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Five Popular Study Strategies: Their Pitfalls and Optimal Implementations

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Abstract

Researchers' and educators' enthusiasm in applying cognitive principles to enhance educational practices has become more evident. Several published reviews have suggested that some potent strategies can help students learn more efficaciously. Unfortunately, for whatever reason, students do not report frequent reliance on these empirically supported techniques. In the present review, we take a novel approach, identifying study strategies for which students have strong preferences and assessing whether these preferred strategies have any merit given existing empirical evidence from the cognitive and educational literatures. Furthermore, we provide concrete recommendations for students, instructors, and psychologists. For students, we identify common pitfalls and tips for optimal implementation for each study strategy. For instructors, we provide recommendations for how they can assist students to more optimally implement these study strategies. For psychologists, we highlight promising avenues of research to help augment these study strategies.

Keywords

study strategies, self-regulated learning, education

Being able to effectively regulate study is an essential part of the educational experience. Indeed, it is plausible that as much, if not more, learning takes place outside the classroom as inside the classroom. As a result, equipping students with effective study strategies is vital to their educational success. Fortunately, recent interest in applying cognitive principles to enhance educational practices has produced a substantial literature on effective study strategies. A number of reviews have been published on empirically supported techniques by both cognitive and educational psychologists (Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013; Fiorella & Mayer, 2015; Mayer, 2008; Roediger & Pyc, 2012). Thus, the good news is that there are potent study strategies that can help students learn more efficaciously. The bad news, however, is that students do not often use the learning strategies that cognitive researchers have identified as being effective (Hartwig & Dunlosky, 2012; Karpicke, Butler, & Roediger, 2009; Kornell & Bjork, 2007; Wissman, Rawson, & Pyc, 2012; Yan, Thai, & Bjork, 2014). Self-report questionnaires typically find that students are not aware of the effectiveness of potent evidence-based study strategies and thus do not regularly implement them (McCabe, 2011). In addition, empirical studies suggest that students seek conditions that maximize their perceived understanding of the material at the moment of study rather than conditions that maximize their learning as indexed by later test results (for additional discussion on the distinction between performance and learning, see Soderstrom & Bjork, 2015). That is, students want to see rapid gains when they are studying and erroneously take these gains as actual understanding, thus preferring whatever study strategies support rapid gains.

Students appear to hold strong preferences for study techniques that they have used throughout their educational careers; consequently, attempts to sell them on new strategies may be met with resistance. Accordingly, we suggest that a fruitful alternative approach is to examine the effectiveness of the study strategies that students regularly implement and identify ways to augment these preferred study strategies. As a first step, we review the empirical evidence on the effectiveness of the study strategies that students *actually* use. An

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examination of students' self-reported study strategies yielded five popular strategies that students routinely prefer: (a) rereading, (b) highlighting or underlining, (c) note-taking, (d) outlining, and (e) using flash cards (Hartwig & Dunlosky, 2012; Karpicke et al., 2009; Kornell & Bjork, 2007; Wissman et al., 2012; Yan et al., 2014); casual observation on any college campus confirms these findings (for a summary of the frequency of use of these top five strategies, see Table 1).

Although a couple of these strategies (i.e., rereading and highlighting or underlining) have been reviewed elsewhere, they have typically been assessed relative to more effective strategies. For instance, Dunlosky et al. (2013) gave rereading and highlighting or underlining a low utility rating relative to other more potent techniques, such as testing and spaced practice. To a casual reader, this overall assessment suggests that rereading and highlighting or underlining should not be used in any educational context. Furthermore, because Dunlosky et al. focused on the general utility of these study strategies, they might have overlooked the possibility that these study strategies may be particularly effective (or commonly misused) in certain situations. Thus, less emphasis has been placed on how effective these strategies are relative to *no* study strategy. All five of the popular study strategies being reviewed here can be potent when properly used. Thus, a primary purpose of the present review is to emphasize the conditions under which these popular techniques do and do not foster effective learning and highlight ways in which they can be precisely prescribed.

We will cover each study strategy in turn, and each study-strategy section is organized into three subsections: *effective implementations*, *ineffective implementations*, and *educational recommendations*. We anticipate that this review will be beneficial for a wide audience, including students, educators, and psychologists. For students and educators, this review will shed some light on *how* and *when* these popular study strategies should be implemented to get the most from students' study time. With this purpose in mind, the Introduction and the Educational Recommendation subsections of each of the five sections are written with minimal technical terminology. For psychologists, our hope is that this review will create excitement about new lines of research on study strategies that are both theoretically interesting and—perhaps more important—educationally motivated.

Table 1. Meta-Analyzed Frequency of the Use of the Five Popular Study Strategies

Rereading (n = 1,517)	Highlighting (n = 1,517)	Note-taking (n = 595)	Outlining (n = 595)	Flash cards (n = 842)
78%	53%	30%	23%	55%

Note: The percentage values were computed by meta-analyzing Carrier (2003), Hartwig and Dunlosky (2012), Karpicke, Butler, and Roediger (2009), Kornell and Bjork (2007), Wissman, Rawson, and Pyc (2012), and Yan, Thai, and Bjork (2014). For each study strategy, the number of participants who reported the use of the strategy was divided by the total number of participants in the studies that included a question about that study strategy. Carrier's Exam 1 and Exam 2 were treated as separate surveys. For Kornell and Bjork (2007) and Yan et al. (2014), only the question "When you study, do you typically read a textbook/article/other source material more than once?" was considered. The answers "Yes, I reread whole chapters/articles" and "Yes, I reread sections that I underlined/highlighted/marked" were taken as the evidence of rereading, and "Yes, I reread sections that I underlined/highlighted/marked" was taken as the evidence of highlighting.

Rereading

A straightforward assumption is that rereading texts should yield benefits of repetition similar to that generally found in list-learning experiments (i.e., multiple exposures of words lead to better recall than a single exposure; e.g., Tulving, 1966; but for an interesting exception, see Mulligan & Peterson, 2015). Yet this assumption has not been investigated as extensively as one would imagine, given the popularity of rereading as a study strategy (e.g., Karpicke et al., 2009). Since the 1970s, cognitive and educational psychologists have typically endorsed study strategies that require active processing of complex materials such as texts (Segal, Chipman, & Glaser, 1985; Weinstein, Goetz, & Alexander, 1988; Wittrock, 1974). Thus, research on rereading has often taken a backseat to research focusing on more active study strategies because rereading may be passive in nature, at least in the manner in which students do it (for a different perspective based on laboratory studies, see Stine-Morrow, Gagne, Morrow, & DeWall, 2004). We posit that this may be the same reason why rereading is so popular among students. Because rereading does not necessarily require active and effortful processing of the text, it gives students the (false) sense that they are effectively learning the text (Roediger & Karpicke, 2006b; although see Rawson, Dunlosky, & Thiede, 2000). That is, the second reading of a text feels more fluent than the first reading, and the increased fluency is perceived by students, accurately or inaccurately, as an indication of successful learning (Rawson & Dunlosky, 2002). Nevertheless, as highlighted next, under certain conditions, rereading can benefit memory and comprehension.

