Effects of Note-taking and Retrieval Practice on Memory Performance

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Abstract

Note-taking is a valuable skill that can influence student learning and achievement (for a review see Friedman, 2014). We explored (a) whether note-taking was more effective with guided prompts (guided notes) versus without prompts (unguided notes) and (b) whether those prompts were more effective when used for note-taking or retrieval practice. Participants were divided into four groups: control, retrieval, guided notes, and unguided notes. The control group watched a video and took a final test on its contents. Both the retrieval and guided notes groups watched the video and received prompts (e.g., ATP); however, the retrieval group received them after the video (as retrieval cues) and the guided notes group received them during the video (as note-taking cues). The unguided notes group did not receive any prompts but were given the chance to take notes during the video. All groups took a final test comprising of two question types (multiple choice and true/false questions) and answered questions about content familiarity. The results from the final test suggested that although there was a significant main effect of question type, there was no main effect of group (nor a significant group × question type interaction). Implications and limitations are discussed.

KEYWORDS:
retrieval practice, guided-notes, memory, study habits
Introduction

Graduating from college can be a challenging feat. As of 2021, the national 6-year graduation rate is only 62% (National Center for Education Statistics, 2021) and as many as 56% of students in the United States drop out within 6 years (Hanson, 2021). Although there are a multitude of reasons for why students might drop out of college (e.g., financial troubles, overbearing work schedules, etc.), perhaps a primary reason may be that some students lack the essential study skills necessary to effectively learn their course content. For instance, many college students rely on passive and ineffective study strategies such as highlighting and rereading (Dunlosky et al., 2013). In contrast, research has repeatedly demonstrated benefits from retrieval practice, which refers to attempting to recall information from memory (e.g., Roediger & Butler, 2011). Research has also shown the benefits of guided notes, or notes that consist of an outline or key prompts provided by the instructor (Biggers & Luo, 2020). In our experiment, we explored the efficacy of retrieval practice compared to guided notes. Assuming no subsequent practice occurs, is it more advantageous to use teacher-provided prompts to engage in retrieval practice or to take guided notes? Below, we describe both strategies and the current evidence supporting their usage.

Retrieval Practice

Retrieval practice involves actively recalling information from memory (Roediger & Butler, 2011). By actively retrieving information from memory, an event known as the testing effect may occur. The testing effect refers to the phenomenon in which test performance is improved following retrieval practice versus no retrieval practice (Roediger & Karpicke, 2006; see also Roediger et al., 2011). Students engage in retrieval practice in situations such as using flash cards, completing practice tests, and completing end-of-the-chapter reviews (Roediger & Butler, 2011). Retrieval practice tends to be most effective when the retrieval attempt is more effortful (e.g., Duchastel, 1981; Pyc & Rawson, 2009), when there are more correct recalls (e.g., Vaughn & Rawson, 2011), when items are practice tested versus not tested at all (McDaniel et al., 2013), and when there are multiple recall attempts spanning across longer time intervals (Roediger & Butler, 2011).

Although retrieval practice is a potent learning strategy (Roediger & Butler, 2011; Roediger & Karpicke, 2006; Kornell & Vaughn, 2016), many students underutilize this technique (Hartwig & Dunlosky, 2012). In contrast, students readily engage in note-taking during lectures, with estimates ranging from 96% (Morehead et al., 2019) to 99% (Palmatier & Bennet, 1974). But is note-taking effective, and if so, is it more effective than retrieval practice?

Note-taking

Note-taking is a broad term and has many variations (e.g., Cornell notes, sketch noting, traditional notes, etc.). First, we will discuss general note-taking and how it influences academic performance. In a later section, we will discuss guided notes specifically.

Research suggests that note-taking is a valuable skill that can enhance learning in college students; however, many students fail to take good notes (e.g., transcribing the lecture verbatim; see Friedman, 2014 for a review). Although note-taking quality can influence performance (e.g., Chen 2013; Peverly et al., 2007), the act of taking notes does not guarantee improved performance. Furthermore, the process of taking notes is cognitively demanding (Roussey & Piolat, 2003, as cited in Piolat et al., 2005), as students are expected to listen, process, transcribe, store, and later recall information being presented in a short amount of time. Given limited working memory resources (e.g., Baddeley, 2010), it is perhaps unsurprising that many students engage in poor note-taking strategies (e.g., Bui, Myerson, & Hale, 2013). For instance, Hartley and Marshall (1974) revealed that students’ notes contained, on average, approximately 11% of the critical information from lecture, potentially interfering with students’ ability to accurately make connections between concepts covered in lecture and their notes (Nakayama et al., 2014, as cited in Biggers & Luo, 2020). Yet, students tend to overly rely on this skill to learn and memorize course material for future examinations (Morehead et al., 2019).

