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Research Article

The Read-Recite-Review Study Strategy

Effective and Portable

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ABSTRACT—*Two experiments with college students investigated the effectiveness of the 3R (read-recite-review) strategy for learning from educational texts. The 3R strategy was compared with rereading and note-taking study strategies using free-recall, multiple-choice, and short-answer inference tests immediately after study and after a 1-week delay. In Experiments 1 and 2, 3R improved immediate and delayed free recall of fact-based passages, relative to the rereading and note-taking strategies. In Experiment 2, which used longer, more complex passages on engineering topics, performance on multiple-choice and problem-solving items was better in the 3R than in the rereading condition, and was equivalent in the 3R and note-taking conditions, though 3R took less study time than note taking. An inherent advantage of 3R relative to other testing methods for improving learning is that 3R is under the learner's control. These results indicate that it is also an efficacious study technique that capitalizes on the mnemonic potency of retrieval and feedback.*

The preferred study strategies for college students are note taking (99% of college students report taking notes; Palmatier & Bennet, 1974) and rereading text or notes (Karpicke, Butler, & Roediger, in press). Although research shows that note taking is generally effective for learning and retention (Dyer, Riley, & Yekovich, 1979; Einstein, Morris, & Smith, 1985; Fox & Siedow, 1985; Jonassen, 1984), there is a body of empirical work suggesting that retrieval produces robust mnemonic benefits that exceed those of additional study (see Carpenter & DeLosh, 2006; M. Carrier & Pashler, 1992; Kang, McDermott, & Roediger, 2007; McDaniel & Masson, 1985; Roediger & Karpicke, 2006b). More recently, on the basis of this evidence, researchers have suggested that testing (i.e., requiring retrieval) may be an especially effective method for improving learning (Karpicke & Roediger, 2008; McDaniel, Anderson, Derbish, & Morrisette, 2007; McDaniel, Roediger, & McDermott, 2007), and have recommended that instructors introduce more quizzing into their courses (Leeming, 2002; Pashler, Bain, et al., 2007).

Thus far, however, the learning benefits of testing have been demonstrated relative to reread control conditions, which do not necessarily reflect students' typical study strategies, such as note taking. Before enthusiastically endorsing testing as a preferred learning method, it is important to compare its effectiveness and efficiency with that of the commonly used and generally effective strategy of note taking. Another critical consideration is that the applicability of testing is limited because testing is externally driven. Students will profit from the advantages of testing only in classes in which instructors are willing to give up valuable class time in order to administer quizzes. Accordingly, an effective learner-controlled testing method would have multiple advantages. For instance, such a method could be portable to all learning settings, both formal and informal.

The learner-controlled testing method that we implemented in this study required learners to read the text, set the text aside and recite out loud all that they could remember, and then read the text a second time (the read-recite-review strategy, termed *3R*). This strategy is a truncated version of Robinson's (1941) SQ3R (survey, question, read, recite, review) method, which also included prereading processes designed to aid readers' comprehension of the text. Research on the full SQ3R approach has been sparse; the most rigorous examination was conducted by Martin (1985), who trained participants in either the SQ3R method or the REAP (reader-specific practice) method, a competing study technique also aimed at improving text comprehension. After training participants for 9 weeks, Martin found

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that the SQ3R group performed significantly better than the REAP group on measures of reading comprehension. In general, the few studies of SQ3R have used extensive training procedures and shown mixed results (see Adams, Carnine, & Gersten, 1982; Darch, Carnine, & Kameenui, 1986).

In another experiment, subjects were instructed to study a 10-paragraph passage by reading, covertly recalling, and reviewing one paragraph at a time (Orlando & Hayward, 1978). This 3R procedure produced improved performance on an immediate, but not a delayed, short-answer test compared with reading the passage twice in succession. Performance of subjects in the 3R group did not differ from that of subjects who read and took notes on the passage.