Effective implementation

Rereading is particularly effective when the first and second readings are spaced out. A plethora of research in the verbal-learning literature has shown that spaced study (i.e., an intervening lag between study opportunities) produces superior memory performance relative to massed study (i.e., no intervening lag between study opportunities; for a recent review, see Cepeda, Pashler, Vul, Wixted, & Rohrer, 2006). In addition, this finding has been extended to text materials. For instance, Glover and Corkill (1987) had students read short paragraphs twice with either an immediate lag (massed group) or a 30-min lag (spaced group). They found that the spaced group was able to recall more of the content than the massed group on an immediate free-recall test (see also Krug, Davis, & Glover, 1990). However, Verkoeijen, Rikers, and Ozsoy (2008) found that too much spacing can be detrimental for text learning. Specifically, they compared a massed reread group with both a shorter-spaced reread group (i.e., 4 days) and a longer-spaced reread group (i.e., 3.5 weeks) and found that only the shorter-spaced reread group outperformed the massed reread group on a free-recall test after a 48-hr delay. The longer-spaced reread group was only able to recall as many details as the massed reread group, which suggests that the benefits of spacing diminish when the lag is too long.

To determine an optimal lag between the first and second readings, one must consider the retention interval. To this end, Rawson and Kintsch (2005) implemented a factorial design manipulating both lag and retention interval in four conditions: (a) immediate lag and immediate retention interval, (b) immediate lag and delayed retention interval, (c) long lag and immediate retention interval, and (d) long lag and delayed retention interval (see also Rawson, 2012). Their results indicated that long lags with a delayed retention interval benefited test performance (relative to a single reading), but long lags with an immediate retention interval yielded no benefits. Instead, with an immediate retention interval, the immediate lag but not the long lag condition yielded superior performance relative to a single reading. These results suggest that long lags between reading opportunities are vital for producing more durable learning (i.e., performance on delayed tests) relative to a single reading. However, under certain conditions (e.g., immediate tests), massed rereading may actually be more beneficial than spaced rereading.[1]

Ineffective implementation

As we have discussed above, spacing out the first and second readings is beneficial for long-term retention of the studied information. On the flip side, massing the readings (or cramming) has been shown to produce limited benefits (Rawson, 2012; Rawson & Kintsch, 2005). Unless the test is going to take place immediately after the second reading (which is unlikely in educational settings), it is not recommended that students engage in massed rereading.

Furthermore, although rereading has been shown to produce robust benefits for free recall and cued-recall tests (particularly if the readings are spaced apart), its benefits for higher order assessments (e.g., application-based, inference-based, or problem-solving tests) are less clear. Callender and McDaniel (2009) had participants read authentic textbook chapters either once or twice and found that (relative to a single reading) rereading did not improve performance on short-answer application questions or summary writing. However, Karpicke and Blunt (2011) compared groups that had different numbers of reading opportunities (i.e., one or four) and found that rereading enhanced performance for inference multiple-choice and short-answer application tests relative to a single reading. It is important to note that participants in the Karpicke and Blunt study were allowed to restudy the passage four times, and the passages were much shorter (i.e., approximately 300 words) than those typically assigned in college classes. As a result, the Karpicke and Blunt study may not have captured the complexity of typical text comprehension at the college level.

Educational recommendations

The major advantage of rereading over most study strategies is that it does not require training. However, its benefits can be enhanced. For immediate tests, massed rereading is an effective strategy for helping learners pick up additional details and facts that might have been missed during the first reading (Amlund, Kardash, & Kulhavy, 1986; Barnett & Seefeldt, 1989; Glover & Corkill, 1987; Haenggi & Perfetti, 1992; but see Callender & McDaniel, 2009). Thus, for assessments that require memorization of key information, rereading can be an effective study strategy. However, for assessments that require students to integrate key information and make inferences from the texts, rereading appears to be less effective. Another takeaway is that spaced rereading is useful for producing durable learning in educational settings; durable learning is important when studying for comprehensive exams later in the semester, forming a strong foundation for future coursework that builds on prior classes, or preparing for a standardized test that covers an array of content (e.g., SAT, MCAT, GRE). On the other hand, if the goal is to do well on an immediate exam, then rereading right before the exam (cramming) may be sufficient.

In addition, retrieving the read contents before rereading bolsters learning (McDaniel, Howard, & Einstein, 2009), probably because the retrieval attempt provides learners with feedback about what they know and do not know (Little & McDaniel, 2015). This increased metacognitive accuracy can guide more effective and focused rereading during further study compared with additional retrieval practice (McDaniel, Bugg, Liu, & Brick, 2015, Experiment 2). Simply recommending to students that they incorporate retrieval practice into their study routines may not prompt much change in students' study activities. For example, even when an instructor set up an online quiz and told his students about the benefit of practice testing, his students' participation in the practice testing was very poor (Trumbo, Leiting, McDaniel, & Hodge, 2016). However, encouraging students to incorporate retrieval practice into their preexisting routine, such as rereading, might meet with less resistance from students (see also the General Discussion section).

The effectiveness of rereading might be further enhanced by training students on reading strategies. For instance, McNamara, O'Reilly, Best, and Ozuru (2006) provided students with a computerized trainer called Interactive Strategy Trainer for Active Reading and Thinking (iSTART), which consisted of an interactive agent training students on self-explanation and five reading strategies (i.e., comprehension monitoring, paraphrasing, prediction, elaboration, and bridging). They found that iSTART improved students' reading comprehension relative to that of a group of students who just received a brief demonstration of how to self-explain texts. Although these results suggest that rereading might not be necessary if the reader can successfully comprehend the text the first time around, we posit that rereading can be leveraged to improve studying if students are more skilled at particular aspects of reading, most notably metacomprehension. That is, if students were able to accurately monitor their comprehension while reading (e.g., after some training such as iSTART), rereading would presumably be more effective because it could target the missing gaps in the student's knowledge.