Guided Notes

To help alleviate some of the cognitive strain imposed by traditional note-taking procedures and to further enhance note-taking quality, one alternative is guided notes (e.g., Biggers & Luo, 2020). Guided notes are a type of note-taking in which the professor provides some material or handout containing key points, concepts, and/or cues that relate to important content to be covered in lecture (e.g., Biggers & Luo, 2020; Heward, 1994; Konrad et al., 2011). Studies suggest that guided notes can lessen the cognitive demand compared to traditional notetaking (for a review, see Biggers & Luo, 2020). By alleviating the strain on working memory, students can better focus on the lecture and participate more in class. Additionally, maximizing available working memory may help students take higher quality notes. For example, Glodowski
and Thompson (2018) suggest that students who use guided notes during a lecture often included more critical points and examples within their notes, which could boost subsequent test performance. Furthermore, Chen et al. (2017) report that 96.9% of participants rated guided notes favorably and that 100% of participants agree that guided notes are beneficial to test preparation.

**Purpose of the Study**

The purpose of the current study was to investigate the effects of retrieval practice and note-taking on memory performance. To equate exposure to information, prompts (e.g., ATP) were created that could either be used as note-taking cues or retrieval practice cues. First, we explored whether note-taking was more effective when using these prompts versus without these prompts (guided notes versus unguided notes). Second, and of primary importance, we explored whether these prompts were more effective when used for note-taking (i.e., providing them during the video) or retrieval practice (i.e., providing them after the video). Both note-taking and retrieval practice can improve student learning, but which learning strategy is more effective? Based on the notion that note-taking can enhance learning (for a review see Friedman, 2014), we predicted that taking notes would improve performance relative to not taking notes. Based on the perceived added benefits of guided notes (Biggers & Luo, 2020), we predicted that note-taking would be further enhanced when prompts were given (guided notes group) versus not given (unguided notes group). Lastly, based on the benefits of retrieval practice (Roediger & Butler, 2011), we predicted that prompts would be more effective as retrieval cues versus guided note-taking cues.

Of secondary interest, we also explored how retrieval practice and note-taking influenced performance on two question types: Multiple-choice questions and true/false questions. Although we did not predict that the pattern of results would change based on question type, an interaction between study strategy and question type remained possible.

**Method**

**Participants**

A repeated measures power analysis was completed to detect a potential within-between interaction at 95% power. The analysis revealed that 76 participants were necessary to detect such an effect, but to account for attrition, we tried to collect data from a minimum of 90 participants. Participants completed the study by clicking a link in SONA (an electronic platform for recruiting research participants), which then directed them to an external website. The web-based study took approximately 20 minutes to complete, and participants received two SONA credits for completing the study. Participants were excluded if they did not finish the experiment (n = 12), watched the video more than once (n = 1), used outside resources (n = 7), were not fluent in English (n = 2), or completed the main portion more than once (n = 3). In total, 49 participants [Mage = 20.71 years old, age range: 18 – 49 years (with 4 participants not entering their age); 35 females, 14 males; majority (67.35%) white] completed the experiment.

**Materials**

An eight-minute-long video about cellular respiration was used as the study material in this experiment. This video described the prokaryotic and eukaryotic cells, ATP production, and the stages of cellular respiration (Amoeba Sisters, 2021). The prompts utilized for the guided notes group and retrieval practice group were chosen to represent the main concepts from the video and are listed in Table 1.

**Procedure**

Participants logged in to SONA to access the experiment. All study procedures were administered online. Participants were randomly assigned to one of four groups. All participants first viewed an eight-minute video about cellular respiration. Participants’ roles varied during and preceding the video, depending on their assigned group. The participants that were randomly assigned to the guided notes and unguided notes groups took notes electronically (i.e., typing with their keyboards) during the video. The guided notes group received prompts during the video to serve as note-taking cues, whereas the unguided notes group did not receive such prompts. The prompts the guided notes group received were cued at the start of the video and were displayed on the right side of the visual field for the entirety of the video. Each prompt (e.g., ATP) appeared along with a corresponding

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text box beneath it for students to type in their notes. The unguided notes group received one large text box on the right side of the visual field without any prompts. The participants randomly assigned to the no notes (control) and retrieval practice groups did not take notes during the video, and thus, did not receive a text box during the video presentation. After the video, participants in the guided notes, unguided notes, and retrieval practice groups had four minutes to review. This amount of review time was chosen to allow for approximately 30 seconds of processing for each of the eight prompts in the guided notes and retrieval practice groups. During this time, participants in the retrieval practice group received the same prompts that the guided notes group received during the video, with those prompts serving as retrieval cues. The control group did not have a four-minute review and instead proceeded directly to the distractor task. For all groups, the distractor task was administered immediately before the final test, and instructed participants to recall as many countries as possible for two minutes. After the distractor task was finished, participants completed the final test, which lasted approximately seven minutes.

**Results**

**Prior Knowledge**

After the final test, we asked students if the concepts described in the video were familiar to them. We wanted to ascertain the degree of prior knowledge that participants had with the content, as this could have influenced the final recall results. Although some participants indicated that they were highly familiar with the content (n = 7), their scores did not vary significantly from those who were not highly familiar with the content for either multiple choice questions, $\Delta M = 0.02$, 95% CI [-0.21,0.26], $t(7.22) = 0.24, p = 0.820$ or true/false questions, $\Delta M = 0.06$, 95% CI [-0.16,0.27], $t(7.22) = 0.62, p = 0.557$. Given no differences in scores, we included these individuals in the analyses below.

