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The Effect of Question Placement on Learning from Textbook Chapters

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Retrieval practice enhances learning of short passages, but its effectiveness for authentic educational materials such as textbook chapters is not well established. In the current experiment, students studied a 40-page textbook chapter on biology. Retrieval practice with correct-answer feedback was manipulated within subjects: some questions appeared only after a chapter section, others only after the whole chapter, and yet others at both times. Two groups served as controls: the reread group read the feedback presented in the retrieval practice condition, and the other group simply read the chapter once. Students took a final test two days later. Practicing retrieval resulted in greater recall relative to the two control groups. On the final test, the two single testing conditions produced comparable benefits, but testing twice produced the greatest benefit. Retrieval practice is effective in learning from authentic text material and placement of the initial test does not matter.

General Audience Summary

In educational settings, testing is typically used to assess knowledge of students; however, research has shown that testing can be a powerful tool to enhance learning. This outcome is referred to as the retrieval practice effect, or the testing effect. Most laboratory studies examining this effect use simple materials, but it is not clear whether testing can be an effective study strategy when students read entire textbook chapters, which is the task faced by many students in introductory courses. Because a textbook chapter is lengthy and complex, a critical issue is where to place practice tests: after each section, after the whole chapter, or both? In the current study, we asked students to study a biology textbook chapter and we tested them two days later with short-answer questions from the chapter. One group of students read the chapter once, another group read the chapter and then reread critical information from the chapter, and a final group read the chapter and answered practice questions on it. The questions could occur after each section, after the entire chapter, or both. We found that answering questions once while reading the chapter increased recall two days later relative to the two control groups. Where the questions were placed did not matter on the final test; however, answering questions twice increased recall more than answering questions once. When studying from textbook chapters, students can use self-testing to improve their grades. Whether they test themselves during reading of the chapter or after reading the chapter does not matter, so long as feedback is provided. To receive the greatest benefit, students should test themselves more than once.

Keywords: Retrieval practice, Testing effect, Learning from text, Question placement

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In educational settings, testing is typically used to assess knowledge but can also be a powerful tool to enhance learning (Roediger & Karpicke, 2006b). Roediger and Karpicke (2006a) have shown in the laboratory that practicing retrieval enhances retention on tests delayed a few days or a week relative to restudying the material. McDaniel, Roediger, and McDermott (2007) further showed that testing can boost performance in academic settings. In fact, a large body of research has shown that testing is an effective technique in both the laboratory and the classroom (see Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013, for a review). Many educators are now familiar with and implement retrieval practice in their classes (Wooldridge, Bugg, McDaniel, & Liu, 2014).

The impetus for the present research is to examine how best to use retrieval practice in learning of authentic educational materials. Many of the laboratory studies have used relatively impoverished materials such as paired associates (e.g., Carrier & Pashler, 1992; Kuo & Hirshman, 1996). The usual technique is to provide a test for some subjects or some materials after study and then to measure how the initial testing affects performance on a later test. The oft-obtained finding is that initial testing, especially with feedback, improves performance on the final test relative to either a restudy control condition or a control with only one study phase (see Karpicke, 2017, for a review).

Research with authentic educational materials is not entirely lacking. For example, some researchers have employed lectures and accompanying slides (Butler & Roediger, 2007; Szpunar, Khan, & Schacter, 2013; Weinstein, Nunes, & Karpicke, 2016). Others have used longer text passages to better simulate the tasks students face when studying (Wissman & Rawson, 2015; Wooldridge et al., 2014). Because most authentic educational materials are lengthy and complex, researchers have also explored the use of different testing schedules, interpolating questions during study, rather than testing at the end. Our research focuses on whether interspersed testing during reading of a chapter or testing concentrated after reading the text is more beneficial for subsequent test performance.

Although questions are generally placed at the end of study, some prior research has also shown benefits of interspersed testing. For instance, educational research on adjunct questions (i.e., questions provided within a text passage) has indicated that answering questions shortly after reading a relevant portion of a passage enhances retention of tested information, relative to answering questions before, to restudying the passage, or to not answering any questions at all (e.g., Bruning, 1968; Hamaker, 1986; Rothkopf, 1970). More recently, Szpunar et al. (2013) showed that providing interpolated tests increased note-taking and reduced mind-wandering during learning and enhanced performance on a final test. Thus, adjunct or interpolated questions may not only aid retention of the tested material but may also keep the focus on learning.

Few studies have compared the benefits of answering adjunct or interpolated questions to answering questions at the end of study. Duchastel and Nungester (1984) compared these conditions relative to a restudy control. They found that the tested groups performed better than the restudy group on a test two weeks later, but that placement of the test did not matter on the initial and the delayed tests. The authors argued that the length and complexity of a passage may affect this comparison, as they used a 1700-word passage that was not college-level. They suggested that the potential benefits of inserting questions within a passage over placing them at the end might be observed when the passage is lengthier and more complex.

More recently, Wissman and Rawson (2015) addressed the issue of question placement using relatively brief text passages. Subjects studied passages ranging from 779 to 1333 words, and were asked to recall the passage after retention intervals ranging from 15 min to two days. Critically, some subjects were quizzed after each section of the passage and some were quizzed at the end of the passage. On the initial test, subjects performed better at interpolated recall than recall at the end of the passage, but the benefits of both placements were equivalent on recall on a delayed test.

In the present experiment, we extended prior research regarding placement of retrieval practice by employing lengthier and more complex materials much like a student's typical reading assignment, a textbook chapter. Dividing the study material into smaller chunks might be beneficial in keeping students engaged with the material throughout study (Szpunar et al., 2013). In addition, waiting until the end of reading a chapter might decrease initial retrieval success, potentially reducing long-term benefits of testing unless feedback is given (Pyc & Rawson, 2009; Rawson & Dunlosky, 2011). Although prior research contrasted interpolated questions with questions provided after study, in the natural setting of reading a textbook chapter, such an either/or arrangement need not be used. Students may be best served answering questions both during learning and after learning, because repeated retrieval boosts the testing effect (Karpicke & Roediger, 2008; Pyc & Rawson, 2009). This issue represented another focus of the current research.

In the current experiment, we asked how three schedules of retrieval practice would affect learning of a biology textbook chapter on evolution. We compared interpolated testing, end-of-study testing, or testing on both occasions. We used a read-only condition and a read and restudy condition as controls, neither of which included any tests until the final test. Briefly, subjects studied a 40-page chapter with 18 sections in one of three conditions. One group simply read the chapter (read-only condition). A second group (the tested condition) read the chapter while answering questions under three schedules manipulated within-subjects: questions were given either after each section of the chapter, after the entire chapter, or on both occasions. Correct-answer feedback was given after subjects provided each response. A third group read the chapter and studied the correct answer statements that served as feedback to the questions for the tested group (a reread condition that focused on the critical material that would be tested rather than the whole chapter). All subjects returned two days later to take a final test.

We predicted that the tested group would perform better on the final test compared to the two control groups due to benefits of retrieval practice on long-term retention, the standard testing effect. The primary interest was in the three schedules of testing. We predicted that repeated questions would result in better

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