Underlining and Highlighting (Marking)

Underlining or highlighting parts of a text is one of the most popular study strategies among students because of its ease of use (Cioffi, 1986; Gurung, Weidert, & Jeske, 2010). The belief that this strategy can improve comprehension is so pervasive that even as early as the 5th grade, students spontaneously underline (Brown & Smiley, 1978). Both underlining and highlighting are believed to benefit learning in two ways: (a) Selecting what is important in the text elicits elaborative thinking (*generative function*), and (b) underlining and highlighting important sections makes it easier to identify them later (*storage function*). Because underlining and highlighting essentially function through the same mechanism, we will hereafter refer to them collectively as *marking* for brevity.

The literature on marking largely consists of two types of experimental designs: learner-generated marking and experimenter-provided marking. In learner-generated-marking experiments, participants mark texts as they read, whereas in experimenter-generated-marking experiments, participants read texts that are already marked. We will focus primarily on the learner-generated marking research to assess the effectiveness of marking as a self-regulated study strategy, but we supplement our literature review with research from experimenter-provided and other marking research, where appropriate.

Effective implementation

Learner-generated marking has been shown to be effective for a variety of assessments, such as multiple-choice tests (e.g., Leutner, Leopold, & Den Elzen-Rump, 2007), free-recall tests (Rickards & August, 1975), short-answer tests (Amer, 1994; Blanchard & Mikkelson, 1987), fill-in-the-blank tests (Yue, Storm, Kornell, & Bjork, 2015), and essay questions (Annis & Davis, 1978; Davis & Annis, 1978; but see Idstein & Jenkins, 1972; Rickards & Denner, 1979; Todd & Kessler, 1971).

There is strong evidence from experimenter-provided marking studies that students can recall the marked information better than unmarked information (Blalick, Blalick, & Wark, 1977; Cashen & Leicht, 1970; Crouse & Idstein, 1972; Hartley, Bartlett, & Branthwaite, 1980; Klare, Mabry, & Gustafson, 1955; Leicht & Cashen, 1972; Lorch, Lorch, & Klusewitz, 1995; Nist & Hogrebe, 1987). Moreover, evidence from studies of learner-generated marking is consistent with this trend (Blanchard & Mikkelson, 1987; Fowler & Barker, 1974).

The question, then, is this: Can students accurately select and mark important information? There seems to be great variability in students' abilities to effectively mark texts. Generally speaking, students' marking behaviors are largely ineffective; they often mark too little or mark noncritical information (Nist & Kirby, 1989). However, high-skilled readers can more selectively mark relevant information as determined by instructors' marking of the same text (Bell & Limber, 1938).

The good news is that students can be taught an effective marking strategy in as little as 60 min. Four published studies (Amer, 1994; Dumke & Schäfer, 1986; Leutner et al., 2007; Schnell & Rocchio, 1978) and an unpublished dissertation (Willmore, 1966) have all shown benefits of marking after training. These successful training programs had students learn a particular marking strategy and then practice applying that strategy. Although the marking strategies taught in these studies varied slightly, one critical feature among them was that students were instructed not to mark the text during their first reading. Rather, marking should occur after a learner finishes reading at least a section of the text. Withholding marking until after an initial read allows the learner to use the first read to identify the key points to be marked, thus eliciting active, elaborative processing of the text. Typically, marking training is conducted in a class format or as a group lesson, but it can also be computerized (Leutner et al., 2007). Although relatively extensive training (five 90-min sessions) has been successfully conducted (Amer, 1994), a 1- or 2-hr training session can be enough to produce benefits (Leutner et al., 2007; Schnell & Rocchio, 1978).

Another approach to improve the effectiveness of marking is through training focused on the text structure (i.e., how the text is organized). Meyer, Young, and Bartlett (1989/2014) showed that teaching students how to outline effectively by identifying various text structures made them able to mark more main ideas than details, a tendency displayed by more expert readers with high vocabulary and higher education (e.g., Meyer & Rice, 1989). More detailed discussions on text structure and its relevance to study strategy training will be provided later in the Outlining section.

There appears to be an interesting inverse relationship between students' inclination for marking and the benefits they receive from marking. For example, Annis and Davis (1978; Davis & Annis, 1978) found that students who did not prefer marking as a study strategy actually benefited more from marking. Likewise, Yue et al. (2015) showed that students who were unsure about the benefits of marking benefited more from marking. A potential explanation for this finding is that learners who are unaccustomed to marking put more effort in selecting which information is important, resulting in better retention. These findings are discouraging because they suggest that students who endorse this popular study strategy and probably engage in it more frequently are probably not using it optimally.

Ineffective implementation

Considering the storage function discussed earlier, one might assume that the benefit of marking may be magnified if a brief review of the marked text occurs before the final test. In fact, reviewing of marked parts of the text is extremely popular (Hartwig & Dunlosky, 2012; Kornell & Bjork, 2007; Yan et al., 2014). However, the literature indicates that reviewing does not add to the benefits of marking. Many studies have shown the benefits of marking without a review (e.g., Fass & Schumacher, 1978; Kulhavy, Dyer, & Silver, 1975; Rickards & August, 1975), but several studies have failed to show benefits even with a review (e.g., Hoon, 1974; Idstein & Jenkins, 1972; Nist & Hogrebe, 1987). In these studies, the control condition was to review unmarked material. Marking with a review did not add benefits above and beyond the generative benefits associated with marking during initial reading.

Younger students failed consistently to benefit from marking without preexperiment training on how to effectively mark texts. Two studies targeting students who were younger than college age failed to show any benefits (high school students: Mathews, 1938; 10-year-olds: Rickards & Denner, 1979). Likewise, no published study has shown that students younger than college age benefit from marking without preexperiment training. In addition, Schellings, Van Hout-Wolters, and Vermunt (1996) asked 10th graders to mark texts either by main points, points portrayed as important by the teacher, or whatever they found interesting, and students were largely unable to adjust their marking. In contrast, experimenter-provided marking research has shown benefits in younger students (high school students: Blalick et al., 1977; 6th graders: Hartley et al., 1980). This may suggest that important information cued by marking is remembered better than nonmarked information by younger students, but they are unable to select important information from a passage on their own.

In addition, whether marking can facilitate performance on higher order assessments is questionable. For example, a study using inference questions failed to show benefits of marking (Peterson, 1992). Experimenter-provided marking has also failed to enhance inference performance (Christensen & Stordahl, 1955; Silvers & Kreiner, 1997; Stordahl & Christensen, 1956).