Though the extant experimental evidence favoring the 3R method is inconclusive and limited at best, several features of the 3R procedure suggest that it should be quite effective. First, 3R is easier to teach to students than the full SQ3R method and is less effortful for students to apply. Second, the 3R strategy incorporates retrieval shortly after study, a condition that maximizes the amount of information retrieved (cf. Kang et al., 2007). Third, the recitation phase provides an assessment that the learner can use to guide his or her efforts during review (rereading). This may be particularly important, as previous research has shown that rereading has minimal benefits in the absence of assessment (Callender & McDaniel, 2009). Finally, the second reading provides immediate feedback on the free-recall test. Because immediate feedback has been shown to bolster the testing effect (McDaniel & Fisher, 1991; Pashler, Cepeda, Wixted, & Rohrer, 2005), it is likely that this component augments the benefits of the 3R strategy.

EXPERIMENT 1

In the first experiment, we contrasted the 3R study condition with two conditions reflecting study activities that college students typically implement. In one of those conditions, participants read the text twice. Rereading is one of the more common study methods students report using (L.M. Carrier, 2003; Goetz & Palmer, 1991); indeed, in a survey of 170 students at a select private institution, 55% listed rereading as their primary strategy (Karpicke et al., in press). In the other comparison condition, participants took notes during their readings of the text. As mentioned earlier, this is also a commonly used study strategy, and one that typically produces learning benefits. The effects of the three study strategies were evaluated on free-recall, multiple-choice, and inference tests.

Method

Design and Participants

The participants were 72 undergraduates enrolled in a psychology course at Washington University in St. Louis. They participated in partial fulfillment of a course requirement or for a payment of $15. Twenty-four students were randomly assigned to each of the three study conditions. The *reread-only* group read each passage twice without engaging in any other activities; the *note-taking* group read each passage twice and took notes on a separate sheet of paper during reading; and the *3R* group read each passage once, engaged in an immediate verbal free-recall test, and then read the passage a second time.

Materials

Each participant read four brief prose passages taken from a test-preparation book for the Test of English as a Foreign Language (Rogers, 2001). Each passage was divided into 30 idea units or propositions and contained between 221 and 283 words. Pilot testing showed that the passages did not vary on average free recall or reader interest levels (see also Roediger & Karpicke, 2006b). The order in which participants read the passages was counterbalanced.

Procedure

Participants were told that they would read each of the four passages first and that they would be tested only after reading all four. They were then given study instructions pertinent to their condition. Participants in the note-taking group were instructed to read each passage twice and to take notes on the passage while they were reading. They were told that the notes were only to help their memory for the material and that they would not be allowed to use their notes on the final tests. Participants in the 3R group were told that they would read each passage once, recite as much as they could remember from the passage into a tape recorder, and then read the passage a second time. Finally, participants in the reread-only group were simply instructed to read each passage twice. All groups were given as much time as they desired to read the passages.

After receiving the appropriate instructions, participants read the four passages. Next, they spent 3 min solving arithmetic problems and completed a basic demographics questionnaire. Then, for the first and third passages read, participants completed a free-recall test, a multiple-choice test (consisting of six questions, each with four alternative choices), and three short-answer inference questions (which required synthesizing two or more ideas from the passage in order to provide the correct answer), in that order.

Finally, participants returned after 1 week and completed the same three tests on all four passages. Thus, after the 1-week delay, participants were retested on two of the passages and were tested for the first time on the other two.

Results

All statistical tests were carried out at the .05 level of significance. Table 1 reports participants' mean performance on the tests.

TABLE 1
Mean Correct Performance in Experiment 1

Test format and condition	Immediate testing	Delayed testing	
		Previously untested material	Previously tested material
Free recall			
3R	.63 (.13)	.33 (.14)	.53 (.15)
Note taking	.51 (.19)	.21 (.14)	.37 (.18)
Rereading	.46 (.18)	.16 (.10)	.33 (.17)
Multiple choice			
3R	.88 (.14)	.67 (.22)	.83 (.14)
Note taking	.90 (.08)	.69 (.16)	.89 (.10)
Rereading	.82 (.18)	.66 (.20)	.78 (.20)
Short answer			
3R	.83 (.13)	.70 (.19)	.86 (.14)
Note taking	.78 (.17)	.73 (.19)	.79 (.18)
Rereading	.84 (.16)	.65 (.19)	.82 (.18)

Note. The table presents the proportion of idea units correctly recalled on the free-recall test and the proportion of correct responses on the multiple-choice test and the short-answer test. Standard deviations are given in parentheses. 3R = read-recite-review strategy.

