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The Effects of Retrieval Practice on Metacognitive Monitoring Accuracy: A Comparison of First- and Other-Generation Students

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ABSTRACT

Being metacognitively accurate, or knowing what you know and do not know, has been correlated with and experimentally related to positive academic outcomes and memory performance. Knowing what you know is also referred to as monitoring accuracy. People that have high monitoring accuracy also effectively control their future study by focusing on the material they have not learned and spending less time on the material they already know, this is known as metacognitive control. Given the connection between metacognitive monitoring and control with performance on criterion tests, much research has been devoted to improving metacognition. The known groups of people that have lesser metacognitive abilities include low performers and may include first-generation college students. Williams and Hellman (2004) found that first-generation students who were taking an online college course did not control their study as effectively as second (or other) generation students. Importantly though, this study did not explicitly measure the participants’ metacognitive accuracy. The purpose of the current study was two-fold. First, we sought to establish any differences in monitoring accuracy between first- and other-generation participants. Second, we sought to establish the effectiveness of retrieval practice to improve metacognitive monitoring accuracy among first- and other-generation participants. Based on the literature, we hypothesized that other-generation participants will
have higher monitoring accuracy than first-generation participants. We also hypothesized that participants who practiced retrieval will show increased monitoring accuracy. A 2 generation (first- or other-generation) X 2 condition (retrieval practice or control) quasi-experimental design found no differences between first- and second-generation participants in terms of monitoring accuracy. However, numerically, first-generation participants were more accurate than other-generation participants. The results also indicated that retrieval practice significantly increased metacognitive accuracy for both first- and other-generation participants. Further research is required to understand the dissociation between first-generation participants’ metacognitive monitoring accuracy and control.

**Keywords:** metacognition, testing effect, first-generation students.

**INTRODUCTION**

Metacognition is what a person knows about what he or she does and does not know. If studying for an upcoming test, a student with high metacognitive monitoring accuracy would know how much information she does and does not know for the test. Then she would be able to focus on material that is less well known. Nelson et. al. (1994) constructed a theoretical framework for metacognition asserting that information flows between an object-level, which is the ongoing cognitive process, and a meta-level which observes the ongoing cognitive process via monitoring. Being able to effectively control the material chosen to be studied or not studied depends on accurate monitoring. Several studies have revealed the practical importance of being accurate about what one does and does not know in terms of test performance. For example, metacognitive accuracy has been correlated with better academic performance (Everson & Tobias, 1998) and has been shown to be experimentally associated with greater memory performance (Thiede et. al. 2003).

Because of the relationship between accurate monitoring and control with performance, researchers have endeavored to improve metacognitive accuracy. For example, a study comparing high and low scholastic achievers by Kelemen et. al. (2007) found that practice obtained through multiple opportunities to study material and make predictions about future test performance improved overall metacognitive accuracy of participants. In addition, the high scholastic achievers (as measured by GPA) were more successful at recalling items.
Hacker *et. al.* (2000) found that higher performing students showed greater metacognitive accuracy in a semester long course especially when multiple exams were administered. Those who were considered moderate performers also showed an increase in metacognitive accuracy while lower performers were overconfident. Another study by Hacker *et. al.* (2008) compared an extrinsic incentives group using extra credit points and a reflection groups in an attempt to improve metacognitive accuracy. They found that higher performing students in a 100-level course made more accurate predictions about their future test performance than lower performing students. However, lower performing students in the incentives group did improve in their performance predictions. None of the studies described narrowed in on the use of retrieval practice to improve metacognitive accuracy.

Not only have low performers been identified as having less metacognitive ability, Williams and Hellman (2004) found that first-generation students in an online-learning environment control their study less effectively than other-generation students. A student participant was a first-generation student if his or her parents had not attained an educational level of “some college” or “college degree.” The researchers evaluated the students’ ability to self-regulate via survey methods. Their interpretation of the results was that first-generation students were less efficient at regulating themselves in the online learning environment. The limitation of this study was that it was not an experimental design and they did not measure metacognitive accuracy directly. Our study sought to address some of these concerns by using an experimental design and by measuring metacognitive accuracy directly.