Educational recommendations

Given the importance of reading in academic settings and the perceived simplicity of marking as a study strategy to enhance reading, marking will likely always be a common study strategy among students. Thus, it might be wise to teach students at various levels of education how to effectively mark texts as they read. Research suggests that training as brief as 60 min may be able to enhance the effectiveness of marking. For example, holding a workshop on how to mark text effectively for college freshmen may enhance their learning during the hundreds of hours they will spend reading throughout their college career. In addition, given that marking can promote retention of marked information, it can be used successfully for memorizing terms and definitions. However, marking should not be students' only preparation method for higher-order assessments, such as problem-solving in physics.

Note-Taking

Look around any college campus and you will see students taking notes during lecture, jotting down notes while reading their textbooks, and copying notes from a fellow classmate. The popularity of note-taking stems from the fact that it holds the appeal of both encoding benefits *and* storage benefits. Similar to marking, encoding benefits refer to the benefits associated with the act of taking notes, whereas storage benefits refer to the benefits associated with being able to review the notes (Di Vesta & Gray, 1972). The majority of the research conducted on note-taking has focused on the encoding benefits, so the present review will mostly focus on these benefits. Nevertheless, we will also discuss relevant findings pertaining to the storage benefits and potential interactions between the note-taking strategies and storage function.

Effective implementation

Note-taking has been shown to be an effective strategy for both text and lecture learning, particularly when learners are engaging in generative processes while taking notes. Summarizing, paraphrasing, organizing, or outlining (see the Outlining section) the presented content has been shown to be especially helpful for the retention of target information (Bretzing & Kulhavy, 1979; Di Vesta & Gray, 1972; Einstein, Morris, & Smith, 1985; Peper & Mayer, 1978). For instance, Howe (1970) found that students who took efficient notes (fewer words to express critical ideas) were more likely to recall the critical information than students who took inefficient notes (more words to express critical ideas). More recently, Bui, Myerson, and Hale (2013) demonstrated that students who were instructed to take organized notes on a computer while viewing a lecture were able to recall more information on a delayed test than those who were instructed to transcribe (even though more notes were recorded under transcription instructions). Mueller and Oppenheimer (2014) had participants listen to a TED talk and take notes by hand or by computer. They found that those who took notes on a computer produced a higher quantity of notes but that these notes were more likely to be verbatim. As a result, learners who took notes on a computer performed worse on a final conceptual test than those who took notes by hand.

It is important that this advantage of generative note-taking over verbatim note-taking might not hold up when students are allowed to review their notes, and reviewing is crucial in reaping the full benefits of note-taking (see the Educational Recommendations section). On the one hand, the participants in Bui et al. (2013) who were instructed to take verbatim notes outperformed another group of participants who were instructed to take organized notes; both groups were given an opportunity to review their notes. On the other hand, Mueller and Oppenheimer (2014, Experiment 3) showed that the advantage of longhand note-taking (with presumably more generative processing) persisted when they gave the participants an opportunity to review their notes before a test after a 1-week delay. This issue of whether generative note-taking or verbatim note-taking with greater quantity makes for better storage function is an important issue that demands further research, especially in the context of increasingly popular note-taking on computers. With computer note-taking, students can type more notes than when they write, but their notes are more likely to be verbatim when typing (Mueller & Oppenheimer, 2014).

Unlike the marking research, where being able to review the marked information yields minimal benefits, being able to review notes is a potent addition to the note-taking strategy (Howe, 1970; Kiewra, 1985; Kobayashi, 2006). Supporting this conclusion, a meta-analysis of 57 studies computed the average effect size of note-taking without review to be relatively small (Cohen's d of 0.22 (95% confidence interval, or CI = [0.17, 0.27]; Kobayashi, 2005). By contrast, another meta-analysis by the same researcher found a large effect size of note-taking with review ($d = 0.75$; 95% CI = [0.61, 0.89]; Kobayashi, 2006). Some researchers have argued, in line with these meta-analyses, that the storage benefits of note-taking are even more robust than the encoding benefits (Kiewra, Dubois, Christensen, Kim, & Lindberg, 1989).

Ineffective implementation

As discussed above, note-taking is an effective encoding strategy when learners are engaging in generative processing of the material (e.g., summarizing or paraphrasing the presented material). On the flip side, when learners do not engage in these generative processes, note-taking has been shown to be a relatively ineffective learning strategy (perhaps unless the notes are available for review). Bretzing and Kulhavy (1979) instructed learners to take notes one of four different ways: (a) summarize, (b) paraphrase, (c) copy verbatim, or (d) search for certain letters. They found that copying verbatim did not yield any benefits relative to not taking notes at all. However, it is important to note that Bretzing and Kulhavy did not allow learners to go back and review their notes before being tested.

Finally, note-taking may be less effective for audio-visual presentations of content (e.g., lecture with PowerPoint). In his meta-analysis, Kobayashi (2005) found that the effect size for note-taking was significantly larger for audio or text presentations than for audio-visual presentations. He reasoned that this might be because visual attention to handwriting (or typing) movements may be interfering with the visual processing of the presented information. No study has experimentally manipulated this factor, however, so it is only speculative at the moment. Nevertheless, it is an important finding that should be given further consideration, given that most lectures consist primarily of audio-visual presentations (e.g., particularly contexts in which the visual presentation is not just a repetition of what the instructor is saying).

Educational recommendations

There are two recommendations that can be drawn from the literature reviewed above. First, if there is no time to review the notes, students should engage in generative note-taking strategies such as summarizing and outlining. The converse of this recommendation, which may point to a pitfall of a note-taking strategy, is that taking notes by simply transcribing verbatim and not reviewing the notes is unlikely to benefit learning. Even worse, shallow processing imposed by the verbatim transcription may actually hinder learning by preventing the learners from engaging with the material more meaningfully. Second, review the notes. As the meta-analyses on the benefits of note-taking with or without review showed (Kobayashi, 2005, 2006), the beneficial effects of reviewing notes is substantial—probably greater than the benefits of the act of taking notes. Although the important issues of optimal strategies (i.e., generative or transcribe as much as possible) and the mode of note-taking (i.e., longhand or on computer) in the context of reviewing remain inconclusive, it is clear that reviewing is imperative in using note-taking optimally.

Outlining

Outlining, a hierarchical representation of the main points of material to be studied, is a long-standing study technique endorsed by both educators and students. A survey of more than 300 teachers in the 1920s found that nearly half of them required their students to prepare an outline while reading texts (Monroe, 1921). A more recent survey in four classes from various disciplines indicated that nearly two thirds (65%) of the students outlined at some point during the class (Walvoord et al., 1995). The effectiveness of outlining is so widely accepted that the most popular text reading and editing programs, such as Microsoft Word and Adobe Acrobat Reader, come with a function to edit or display the outline of the text. One reason for outlining's popularity might be that it offers an opportunity for learners to engage in active learning through identification and structured organization of key information (Mayer, 2008, Chapter 11). In addition, reading a provided outline of a lecture beforehand or in conjunction with the lecture can facilitate students' organization of the information to be learned and result in better learning (e.g., Bui & McDaniel, 2015; advance organizers: Mayer, 2008, Chapter 10).