Study Time

Total processing time (reading, reading plus taking notes, or reading plus reciting) across the four passages was tabulated for each participant. (Because of experimenter error, study times were not available for 2 participants in the note-taking group and 1 participant in the reread-only group.) A one-way analysis of variance (ANOVA) on these data indicated that there was a significant effect of study condition on study time, $F(2, 66) = 10.89$, $\eta_p^2 = .25$, $p < .001$. Least significant difference (LSD) post hoc analyses revealed that participants in the note-taking condition spent significantly more time studying (reading plus taking notes) the passages ($M = 17.5$ min) than participants in the 3R (reading plus reciting; $M = 13.5$ min; $p < .05$) and reread-only ($M = 9.2$ min; $p < .001$) conditions. In addition, study time was significantly longer in the 3R than the reread-only condition ($p < .05$).

Free-Recall Performance

We conducted two ANOVAs for each criterion measure (free recall, multiple-choice questions, short-answer questions). The first 3 × 2 mixed ANOVA included study condition as the between-subjects variable and time of test (immediate, delayed) as the within-subjects variable. For this ANOVA, the performance data for the delayed test were taken only from the passages that had not been included on the immediate test. The second 3 × 2 mixed ANOVA examined performance only on the 1-week-delayed test. This ANOVA included study condition as the between-subjects variable and presence of a prior test (whether or not that passage had been tested the week before) as the within-subjects variable.

The average proportion of idea units (out of 60) correctly recalled from the two passages in each experimental condition was tabulated for each participant. As expected, the first ANOVA showed that recall was significantly higher when testing was immediate rather than delayed, $F(1, 69) = 328.70$, $\eta_p^2 = .83$, $p < .001$. More important, study condition significantly influenced recall levels, $F(2, 69) = 10.80$, $\eta_p^2 = .24$, $p < .001$, and this main effect did not interact with time of the initial test ($F < 1$). LSD post hoc analyses indicated that the 3R group performed significantly better than each of the other two groups ($ps < .05$). There was no significant difference in recall between the note-taking and reread-only conditions.

The second ANOVA, which evaluated the influence of 3R on retention, indicated that participants' free recall was better when an immediate test preceded the 1-week-delayed test than when there was no immediate test (i.e., a testing effect), $F(1, 69) = 165.10$, $\eta_p^2 = .70$, $p < .001$. There was again a significant main effect of study condition, $F(2, 69) = 11.42$, $\eta_p^2 = .25$, $p < .001$, such that participants in the 3R group demonstrated significantly higher recall levels than did participants in the reread-only and note-taking groups (as indicated by LSD analyses; $ps < .001$). This effect did not interact with prior testing.

Multiple-Choice Performance

The proportion of correct multiple-choice responses was analyzed with ANOVAs paralleling those described for the analysis of free recall. The first ANOVA showed that performance was better for the immediate test than for the 1-week-delayed test (with no prior initial test), $F(1, 69) = 57.93$, $\eta_p^2 = .46$, $p < .001$. However, there was no effect of study condition, $F(2, 69) = 1.04$, and no interaction between time of test and study condition ($F < 1$).

For the delayed testing, there was a significant testing effect, $F(1, 69) = 45.44$, $\eta_p^2 = .40$, $p < .001$, such that performance

on the 1-week-delayed test was higher for material that had been tested previously than for material that had not been tested previously. There was no main effect of study condition, $F(1, 69) = 1.52$, and no interaction between prior testing and study condition ($F < 1$).

