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Improving metacognitive accuracy: How failing to retrieve practice items reduces overconfidence

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ABSTRACT

People often exhibit inaccurate metacognitive monitoring. For example, overconfidence occurs when people judge that they will remember more information on a future test then they actually do. The present experiments examined whether a small number of retrieval practice opportunities would improve participants' metacognitive accuracy by reducing overconfidence. Participants studied Lithuanian–English paired associates and predicted their performance on an upcoming memory test. Then they attempted to retrieve one or more practice items (or none in the control condition) and made a second prediction. Experiment 1 showed that failing to retrieve a single practice item lead to improved subsequent performance predictions – participants became less overconfident. Experiment 2 directly manipulated retrieval failure and showed that again failure to retrieve a single practice item significantly improved subsequent predictions, relative to when participants successfully retrieved the practice item. Finally, Experiment 3 showed that additional retrieval practice opportunities reduced overconfidence and improved prediction accuracy.

1. Introduction

The term metacognition refers to a person's knowledge about the quality and accuracy of their own cognition. Flavell (1979) formalized the term and investigated the phenomena from a developmental perspective. In the earliest studies, children were asked to study a list of items until they believed they had memorized them completely. The younger children said they had completely memorized the items and were ready for the test when they actually had not memorized the words (Flavell). Studies today show a similar pattern for college-aged participants. They predict that they will earn a much better score on a given test than they actually do (for one example see Hacker, Bol, Horgan, & Rakow, 2000). People are also overconfident in other abilities, including their driving ability (Knouse, Bagwell, Barkley, & Murphy, 2005), dating popularity (Preuss & Alicke, 2009), ability to complete projects before deadlines (Buehler, Griffin, & Ross, 1994), and even their gun-safety knowledge (Ehrlinger, Johnson, Banner, Dunning, & Kruger, 2008).

Although some have claimed that overconfidence is adaptive (Gramzow, Willard, & Mendes, 2008), a large literature suggests that there are costs to overconfidence and that being metacognitively accurate is useful (e.g., Thiede, Anderson, & Therriault, 2003; Thiede, Dunlosky, Griffin, & Wiley, 2005). Accurate metacognition is particularly beneficial in educational contexts. For example, more accurate metacognition is associated with better academic performance (Everson & Tobias, 1998) and memory performance (Thiede et al., 2003, 2005). Other studies have confirmed the link between accurate

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metacognition and improved performance (e.g., Nelson, Dunlosky, Graf, & Narens, 1994). This finding makes sense – students who can accurately determine which information they do not know can then focus their efforts on learning that information to perform well on an upcoming test. Students who do not know which information they know well enough for the test may be inefficient with their study time and may focus unnecessary efforts on already-learned-material. And they may stop studying prematurely, falsely believing that they understand material that they do not yet know well enough for the test.

Because accurate metacognition can lead to good memory performance, researchers have attempted to improve metacognitive accuracy. In many of these intervention studies, participants are encouraged to practice making performance predictions (Kelemen, Winningham, & Weaver, 2007) either with or without feedback (Lichtenstein & Fischoff, 1980; Miller & Geraci, 2011) and incentives for accuracy (Ehrlinger et al., 2008; Miller & Geraci, 2011). In the classroom, students have been given entire practice tests to help them prepare for the test with instructions to use their performance on the practice test to identify strengths and weaknesses in their understanding of the content (Hacker et al., 2000). In other cases, people have been asked to generate keywords after reading expository texts and asked to self-select texts for additional study (Thiede et al., 2003). Finally, people have been asked to engage in self-reflection in which they formulated plans to prepare for the next exam after they received feedback about the inaccuracy of their predictions (Hacker et al., 2000). While a few of these attempts have been modestly successful at improving metacognitive monitoring accuracy, the general theme of this research is that metacognitive ability is highly resistant to change. And when there is improvement, sometimes it only helps the students who need it the least; that is, it helps the highest performers (Kelemen et al., 2007; Hacker et al., 2000). The present study examined a different method for improving metacognitive accuracy. Here, we examined whether practice retrieving a single test item (Experiments 1 and 2) or more test items (Experiment 3) could lead to more accurate metacognitive monitoring. To examine this issue, we used a novel paradigm in which participants studied a list of paired-associates for a later memory test, made a performance prediction, attempted to retrieve one or more practice items, and then made a second performance prediction. The idea was that providing participants with direct experience answering even a single practice test item may improve the accuracy of their performance predictions. Experiment 1 examined whether a single practice opportunity would lead to more accurate memory performance predictions. Experiment 2 directly manipulated retrieval failure and to directly examine the role of retrieval failure on metacognition. Experiment 3 examined the effect of a mixed record of retrieval practice success and failure on participants' performance predictions and metacognitive accuracy.

1.1. The effects of testing on metacognition

A large body of research now demonstrates the memory advantages of taking a practice test versus restudying material prior to taking a final memory test (for reviews see Dunlosky, Rawson, Marsh, Nathan, & Willingham, 2013; Roediger, Putnam, & Smith, 2011). It has also been suggested that testing has other benefits. For example, testing produces better organization of knowledge (Zaromb & Roediger, 2010) and it reduces proactive interference (Szpunar, McDermott, & Roediger, 2008).

One can ask at least two questions regarding the relationship between testing and metacognition. One, are people aware of the benefits of testing and two, does testing improve metacognition? The literature is somewhat mixed with respect to the first question – are people aware of the benefits of testing. In one survey study that asked participants to free-report study strategies, results showed that students did not report testing themselves as a preferred study strategy; rather they reported non-testing strategies like rereading their notes or textbooks. The survey also included a question that forced respondents to choose a testing or restudying strategy. Again, restudying was the more popular choice of study strategy. Taken together, the results suggest that students have little to no awareness of the benefits of testing because they do not use it in practice (Karpicke, Butler, & Roediger, 2009). In contrast, other research indicates that people may be aware of the benefits of testing (Tullis, Finley, & Benjamin, 2013). In the Tullis et al. study, participants reported judgments of learning (JOL) for items that had been previously tested or restudied. In some conditions, the participants' JOLs indicated that they were aware of the mnemonic benefits of testing because participants believed tested items would be remembered more than restudied items. Participants in this study were even aware that the benefit of testing interacts with the retention interval because they assigned comparatively higher JOLs for re-studied items than tested items on an immediate test and vice versa for the delayed test – a result that suggests that participants may be aware of the memory advantages of tested material. Other work suggests that participants are aware of the benefits of testing (Kornell & Bjork, 2007). When given a choice of how to study items, participants start in a simple "presentation" mode, but then switch to a testing strategy.

Thus, the evidence regarding whether people have good metacognitive awareness of the benefits of testing is equivocal. What about the other question? Does testing improve students' metacognition? Thus far there is little direct evidence to answer this question. In one study that examined the effect of retrieval practice on performance and metacognitive accuracy, participants were assigned to one of four conditions where study and testing circumstances were manipulated (Karpicke & Roediger, 2008). During the learning phase, participants in the standard condition studied foreign language word pairs, were tested on the entire list, studied the entire list again, and were tested on the entire list again for a total of four study-test cycles. In the drop-out conditions, recalled items were treated differently – they were dropped from subsequent study sessions, dropped from subsequent test sessions, or dropped from both subsequent study and test sessions. Participants in the drop-out conditions also completed four study-test cycles. Following the learning phase, all participants made a metacognitive monitoring judgment – a prediction – about how they would perform on the memory test one week later. Results showed that participants in the standard learning condition and in the drop-out condition in which recalled items were