The distinction between learner-generated and instructor (or experimenter)-generated outlines is an important one when evaluating the research on outlining. In experiments using learner-generated outlines, participants construct their own outline from scratch as they learn the material, whereas in experiments with experimenter-generated outlines, learners are given an outline prepared by the experimenter to guide their study. There is also a hybrid of these two types of outlining, often called skeletal outlines (e.g., Barbetta & Skaruppa, 1995; Collingwood & Hughes, 1978; Kiewra, Benton, Kim, Risch, & Christensen, 1995; Montis, 2007; for a review, see Larson, 2009), in which learners are given parts of an outline (e.g., only the headings) and asked to complete it as they study. Next, we review studies on these different types of outlining separately to draw out when they are (and are not) effective.

Effective implementation

Experimenter-generated outlines benefit students' learning whether they are given before studying (see also the information below on advance organizers; Eggen, Kauchak, & Kirk, 1978; Eylon & Reif, 1984; Glynn & Di Vesta, 1977; Hartley, 1976) or after studying as a review aid (Kiewra, DuBois, Christian, & McShane, 1988; but see Glynn & Di Vesta, 1977). The benefits are observed in text (e.g., Eylon & Reif, 1984) and lecture material (Hartley, 1976; Kiewra et al., 1988), among college (e.g., Hartley, 1976) and younger students (4th–6th graders: Eggen et al., 1978), and in higher-order assessments such as problem solving (Eylon & Reif, 1984) and transfer (Kiewra & Frank, 1988).

Skeletal outlines, which are incomplete outlines to be filled out during study, can further enhance performance (Cornelius & Owen-DeSchryver, 2008; Hartley, 1976; Russell, Caris, Harris, & Hendricson, 1983). College students benefit from having a skeletal outline when listening to lectures on a variety of educationally relevant topics (psychology: Hartley, 1976; comparative physiology: Klemm, 1976; types of creativity: Kiewra et al., 1995; the mechanics of breaks and pumps: Bui & McDaniel, 2015; for an experiment with medical students, see also Russell et al., 1983), and the benefits hold across various test types, including higher-order assessments (application questions: Bui & McDaniel, 2015; Russell et al., 1983; conceptual questions: Cornelius & Owen-DeSchryver, 2008) as well as at a surprise test with a week's delay (Klemm, 1976). Finally, a few studies have demonstrated the benefits of skeletal outlines throughout an entire semester of a course (Austin, Lee, Thibeault, Carr, & Bailey, 2002; Cornelius & Owen-DeSchryver, 2008).

One form of outlining that we have not discussed but that has received substantial attention is advance organizers (e.g., Ausubel, 1960, 2012; Chapter 1). An advance organizer is a presentation of the overarching idea before learning from a text or a lecture, and it often takes the form of an experimenter-generated outline with a pictorial representation of the concept. It has been shown to benefit learning across a variety of scientific concepts (e.g., computer science: Mayer, 1975; mechanics of radars: Mayer, 1983) and on higher-order assessments (e.g., Mayer, 1980, 1983; see also Corkill, 1992). Because advance organizers include pictorial representations (e.g., illustrations, diagrams), teasing apart the effects of outlining per se is difficult. Therefore, we do not include an in depth review of this literature (for a review, see Mayer, 2008, Chapter 10; for a meta-analysis on oral advance organizers, see Preiss & Gayle, 2006). Nevertheless, this literature reinforces the effectiveness of presenting an experimenter-generated outline before the learning of the material.

Ineffective implementation

Learner-generated outlines, by contrast, show benefits only when participants go through an outline training process (Barton, 1930; Berkowitz, 1986; Taylor, 1982, Experiment 1; Taylor & Beach, 1984; but see Taylor, 1982, Experiment 2). Studies with college students (Tuckman, 1993) and younger students (Eggen et al., 1978) in which participants were simply told to outline as they studied (without any prior training) failed to show any benefit of outlining relative to unguided note-taking or simply reading. Sometimes younger students do not outline effectively even with extensive training (Taylor, 1982, Experiment 2). What is noteworthy here is that after appropriate training (for details, see the next paragraph), learner-generated outlining can enhance younger students' comprehension (middle and high school students: Barton, 1930; 5th graders: Taylor, 1982, Experiment 1; 7th graders: Taylor & Beach, 1984) using educationally authentic texts (history: Barton, 1930; health and social studies: Taylor, 1982, Experiment 1; Taylor & Beach, 1984).[2]

Although the length of the outlining training used in different experiments has varied (45 min a week for 6 weeks: Berkowitz, 1986; 1 hr a week for 7 weeks: Taylor, 1982; Taylor & Beach, 1984), a common feature is that the training included regular sessions to practice the skill over several weeks. Other important commonalities among these successful outlining-training protocols include an emphasis on identifying the main points after reading through the whole section, identifying the text structure, and retrieving the contents using the outline as a cue. Correctly identifying the main points of the text is the fundamental component of successful outlining. This identification process starts from first reading through the entire text (or a section, depending on the length) before identifying the main points. Some training programs also emphasized the importance of identifying the text structure (Berkowitz, 1986; Taylor, 1982; Taylor & Beach, 1984). Correctly identifying how the text is structured not only allows the learner to identify the main points more easily but also gives the learner a better understanding of how the ideas in the text are organized. Finally, successful training also incorporated retrieval practice, which is one of the most powerful learning techniques (e.g., Roediger & Karpicke, 2006a; see also the Using Flash Cards section), using the outline as a cue. In some cases, learners were specifically taught to try to retrieve the supporting details from the main idea headings (Barton, 1930; Berkowitz, 1986). In other cases, the retrieval with the generated outline was incorporated into the discussion with the teacher (Taylor, 1982) or peers (Taylor & Beach, 1984).

Educational recommendations

Students who take notes using a skeletal outline during a lecture benefit in terms of understanding the presented information, remembering the information at a delay, and applying that information to solve problems. In addition, the majority of the studies investigating this issue were authentic classroom studies (including a few semester-long investigations)—and the remaining studies at least compared outlining conditions to strong control conditions such as note-taking—leaving little doubt on the generalizability of the benefits of skeletal outlines. Accordingly, instructors should make an effort to provide a list of topics and subheadings before a lecture so that students can use it as a skeletal outline. From a student's perspective, if an instructor structures a lecture in a predictable way (e.g., on the basis of the textbook), it is advisable to take notes of the headings and subheadings (i.e., main points and components) that will be covered and prepare a skeletal outline before the lecture. This will not only provide students with a better sense of organization but also save students from wasting time in copying the obvious headings, precious time they can use to process the material in a more meaningful way.