**Performance**

Performance as a function of group and question type is plotted in Figure 1. We conducted a 4 (Groups: Control, guided notes, retrieval practice, unguided notes) x 2 (Question type: Multiple choice, true/false) repeated measures ANOVA. There was no main effect of group, $F(3, 45) = 0.41, p = 0.744$, partial eta squared = 0.027. There was a significant main effect of question type, $F(1, 45) = 39.06, p < 0.001$, partial eta squared = 0.465. Lastly, there was no significant interaction between group and question type, $F(3, 45) = 0.96, p = 0.422$, partial eta squared = 0.060.

**Discussion**

Although research has shown that both guided notes and retrieval practice are potent learning strategies, we are unaware of any prior studies that have directly compared the benefits of these two strategies. We investigated the effects of retrieval practice and note-taking on memory performance. Participants viewed a video on cellular respiration (a concept readily taught in a variety of biology courses), during which they either took notes (with guided prompts or unguided prompts) or did nothing (retrieval practice and control group). After viewing the video, participants in the retrieval practice group attempted to recall key concepts from the video (having received the same prompts as the guided notes group). Participants in the control group completed no extra review of the video, and provided a baseline level of performance. Results suggested that participants scored higher on true/false questions compared to multiple choice questions; however, performance did not vary between our groups. These results are inconsistent with prior literature showing robust testing effects (Roediger & Karpicke, 2006).

In contrast to the prior literature, we did not find a benefit of retrieval practice (Roediger & Butler, 2011). One potential reason is that the prompts provided during the retrieval practice phase were related to major concepts from the video (e.g., ATP). These types of concepts are wide in scope and multifaceted, requiring recall of many intricate details. As such, a student could have been overwhelmed during the recall phase, failing to retrieve some (or most) pertinent content. Although retrieval success is not required to benefit from retrieval practice (Kornell et al., 2015), we might have observed more benefits of retrieval practice with more targeted prompts.

**Limitations**

There were several limitations within our experiment. The first limitation is that we failed to collect data from 76 participants,
which was deemed necessary to detect a potential within-between interaction at 95% power. Given the limitations in sample size, these results are considered preliminary findings.

A second limitation is that despite being explicitly instructed to take notes, a fair number of participants (n = 9) did not. There are a variety of reasons that students might not have taken notes, including lack of effort and/or a lack of understanding of the content. Additionally, the participants who did take notes might not have taken adequate notes (which is a perennial issue; see Friedman, 2014 for a review). Future research could explore ways to increase note-taking behavior, as well as improve the quality of their notes.

A third limitation is that final performance was assessed only a few minutes after the material was presented. A possible future direction would be to increase the delay between initial learning and the final test to assess potential differences in performance with an increased retention interval.

A fourth limitation is that, as opposed to the note-taking groups, participants in the retrieval practice and control groups might have paid less attention to the video. Research has recently shown that taking notes can help prevent mind-wandering during a lecture (see Wong et al., 2021), which has shown to impair learning (see Blondé et al., 2022). A future study could investigate the role of distraction by altering the structure of the video. For instance, periodic “checkpoints” could be inserted into the video to verify that participants are paying attention. In any case, if guided notes (or note-taking in general) help keep students focused, this is an important issue to explore further. Perhaps a particularly potent strategy would be to have students engage in guided notes during lecture to keep them focused, with subsequent retrieval practice occurring afterwards to facilitate recall of the concepts. Conversely, intermittent retrieval prompts during the video would also (presumably) keep students focused, which might allow for a fairer comparison regarding the efficacy of note-taking versus retrieval practice.

A fifth limitation was that participants in the retrieval practice group may have inaccurately recalled information during the practice test phase. If an item was not recalled correctly on the practice test, the learner had no opportunity to correct their mistake given that no feedback was provided. Therefore, an item missed during the practice test would have a high probability of being missed on the final test. Future studies could mitigate this concern by providing correct-answer feedback after the recall phase (or an additional opportunity to review the video).

A final limitation is that we utilized a video that was accessible to the general public and may have covered concepts that were familiar to participants. Despite this possibility, participants’ final test scores did not provide any indication that they were overly familiar with the material (i.e., performance scores were below ceiling). Furthermore, those that did indicate high familiarity with the content scored no better than their low-familiarity counterparts.

### Conclusions

We explored the benefits of note-taking (particularly guided notes) versus retrieval practice in learning from a video lecture on cellular respiration. Although participants in the guided notes group scored the best (numerically) on the final test, this difference was not statistically significant. Future research is needed to explore whether these results would emerge if we controlled for potential attentional differences, whether a combination of strategies would be more effective than any one strategy in isolation, and whether these results will persist across a longer retention interval.

### References