Short-Answer Performance

The first ANOVA on performance on the short-answer inference tests revealed that participants performed better on the immediate test than on the delayed test (with no prior initial test), $F(1, 69) = 24.93$, $\eta_p^2 = .26$, $p < .001$. As was the case for multiple-choice performance, there was no effect of study condition ($F < 1$) and no significant interaction between study condition and time of test, $F(2, 69) = 2.44$. The ANOVA that focused on delayed testing revealed a significant testing effect, with delayed test performance improved when an immediate test preceded the delayed test, $F(1, 69) = 21.54$, $\eta_p^2 = .24$, $p < .001$. There was no effect of study condition and no interaction between prior testing and study condition (largest $F = 1.40$).

3R Recitation Performance

The verbal recitations of participants in the 3R group were scored for the percentage of idea units recalled. Participants recalled 10.0% to 80.8% of the idea units, with a mean of 52.4%. Mean recall was significantly lower during the recitation phase than during the immediate free-recall test, $F(1, 23) = 11.78$, $\eta_p^2 = .34$, $p < .005$, indicating that participants in the 3R condition did learn more information about the passages during the second reading. We conducted a conditional probability analysis to determine the likelihood that an item recalled during the recitation phase would also be recalled during the immediate free-recall test. This analysis indicated that the likelihood of being recalled on the immediate free-recall test was 87.5% for recited items, but 37.8% for nonrecited items.

Note-Taking Performance

The notes taken by the participants in the note-taking group were analyzed for the quantity of idea units written down. Participants noted between 2.0% and 93.3% of the idea units, with a mean of 40.3%. We also conducted a conditional probability analysis to determine the influence that noting a particular idea unit had on the probability that that idea unit would be recalled on the immediate free-recall test. Noted ideas were recalled at a rate of 75.4%, whereas nonnoted ideas were recalled at a rate of 31.6%.

Discussion

The most notable finding of Experiment 1 was the significant benefit to free-recall performance displayed by participants who used the 3R strategy, relative to those who used the rereading and note-taking strategies. These free-recall benefits for immediate testing and for testing after a week-long delay (for both material that had been tested immediately and material that had not been tested immediately) are the first such advantages to be reported for 3R (cf. Orlando & Hayward, 1978). However, the benefits of the 3R strategy did not extend to multiple-choice or short-answer inference questions.

EXPERIMENT 2

Experiment 1 used four short, simple passages that consisted entirely of factual information. In Experiment 2, we explored whether the benefits of the 3R strategy might extend to criterial measures other than free recall when the learning materials are more relationally complex, describing mechanical devices. Mayer and Gallini (1990) demonstrated that when participants are given schematic illustrations designed to promote learning of a mental model of the operation of a mechanical device (e.g., brakes) described in the text, performance on inference tests improves. It seems reasonable that recitation and review may encourage the development of more cohesive mental models and thus produce benefits that extend beyond improved free recall to performance on inference and problem-solving questions.

Method

Design and Participants

The participants were 72 undergraduates enrolled in psychology courses at Washington University in St. Louis. They participated in partial fulfillment of a course requirement or for a payment of $15. Twenty-four students were randomly assigned to each of the same three study conditions used in Experiment 1 (note-taking, 3R, and reread-only).

Materials and Procedure

Each participant read two passages taken from articles in *The World Book Encyclopedia* and used by Mayer and Gallini (1990). The "Pumps" passage consisted of 93 idea units and 864 words, and the "Brakes" passage consisted of 100 idea units and 915 words.

Participants in all three conditions were told that they would be reading two educational texts and were then given the study instructions used in Experiment 1. Next, participants read the passages in a self-paced fashion. The order of the passages was counterbalanced in each study condition. Participants then spent 3 min solving arithmetic problems and completed the demographics questionnaire. Next, for the first passage read, participants were given (a) a free-recall test, (b) a multiple-choice test containing eight four-alternative forced-choice questions (four questions tested factual knowledge and four tested inferential knowledge), and (c) four problem-solving items (i.e., short-answer inference questions, such as "What could be done to make brakes more effective, that is, to reduce the distance needed to stop"; see Mayer & Gallini, 1990, for further examples). Finally, participants returned after 1 week

and completed all three tests for both passages. Thus, after the 1-week delay, the participants were retested on one of the articles and tested for the first time on the other article.