We were also interested in the influence retrieval practice (or testing) has on metacognitive monitoring accuracy for first- and other-generation students. In practice the testing effect occurs when a researcher might ask participants to memorize information and then attempt to practice recalling that information before the actual test is taken. The act of practicing retrieving the information actually increases retention. Although the exact mechanism of the testing effect is unknown, it has been theorized to increase metacognitive accuracy (Roediger and Karpicke, 2006). Researchers have examined retrieval practice’s effects on metacognitive accuracy. For example, Rawson *et. al.* (2011) attempted to improve metacognitive accuracy by testing their participants on the to-be-remembered information.
They found that metacognitive accuracy increased after testing because participants’ self-selection of to-be-remembered materials for restudy before an upcoming test was more effective than participants who were not tested on the to-be-remembered information. Participants selected more relevant material (material they did poorly on initially) for restudy and performed better on the test. However, there are limitations of this study. For example, the researchers did not measure metacognitive accuracy directly (e.g., by calculating difference scores) and there were no comparisons of specific populations such as first- and other-generation students. The present study measured metacognitive accuracy directly creating difference scores based on retrieval practice and generation condition.

Another experiment examining the influence of retrieval practice on metacognitive monitoring accuracy was conducted by Miller and Geraci (2013). In this study, participants memorized a list of 40 Lithuanian-English word pairs and took a test on those word pairs. After study, but prior to taking the memory test, the participants predicted their performance on the upcoming memory test. Then, participants attempted to retrieve either easy or difficult word pairs from the list and then made a second performance prediction about how many word pairs they thought they would remember. The results indicated that the more failure participants experienced when attempting to retrieve the word pairs, the more metacognitively accurate their second performance predictions were. In other words, participants in the difficult retrieval practice condition made predictions that were more metacognitively accurate compared to participants in the easy condition. They also found that participants were usually overconfident in their predictions. This study did not consider the differences in metacognitive accuracy between specific populations such as first- and other-generation students.

Based on previous research, we hypothesize that there will be a main effect of generation. Participants who identify themselves as other-generation students will show more accurate metacognitive monitoring than first-generation participants. We also hypothesize that there will be a main effect of practice (i.e., retrieval practice or no retrieval practice). Participants will have more monitoring accuracy when they are in the retrieval practice condition compared to the control. There is no hypothesis about the interaction as we are unsure of the effect retrieval practice will have on metacognitive accuracy depending on the participants’ generation (first- or other-generation).
METHOD

Participants

Participants included 58 young adults in a 100-level psychology course enrolled at South Dakota State University located in Brookings, SD. There were 28 first-generation students and 30 other-generation students. In addition, 31 females and 27 males participated with ages ranging from 18-26 (M =19.3, SE= 0.7). Participants were informed about the tasks they were asked to perform, the risks/benefits of their participation, and their right to leave the experiment at any time. In addition, participants were asked to give written consent for their participation. For participating, each participant received research credit from his or her 100-level psychology course.

Design

This study is a 2 Generation (first- or other-generation student) X 2 Practice (retrieval practice or no retrieval practice) quasi-experimental design. During an online pre-screen questionnaire, participants read a statement explaining what it means to be a first-generation student and then were asked to indicate if they were in fact a first-generation student. We defined first-generation participants as students whose parents had not completed a college degree and other-generation participants as students whose parents had completed a college degree(s). Emails were sent to first-generation students informing them about available research appointment times.

This study included the memorization of 40 Lithuanian-English word pairs. These word pairs were chosen for study as they have been normed by previous researchers (Grimaldi et. al. 2010). That is, the word pairs have been tested to establish how the difficult they are for participants to learn and retrieve them on a memory test. Medium difficulty word pairs were chosen for the retrieval practice condition because the medium condition has been associated with an optimal level of metacognitive accuracy (Miller and Boettcher, 2013).
Procedure

The psychology department’s human subjects pool system (SONA systems) was used to email first-generation students to recruit them for this study (other generation students simply signed up for available research appointments). Participants came to the research lab to participate in the study. After completion of the informed consents, participants were randomly assigned to a retrieval practice or no retrieval practice condition. Then participants were informed about studying a list of word pairs and the subsequent memory test over the word pairs. They studied the list of 40 Lithuanian-English word pairs on a computer screen for 10 seconds per word pair (e.g., sesuo-sister). In the retrieval practice condition, following study, participants were asked to attempt to retrieve four word pairs from the study list (e.g., sesuo-____). After studying the word pairs and attempting to retrieve the practice items, participants made a performance prediction about their upcoming memory performance on a scale of 0-40. In the control condition, participants made a performance prediction immediately after study.