Properly constructed outlining training (i.e., identifying the main ideas after reading, identifying the text structure, and using the constructed outline as a retrieval cue) is strongly recommended, especially for younger students who cannot effectively outline on their own. There is evidence that training incorporating outlining and text structure can improve reading comprehension (Meyer et al., 1989/2014; Wijekumar, Meyer, & Lei, 2012, 2013). The extensive training (e.g., 1 hr a week for several weeks) and the need for constant feedback during these training sessions are costly but from our perspective, assuming that the benefits are relatively long lasting, that training expense is relatively minor.

Finally, the effectiveness of providing an experimenter-generated outline before reading texts emphasizes the importance of reading the table of contents or any outline before reading, which is often neglected. For example, when reading textbooks, students may be tempted to skip the table of contents, using it primarily when they need to locate particular topics of interest. However, research reviewed above suggests that reading through the table of contents and building an understanding of how the text is organized is likely to improve comprehension and retention.

Using Flash Cards

Using flash cards is essentially the real-world application of self-testing studies conducted in the laboratory (Kornell, 2009; Pyc & Rawson, 2007, 2011; Rawson & Dunlosky, 2011; Vaughn & Rawson, 2011). Thus, it should be expected that using flash cards is an effective study strategy, given that self-testing has been shown to produce robust benefits on retention (for a review; see Roediger & Karpicke, 2006a). However, it is important to note that cognitive psychologists and college students differ considerably in why they believe flash cards are effective. Specifically, cognitive psychologists posit that the retrieval component of using flash cards is helping students learn and retain the target information. Students, on the other hand, use flash cards because they believe that it helps them gauge how well they have learned the material (Kornell & Son, 2009; Wissman et al., 2012). Although students commonly report using flash cards as a study strategy, empirical research on this topic is lacking. To our knowledge, only a handful of studies have investigated the benefits of using flash cards (or self-testing). As such, we will borrow significantly from the experimenter-guided testing literature to make this section a more informed review. Because testing of associative material is essentially the laboratory corollary of using flash cards, we believe that the findings should generalize to self-testing with flash cards in an authentic educational setting. Thus, the present review makes the assumption that students are actually engaging in self-testing rather than just reading the flash cards.

Effective implementation

If the goal is to retain specific, detailed information, using flash cards is one of the most effective study strategies. Consequently, much of the research on experimenter-guided testing has used associative learning materials, such as foreign vocabulary (Carrier & Pashler, 1992; Karpicke & Roediger, 2008; Pyc & Rawson, 2011), concept definitions (Rawson & Dunlosky, 2011), and medical terms (Schmidmaier et al., 2011), as the study material. The benefits of testing have also been demonstrated in more authentic educational contexts. For example, Schmidmaier et al. (2011) found that medical students who engaged in repeated testing with flash cards were able to recall more medical terms on a test after a 1-week delay than students who engaged in repeated studying. Likewise, Golding, Wasarhaley, and Fletcher (2012) found that students who reported using flash cards more often scored higher on exams in an introductory psychology course, and Senzaki, Hackathorn, Appleby, and Gurung (2017) showed that students who were randomly assigned to receive a short lecture on the use of flash cards, incorporating generation of flash cards and tying the content to their own experience, scored higher in the term exams.

Although any amount of testing is beneficial, the benefits can be further augmented by increasing the amount of practice. Laboratory studies have shown that recalling an item more than once can improve the likelihood of future recall (Karpicke, 2009; Rawson & Dunlosky, 2011; Vaughn & Rawson, 2011). For instance, Vaughn and Rawson had participants learn pairs of Lithuanian and English words until they were correctly recalled a certain number of times; some items were recalled once, whereas other items were recalled twice, three times, four times, or five times. They found that after a 48-hr delay, learners were able to recall only 31% of the items that were originally recalled only once. However, learners were able to recall 71% of the items that were originally recalled four or five times. These results suggest that students should continue to practice recalling the target information even after they can get it correct the first time.

Another factor that can enhance the benefits of self-testing is the amount of lag or spacing between studying an item. As we discussed in the Rereading section, spacing study of the same information can have potent benefits for long-term retention (for a review, see Cepeda et al., 2006). It has also been shown that having longer lags between the same items yields better memory performance than shorter lags (Kornell, 2009; Pyc & Rawson, 2007, 2011). For instance, Pyc and Rawson (2011) had students learn pairs of Swahili and English words that were separated by either 6 or 34 other items, and they found that the longer lag condition led to better retention (76% vs. 55% for test after a 25-min delay; 30% vs. 5% for a test after a 1-week delay). Thus, it is important for students not to just keep drilling the same item; rather, they should take a break and come back to that item later on.

Ineffective implementation

One potential pitfall associated with using flash cards is knowing when to drop a flash card. Specifically, how does one determine when an item has been learned? Theoretically and intuitively speaking, dropping flash cards that are well learned from study should allow more study opportunities for yet-to-be-learned flash cards and thus result in better overall learning. However, Kornell and Bjork (2008) found that allowing students to self-regulate their own study by dropping flash cards (relative to not dropping) had detrimental effects on learning. Their explanation was that students lacked the requisite metacognitive accuracy to effectively drop flash cards from future study. This is not the entire story, however. Even assuming that metacognitive accuracy was perfect, dropping items from additional testing may also have detrimental effects because the learner loses out on additional practice. For instance, Karpicke and Roediger (2007) dropped correctly recalled items from further testing and found that it still had negative consequences relative to repeated testing. A potential explanation is that dropping correctly recalled items diminished spacing, which has significant benefits for retention of information (see Soderstrom, Kerr, & Bjork, 2016).

Another potential limitation of using flash cards is that it is difficult to target higher order information. Because flash cards were developed to learn specific, detailed information, zero investigation has examined whether flash cards can be used to learn complex information that is not simply associative learning.

A final consideration of using flash cards optimally concerns whether mixing (also referred to as interleaving) flash cards from two different topics is beneficial for long-term retention. Although a good deal of laboratory evidence suggests that mixing is beneficial in category and math learning (e.g., Kang & Pashler, 2012; Kornell & Bjork, 2008; Taylor & Rohrer, 2010; Wahlheim, Dunlosky, & Jacoby, 2011), the story is less clear in flash card studies. To address this question, Hausman and Kornell (2014) varied whether learners studied flash cards for two different topics (i.e., anatomical definitions and Indonesian translations) in a mixed or a separate condition. Their results indicated that mixing flash cards from two different topics had no influence on long-term retention, which suggests that students have much flexibility in how they use flash cards to study for different classes.