Results

Study Time

A one-way ANOVA indicated that there was a significant effect of study condition on time spent studying the passages, $F(2, 67) = 4.15$, $\eta_p^2 = .11$, $p < .05$. LSD post hoc analyses revealed that participants in the note-taking condition spent significantly more time reading the passages ($M = 25.4$ min) than did those in the 3R ($M = 21.5$ min) and reread-only ($M = 20.9$ min) conditions ($ps < .05$).

Free-Recall Performance

For each criterion measure, we conducted two ANOVAs paralleling those in Experiment 1. Participants' free recall of the passages was scored for the percentage of idea units that were correctly recalled. The 3 (study condition) × 2 (time of initial test) mixed ANOVA indicated that performance was better immediately than after a delay, $F(1, 69) = 125.79$, $\eta_p^2 = .65$, $p < .001$ (see Table 2 for means). There was also a significant effect of study condition, $F(2, 69) = 13.14$, $\eta_p^2 = .14$, $p < .05$. LSD post hoc analyses indicated that the 3R group performed significantly better than the note-taking and reread-only groups ($ps < .05$). Performance did not differ significantly between the reread-only group and the note-taking group.

The second ANOVA, which focused on delayed free recall, revealed that immediate testing enhanced delayed recall, $F(1, 69) = 39.23$, $\eta_p^2 = .36$, $p < .001$, and that recall was better in the 3R condition than in the other two study conditions, $F(2, 69) = 14.19$, $\eta_p^2 = .29$, $p < .001$ (LSD pair-wise comparisons confirmed the pattern). There was no interaction between prior testing and study condition ($F < 1$).

Multiple-Choice Performance

Because there were no significant performance differences between the fact-based and inference-based types of multiple-choice questions for any of the three study conditions, we collapsed over multiple-choice question type for the analyses reported here. The first ANOVA on the multiple-choice data indicated that performance was better on the immediate test than on the delayed test (with no prior test), $F(1, 69) = 57.63$, $\eta_p^2 = .46$, $p < .001$ (see Table 2 for means). More important, there was a significant effect of study condition on multiple-choice performance, $F(2, 69) = 4.52$, $\eta_p^2 = .12$, $p < .05$. LSD post hoc analyses indicated that the 3R group performed significantly better than the reread-only group ($p < .05$). There were no other significant pair-wise differences.

The second ANOVA, which focused on delayed testing, revealed that delayed multiple-choice performance was significantly better for material that had been tested immediately than for material that had not been tested immediately, $F(1, 69) = 45.71$, $\eta_p^2 = .40$, $p < .001$. On delayed testing, 3R had a significant advantage relative to rereading and note taking, $F(2, 69) = 5.44$, $\eta_p^2 = .14$, $p < .01$; performance did not differ between the rereading and note-taking conditions (as revealed by LSD comparisons). There was no interaction between presence or absence of prior testing and study condition, $F(2, 69) = 1.85$.

Problem-Solving Performance

Both ANOVAs on problem-solving performance revealed a significant effect of study condition, $F(2, 69) = 6.75$, $\eta_p^2 = .16$,

TABLE 2

Mean Correct Performance in Experiment 2

Test format and condition	Immediate testing	Delayed testing	
		Previously untested material	Previously tested material
Free recall			
3R	.22 (.10)	.09 (.05)	.15 (.09)
Note taking	.12 (.07)	.03 (.02)	.07 (.05)
Rereading	.17 (.10)	.04 (.02)	.10 (.07)
Multiple choice			
3R	.72 (.18)	.59 (.24)	.74 (.20)
Note taking	.70 (.20)	.49 (.20)	.62 (.19)
Rereading	.63 (.23)	.38 (.21)	.62 (.24)
Problem solving			
3R	.51 (.24)	.44 (.22)	.50 (.22)
Note taking	.52 (.26)	.39 (.27)	.47 (.26)
Rereading	.37 (.19)	.30 (.21)	.39 (.20)

Note. The table presents the proportion of idea units correctly recalled on the free-recall test, the proportion of correct responses on the multiple-choice test, and the proportion of points earned on the problem-solving test. Standard deviations are given in parentheses. 3R = read-recite-review strategy.

