without a proper allotment of time and instructional resources. The students in the current study were given 10 minutes to learn and master the self-explanation method before applying it to information for study. These conditions are significant because they show that students may benefit from even a small investment of time by an instructor to strengthen their study skills through the teaching of an applicable method, such as self-explanation. Students may benefit further from additional time being devoted to the demonstration and practice of self-explanation; future researchers may wish to investigate the benefit of self-explanation under various conditions of instruction.

Students were also given only ten minutes to self-explain the entire passage that they had read previously, divided into 9 segments of one or two sentences each. Many students did not finish self-explaining before their time was up, suggesting that self-explanation may require a larger time investment during student study periods than the other study methods examined in this experiment. If students were given more time to self-explain the entire passage, it may have been possible for them to make more inferential connections, though this cannot be determined from the current study's data. Future researchers may wish to compare conditions in which students either work at their own pace or are under a time constraint when self-explaining.

A limitation of the current study is the length of its total run time. Students will not maintain information in short-term memory for one week, but it would be interesting to have observed the level of forgetting observed over a more extensive time frame, perhaps one month to a full semester after initial study. Students often must maintain knowledge of course materials for great lengths of time, between the initial lecture and the final test at the end of a semester. Additionally, our procedure did not vary the study period length to examine a possible effect or interaction of time spent using a study method. As previously mentioned, self-explanation's effectiveness may benefit from additional temporal and instructional resources.

Conclusion

Students who use self-explanation as a study method may have an advantage over their counterparts who practice test themselves during study periods, but self-explanation is in need of further research in order to determine whether it is superior to rereading for students who may encounter verbatim or inference-based questions (or both) on an exam. We have shown here that practice retrieval may have some limitations to its effectiveness, and that self-explanation has some benefits over practice retrieval, with the proper time investment. If students cannot find an effective way to make use of the practice retrieval and self-explanation methods with the time that they have, they will continue to use rereading due to its simplicity and ease of use. Thus, it is important to continue research on the study methods of practice retrieval and self-explanation, in order to clarify the conditions under which they are most effective.

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