Educational recommendations

There are two important points to take away from the present review on how to use flash cards effectively. First, students should keep studying and testing themselves even after they get an item correct. Doing so results in dual benefits: (a) The additional practice is crucial for strengthening their memory for the target information, and (b) they will be able to avoid the pitfall of inaccurate metacognition (i.e., not discriminating between learned and unlearned information). This is contrary to the conventional wisdom that once you get an item correct, you should stop studying it. Second, students should space out their studying of a given flash card. According to Wissman et al. (2012), students do not appear to recognize the importance of self-testing with longer lags even though it has been shown empirically that spacing out an item between practice attempts makes that item more likely to be recalled in the future.

General Discussion

There has been a growing interest in applying findings from cognitive science to enhance educational practices. Recent reviews strongly suggest that there are potent study strategies that foster effective learning (Bjork, Dunlosky, & Kornell, 2013; Dunlosky et al., 2013; Fiorella & Mayer, 2015; Roediger & Pyc, 2012). Yet students' study-strategy choices are largely driven by their perceived understanding at the moment of studying (Soderstrom & Bjork, 2015), and it appears that students rarely use these strategies that truly promote learning. Accordingly, in the present review, using existing empirical evidence from the cognitive and educational literatures, we explored whether students' preferred study strategies might have merit. Given students' strong preferences in using these strategies anyway, illuminating when they do benefit learning—and when they do not—may at least guide students to use the strategies optimally. In Table 2, we summarize the main outcomes of our review of five popular study strategies (rereading, highlighting, note-taking, underlining, and using flash cards) in terms of (a) common pitfalls, (b) tips for optimal implementation, and (c) effectiveness for different test types.

A few common themes have emerged about how to appropriately leverage these five strategies to produce

Table 2. Common Pitfalls, Tips for Optimal Implementation, and Effective Test Types

			Test types	
Strategy	Common pitfalls	Tips for optimal implementation	Factual	Application
Rereading	× Mistaking the fluency associated with a second reading as having learned the material successfully.	✓ Space out the readings. ✓ Test yourself in between the readings.	Yes	No
Marking	× Marking too little; marking noncritical information. × Mindless marking (frequent users need to be careful).	✓ Read through the text first before marking. ✓ Pay attention to the text structure when identifying important information to mark.	Yes	No
Taking notes	× Copying lecture notes verbatim and not reviewing them.	✓ Make sure to review the notes before an exam.	Yes	Yes
Outlining	× Outline from scratch without paying attention to the text structure.	✓ Identify the main points after reading through the whole section. ✓ Pay attention to the text structure. ✓ Use skeletal outline as a guide.	Yes	Yes
Flash cards	× Dropping flash cards from study after one successful retrieval.	✓ Retrieve an item correctly at least three times before dropping it from study.	Yes	No

Note: Factual tests assess whether the learner can recall the studied information, whereas application tests assess whether the learner can apply the studied information to a new context (e.g., problem solving). "Yes" and "No" indicate whether empirical evidence shows that a particular strategy benefits learning assessed by different types of tests.

optimal memory and comprehension performance. One clear conclusion from our review is that students, when left to their own devices, do not use these popular strategies very effectively. Students are often unaware of the pitfalls associated with these strategies, including mistaking fluency for learning when rereading, highlighting too much, copying notes verbatim, and prematurely dropping flash cards from further study. However, these pitfalls can be overcome once students are made aware of them and are provided with explicit instructions to avoid them.

Aside from avoiding the pitfalls listed in Table 2, our review suggests that there are potent ways to augment these popular study strategies, including incorporating cognitive-psychologist-endorsed strategies (e.g., retrieval practice, distributed practice), hosting training, and providing instructor assistance.

First, in some of our recommendations, we suggested the incorporation of study strategies that are strongly endorsed by cognitive psychologists but rarely used by students. One might wonder what is new about these recommendations. For instance, in the case of rereading, some might argue that recommending spacing the readings or self-testing between readings is the same as simply recommending distributed practice or retrieval practice (which may not be fruitful in changing students' study behavior). However, our recommendations in this regard are different from the previous recommendations because they align with the principle that new behaviors are attained most efficiently when they are incorporated into preexisting behaviors. This principle is well established in other fields, such as exercise intervention (e.g., Lutes et al., 2012), and we think that it is likely to also have bearing on study-strategy intervention. Specifically, students might not know how exactly to implement retrieval practice effectively, so identifying novel occasions and implementing it properly takes effort, thus potentially diminishing the likelihood that students will actually implement retrieval practice. On the contrary, students already have a strong tendency to reread, so having them take a moment to try to retrieve what the read contents were before rereading would better align with students' established study habits and, accordingly, might be more fruitful in making a change. In this sense, some of our recommendations are intended not only to make students' preferred study strategies more effective, but also to use these habitual strategies as vehicles to introduce more effective but rarely practiced strategies into students' routines.

Second, training students on how to use the study strategies can also produce more robust benefits on learning outcomes. Research has demonstrated that marking yields more robust benefits after learners have been trained on effective marking strategies (Amer, 1994; Dumke & Schäfer, 1986; Leutner et al., 2007; Schnell & Rocchio, 1978) and learner-generated outlining is especially effective when participants receive training on how to outline (Barton, 1930; Berkowitz, 1986; Taylor, 1982, Experiment 1; Taylor & Beach, 1984). Thus, it is critical that students receive some training on how to effectively use these study strategies to reap the full benefits. Further, because these training programs can benefit even young students (as young as 5th graders in the case of outlining training), starting the training at an early age and ensuring that these students use the strategies effectively for the years to come may confer significant dividends for students and educators alike.

Finally, instructors can play an important role in assisting students to use their preferred study strategies effectively. For instance, it has been found that students of all ages can benefit from outlining when provided with a skeletal outline, whereas many students fail to benefit from outlining from scratch (see the Outlining section). A simple and effective solution would be for instructors to provide their students with a skeletal outline before the lecture starts. Another instance in which instructors can assist students is by quizzing them on a given topic on various occasions, which would indirectly require students to engage in spaced review (e.g., rereading or flash cards). Instructors may even incentivize these effective implementations by awarding a small portion of the course grade to students for turning in their completed outlines or performing well on the quizzes.