$p < .05$, and $F(2, 69) = 5.03$, $\eta_p^2 = .13$, $p < .01$ (see Table 2). LSD post hoc analyses revealed that for both initial testing (performance collapsed across immediate testing and delayed testing with no prior test) and delayed testing, the 3R and note-taking groups performed significantly better than the reread-only group ($ps < .05$). For initial testing, there was no significant effect of time of test ($F = 3.94$, $p < .10$) and no interaction between study condition and time of test ($F < 1$). For delayed testing, there was no significant benefit of a prior immediate test ($F = 3.03$, $p < .10$) and no interaction between study condition and presence or absence of a prior test ($F < 1$).

3R Recitation Performance

The verbal recitations of participants in the 3R group were scored for the percentage of idea units recalled. Participants recalled between 5.4% and 42.2% of the idea units, with a mean recollection of 15.7%. As in Experiment 1, participants in the 3R condition recalled more on the immediate free-recall test than during verbal recitation, $F(1, 23) = 18.85$, $\eta_p^2 = .45$, $p < .001$, again providing evidence that they benefited from the second reading after the recitation phase. Conditional probability analyses indicated that during the immediate free-recall test, participants in the 3R condition recalled previously recited idea units at a rate of 60.8%, compared with a rate of 14.4% for nonrecited idea units.

Note-Taking Performance

The notes taken by the participants in the note-taking group were analyzed for the quantity of idea units written down. Participants noted between 3.2% and 69.8% of the idea units, with a mean of 29.6%. We conducted a conditional probability analysis to determine the influence that noting a particular idea unit had on the probability that that idea unit would be recalled on the immediate free-recall test. Noted items were recalled at a rate of 26.2%, and nonnoted items were recalled at a rate of 7.0%.

Discussion

Using longer and more complex passages than in Experiment 1, we again found that the 3R strategy had benefits for immediate and delayed recall, relative to both note taking and rereading only. A new finding in Experiment 2 is that the 3R strategy, relative to rereading only, yielded benefits for multiple-choice performance (on a test that included inference questions) and for problem solving. Thus, the consequences of 3R go beyond boosting performance on a criterial test that parallels recitation (i.e., free recall).

GENERAL DISCUSSION

The 3R study strategy capitalizes on the mnemonic benefits of testing and feedback. Two experiments revealed robust advantages of this strategy (relative to both rereading only and note taking) for free recall of both shorter and longer educational texts at both immediate and 1-week-delayed testing. These potent improvements are in line with previous research showing the mnemonic benefits of testing relative to study that involves reading only (McDaniel, Roediger, & McDermott, 2007; Pashler et al., 2005; Roediger & Karpicke, 2006b) and demonstrate that testing (recitation) produces benefits relative to note taking as well. This demonstration of the superiority of the 3R strategy for free recall at both immediate and delayed testing is important because note taking is a commonly used study strategy (Palmatier & Bennet, 1974), is presumed to be generative (Peper & Mayer, 1978), and has been shown to be effective (Dyer et al., 1979; Einstein et al., 1985; Fox & Siedow, 1985; Jonassen, 1984).

Additionally, in Experiment 2, the 3R method improved performance on inference items (some multiple-choice items and problem-solving questions), relative to rereading only. This finding suggests that 3R may promote deep learning of the material (perhaps construction of an effective mental model; cf. Mayer & Gallini, 1990), and may promote such deep learning more than reading alone does. Given that the focus of the testing-effect literature has been on retention (see Roediger & Karpicke, 2006a), an important implication of our results is that retrieval and feedback can have benefits beyond improving retention. The finding that note taking produced similar improvements on inference items (relative to rereading) reinforces the hypothesis that note taking is a generative study activity (Peper & Mayer, 1978). Nevertheless, the 3R method produced equivalent inference performance, but did so more efficiently (i.e., with significantly less study time).