Individual differences

Although our review thus far has focused on the general effectiveness of study strategies for all learners, it would be a disservice not to briefly discuss how individual differences may moderate the effectiveness of these study strategies. Research on this issue is sorely lacking, but for two of the strategies, there has been preliminary research that is worth mentioning. First, rereading seems to be a much more useful study strategy for good comprehenders (as indexed by the Multi-Media Comprehension Battery; Gernsbacher, Varner, & Faust, 1990) than for poor comprehenders (Martin, Nguyen, & McDaniel, 2016). In particular, Martin et al. found that good comprehenders demonstrated superior metacognitive control—the ability to effectively guide their restudy opportunity. Specifically, good comprehenders were more likely than poor comprehenders to engage in a discrepancy-reduction strategy (i.e., allocate more study time for information identified as less well learned than information identified as well learned; cf. Thiede & Dunlosky, 1999) during a second reading. These results suggest that students who are already good comprehenders can benefit from a variety of study strategies, even those strategies that provide little guidance. On the other hand, poor comprehenders might benefit more from study strategies that provide them with specific instructions on how to study.

Second, the benefits of note-taking may be moderated by working memory ability. In particular, learners with low working memory are better off transcribing than synthesizing lecture notes (Bui & Myerson, 2014). A plausible explanation is that learners with low working memory are unable to hold in mind and manipulate different pieces of information while initially recording notes. By contrast, learners with high working memory, who have the capacity to hold and manipulate information while recording notes, should attempt to organize and synthesize the lecture content during note-taking to develop a deeper understanding of the content.

Future research on individual differences in the effectiveness of study strategies may benefit from considering two additional core skills, metacognition and organization, that we believe underlie students' ability to use these popular study strategies efficaciously. Metacognition plays a vital role in mediating successful learning, especially in the cases of rereading and using flash cards, during which learners need to be cognizant of what they know and do not know to determine what to focus on during a second reading or deciding when to drop a flash card from further studying. Organization, which is the ability to understand the relationship between key points and grasp what is important, plays an important role in identifying important information to mark or constructing a coherent outline structure.

Future directions

One fruitful avenue for future research would be to investigate the benefits of combining study strategies. Much of the prior research has investigated various study strategies in isolation and characterized their efficacy and mechanisms that way. However, combining suitable study strategies can be more effective and efficient than using a single strategy. Basic research on this issue is in its infancy, and only a handful of potential potent combinations are being investigated (retrieval practice and the keyword mnemonic: Miyatsu & McDaniel, 2018; retrieval practice and rereading: Nguyen & McDaniel, 2016; marking and massing/spacing: Yue et al., 2015; see also Intelligent Tutoring of the Structure Strategy[3]: for applied research taking this approach, see Meyer et al., 2002; Meyer & Wijekumar, 2017; Meyer, Wijekumar, & Lin, 2011; Wijekumar et al., 2014). More research is needed to provide insights into powerful and practical combinations of study strategies.

Another exciting avenue for future research is examining how technology might interact with these different study strategies. Because much of the research on these popular study strategies was conducted before the advent of technological advances such as laptops, iPads, and smartphones, it is unclear how technology might influence the benefits of these study strategies (but for exceptions, see Bui et al., 2013; Mueller & Oppenheimer, 2014). For example, the use of computers makes it easier for learners to take and edit notes and outlines. As mentioned in the note-taking section, an emergent question is whether students should take notes by writing and engage in generative strategies or by typing and transcribing as many notes as possible. Does the editing allowed by computers make outlining on computers better than hand-written outlines? There are various smartphone applications that allow students to easily copy and paste information to create flash cards or even websites that provide premade flash cards. Is studying with these new types of flash cards as effective as studying with flash cards that are made by learners themselves?

Finally, a venerable idea that merits revisiting is the concept of generative learning and how it contributes to the observed benefit of each strategy. As touched upon in the previous sections, many study strategies have generation and utilization components (e.g., the encoding and storage function of note-taking). Isolating the benefits of these components will provide important insights on optimal implementation. For instance, the existing research on flash cards has focused primarily on the use component. Thus, it is unknown whether generation of flash cards (by students) has any unique benefits to learning aside from simply using the flash cards. Likewise, would instructor-provided notes be more beneficial than student-generated notes?

Concluding comments

It is clear that students have strong study-strategy preferences that do not align with the strategies being advocated by cognitive psychologists (Dunlosky et al., 2013; Hartwig & Dunlosky, 2012; Karpicke et al., 2009; Kornell & Bjork, 2007; Wissman et al., 2012; Yan et al., 2014). Accordingly, a productive approach might be to assist students with optimizing the strategies that they prefer. In addition, we suggest using these popular study strategies as vehicles to introduce the strategies endorsed by cognitive psychologists into students' study routines. Our review serves as a starting point for the approach of identifying and augmenting strategies that students already use. It is our hope that students use these assessments of their favorite study strategies to help them study more effectively, that instructors become aware of opportunities to actively assist students' optimal implementation of these strategies, and that psychologists become interested in conducting research on exploring effective augmentations to these strategies.

Declaration of Conflicting Interests

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Notes

1. Aside from spaced study, another way to augment rereading might be to encourage high-level processing (i.e., situation-model processing; Johnson-Laird, 1983; Kintsch, 1988; see also Bos, De Koning, Wassenburg, & van der Schoot, 2016) during the second reading. One way to stimulate such processing is to encourage the reader to explicitly consider the state of his or her situation model by making judgments of inferencing (JOIs; i.e., learners judge how likely they would be able to apply the core knowledge they just learned in the future) before the second reading, which can enhance inference and problem-solving performance relative to a second reading with no JOIs (e.g., Nguyen & McDaniel, 2016, in which JOIs followed a retrieval practice phase before a second reading).
2. It bears mention that outlining can be used for writing rather than for improving comprehension of text or lecture material. Learner-generated outlining without prior training facilitates essay writing by improving the structure of the written product and it appears to reduce mental effort (De Smet, Brand-Gruwel, Leijten, & Kirschner, 2014; De Smet, Broekkamp, Brand-Gruwel, & Kirschner, 2011; Kellogg, 1990; but see De Smet, Brand-Gruwel, Broekkamp, & Kirschner, 2012).
3. Intelligent Tutoring of the Structure Strategy is a reading comprehension training that incorporates several study strategies, such as identifying text structure, monitoring comprehension through summarizing main points according to the identified test structure, and retrieval using the text structure as the guide (see also Bartlett, 1978; Meyer & Poon, 2001; Meyer & Ray, 2011; Meyer et al., 1989/2014; Ray & Meyer, 2011; Williams et al., 2005).

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