The current findings were obtained in a laboratory setting, which raises the issue of whether learners' motivation levels were comparable to those in a more high-stakes setting (such as a classroom environment). If learners are in a more motivating setting and consequently are more conscientious in their study activities, would the effects of 3R be attenuated?[1] Given previous findings that level of processing does not interact with motivation level (as manipulated through financial rewards) in influencing learning (Craik & Tulving, 1975), we think it unlikely that higher motivation levels would attenuate the processing benefits of retrieval and feedback that are afforded by 3R.

The positive benefits of 3R for learning and retention are especially noteworthy when one considers that this is a learner-controlled testing activity. By contrast, research on testing effects has culminated in calls for increased instructor-provided testing (see Pashler, Bain, et al., 2007). A possible advantage of instructor-provided testing is that it can force spaced presentation of material, thereby promoting long-term retention (see Pashler, Rohrer, Cepeda, & Carpenter, 2007). Although the 3R method as implemented here did not space targeted content, this method does not preclude spacing. Moreover, the 3R method seems to be an easily learned method that can be performed efficiently, that can produce memory benefits as well as gener-

[1]We thank Hal Pashler for raising this issue.

ative learning, and that can be self-applied in both formal and informal learning settings. In formal educational settings, instructors or study guides (e.g., see Straub, 2007) might inform students about the 3R method, emphasizing that the effectiveness of the typical rereading approach to studying (e.g., see Callender & McDaniel, 2009) could be greatly improved by reciting before rereading. Students could be encouraged to implement the method for remembering information in assigned readings or for remembering information from class notes or handouts. Students may find 3R attractive because they can implement it without setting aside time for studying; that is, they can engage in 3R while exercising, waiting in lines, walking to class, and so on. In this regard, an open question is the extent to which delays between reading and recitation and between recitation and rereading affect the potency of the 3R method.

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REFERENCES

Adams, A., Carnine, D., & Gersten, R. (1982). Instructional strategies for studying content area texts in the intermediate grades. *Reading Research Quarterly*, *18*, 27–55.

Callender, A.A., & McDaniel, M.A. (2009). The limited benefits of rereading educational texts. *Contemporary Educational Psychology*, *34*, 30–41.

Carpenter, S.K., & DeLosh, E.L. (2006). Impoverished cue support enhances subsequent retention: Support for the elaborative retrieval explanation of the testing effect. *Memory & Cognition*, *34*, 268–276.

Carrier, L.M. (2003). College students' choice of study strategies. *Perceptual and Motor Skills*, *96*, 54–56.

Carrier, M., & Pashler, H. (1992). The influence of retrieval on retention. *Memory & Cognition*, *20*, 633–642.

Craik, F.I.M., & Tulving, E. (1975). Depth of processing and the retention of words in episodic memory. *Journal of Experimental Psychology: General*, *104*, 269–294.

Darch, C.B., Carnine, D.W., & Kameenui, E.J. (1986). The role of graphic organizers and social structure in content area instruction. *Journal of Reading Behavior*, *18*, 275–295.

Dyer, J.W., Riley, J., & Yekovich, F.R. (1979). An analysis of three study skills: Notetaking, summarizing, and rereading. *Journal of Educational Research*, *73*, 3–7.

Einstein, G.O., Morris, J., & Smith, S. (1985). Note-taking, individual differences, and memory for lecture information. *Journal of Educational Psychology*, *77*, 522–532.

Fox, B.J., & Siedow, M.D. (1985). An investigation of the effects of note taking on college students' recall of signalled and unsignalled text. *Journal of Research & Development in Education*, *18*, 29–36.

Goetz, E.T., & Palmer, D.J. (1991). The role of students' perceptions of study strategy and personal attributes in strategy use. *Reading Psychology*, *12*, 199–217.

Jonassen, D.H. (1984). Effects of generative text processing strategies on recall and retention. *Human Learning: Journal of Practical Research & Applications*, *3*, 241–256.

Kang, S.H., McDermott, K.B., & Roediger, H.L., III. (2007). Test format and corrective feedback modify the effect of testing on long-term retention. *European Journal of Cognitive Psychology*, *19*, 528–558.

Karpicke, J.D., Butler, A.C., & Roediger, H.L., III. (in press). Metacognitive strategies in student learning: Do students practice retrieval when they study on their own? *Memory*.

Karpicke, J.D., & Roediger, H.L., III. (2008). The critical importance of retrieval for learning. *Science*, *319*, 966–968.

Leeming, F.C. (2002). The exam-a-day procedure improves performance in psychology classes. *Teaching of Psychology*, *29*, 210–212.

Martin, M.A. (1985). Students' applications of self-questioning study techniques: An investigation of their efficacy. *Reading Psychology*, *6*, 69–83.

Mayer, R.E., & Gallini, J.K. (1990). When is an illustration worth ten thousand words? *Journal of Educational Psychology*, *82*, 715–726.

McDaniel, M.A., Anderson, J.L., Derbish, M.H., & Morrisette, N. (2007). Testing the 'Testing Effect' in the classroom. *European Journal of Cognitive Psychology*, *19*, 494–513.

McDaniel, M.A., & Fisher, R.P. (1991). Tests and test feedback as learning sources. *Contemporary Educational Psychology*, *16*, 192–201.

McDaniel, M.A., & Masson, M.E. (1985). Altering memory representations through retrieval. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *11*, 371–385.

McDaniel, M.A., Roediger, H.L., III, & McDermott, K.B. (2007). Generalizing test enhanced learning from the laboratory to the classroom. *Psychonomic Bulletin & Review*, *14*, 200–206.

Orlando, V.P., & Hayward, K.G. (1978). A comparison of the effectiveness of three study techniques for college students. In P.D. Peterson & J. Hansen (Eds.), *Reading: Disciplined inquiry in process and practice* (pp. 242–245). Clemson, SC: National Reading Conference.

Palmatier, R.A., & Bennet, J.M. (1974). Note-taking habits of college students. *Journal of Reading*, *18*, 215–218.

Pashler, H., Bain, P., Bottge, B., Graesser, A., Koedinger, K., McDaniel, M., & Metcalfe, J. (2007). *Organizing instruction and study to improve student learning: A practice guide* (NCER 2007-2004). Available from the U.S. Department of Education, Institute of Education Sciences, National Center for Education Research Web site: http://ies.ed.gov/ncee/wwc/pdf/practice guides/20072004.pdf

Pashler, H., Cepeda, N.J., Wixted, J.T., & Rohrer, D. (2005). When does feedback facilitate learning of words? *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *31*, 3–8.

Pashler, H., Rohrer, D., Cepeda, N.J., & Carpenter, S.K. (2007). Enhancing learning and retarding forgetting: Choices and consequences. *Psychonomic Bulletin & Review*, *14*, 187–193.

Peper, R.J., & Mayer, R.E. (1978). Note taking as a generative activity. *Journal of Educational Psychology*, *70*, 514–522.

Robinson, F.P. (1941). *Effective study*. New York: Harper and Brothers.

Roediger, H.L., III, & Karpicke, J.D. (2006a). The power of testing memory: Basic research and implications for educational practice. *Perspectives on Psychological Science*, *1*, 181–210.

Roediger, H.L., III, & Karpicke, J.D. (2006b). Test-enhanced learning: Taking memory tests improves long-term retention. *Psychological Science*, *17*, 249–255.

Rogers, B. (2001). *TOEFL CBT success*. Lawrenceville, NJ: Peterson's.

Straub, R.O. (2007). *Study guide to accompany David G. Myers' "Psychology"* (8th ed.). New York: Worth.

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