Metacognition has been defined as what a person knows about what he or she does and does not know. In this study, metacognition was operationally defined by creating a difference score for each participant. A participants’ performance on the memory test was subtracted from their performance prediction, thus, positive difference scores indicate overconfidence and negative difference scores indicate underconfidence.

After the study was completed, all participants were verbally debriefed to ensure their understanding of the experiment. The verbal debriefing gave information regarding the purpose of the study and how the information collected would be used to further understanding of metacognitive differences between first- and other-generation students. Participants were allowed to terminate their participation in the study and / or remove their data without repercussion. Participants were given written version of the debriefing and a copy of the consent form.

RESULTS

The results from the two-factor ANOVA found no differences in metacognitive monitoring accuracy between first- and other-generation participants, $F(1, 54) = 1.43, p = .24, \eta^2_p = .03$. 
In other words, first-generation participants were just as metacognitively accurate as the other-generation participants. The results also revealed a significant main effect of Practice condition, $F(1, 54) = 6.46, p = .01, \eta_p^2 = .10$. Participants in the retrieval practice condition made more accurate predictions than participants in the no retrieval practice condition. The interaction effect was not significant, $F(1, 54) = 1.99, p = .16, \eta_p^2 = .04$ (Table 1 and Figure 1). Figure 1 illustrates that other-generation students in the control condition were, on average, 14% overconfident and that other-generation students in the RP condition were 1% underconfident. A similar pattern, albeit attenuated, was observed for first-generation students, with 4% overconfidence in the control condition and less than 1% underconfidence in the retrieval practice condition.

<table>
<thead>
<tr>
<th>Generation</th>
<th>No Retrieval Practice (Control)</th>
<th>Retrieval Practice (RP)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SE</td>
</tr>
<tr>
<td>First</td>
<td>1.64</td>
<td>1.37</td>
</tr>
<tr>
<td>Other</td>
<td>5.6</td>
<td>1.58</td>
</tr>
</tbody>
</table>

Table 1. Mean difference scores (prediction - performance) for first- and other-generation students in both practice conditions.
Figure 1. Mean difference scores (prediction – performance) for first- and other-generation students in both practice conditions. Standard errors are represented in the figure by the error bars attached to each column.

DISCUSSION

The purpose of this study was to understand differences in metacognitive accuracy between first- and other-generation participants and to examine how these participants’ metacognitive accuracy would be affected by retrieval practice. The first hypothesis, that other-generation participants would be more metacognitively accurate than first-generation participants was not supported by the data. In fact, the results indicated that first-generation participants were numerically more metacognitively accurate than other-generation participants, although this difference did not reach statistical significance, perhaps due to insufficient statistical power ($\beta = .28$). With respect to Nelson et al. (1994) model, which posits that monitoring processes inform control processes, and previous research on first-generation students which indicates that first-generation students do not control their study as effectively as other-generation students, the results from the current study identify a dissociation between monitoring and control in first-generation students. This dissociation
could be the result of other moderating factors that may include self-efficacy, motivation, and/or locus of control.

The second hypothesis was that retrieval practice would significantly increase metacognitive accuracy. Our results indicated that most participants in the control condition made overconfident performance predictions and participants in the retrieval practice made more accurate performance predictions thus supporting the second hypothesis. Although we did not test any hypothesis about the interaction between Generation and Practice conditions, the results indicated that both first- and other-generation participants respond favorably to retrieval practice thus confirming previous studies that indicate retrieval practice is an effective method to reduce overconfidence (Miller and Geraci, 2013).

A difference between the current study and the previous study by Williams and Hellman (2004) that may account for some differences in the findings is that they conducted their study in an online learning environment where first-generation students had a mean age of 29.64 years. The mean age calculated in this study was 19.3 years; therefore, the differences in age might account for the finding that our first-generation participants were more metacognitively accurate. In fact, Souchay and Isingrini (2004) found that younger adults are more efficient at adjusting their study time and rehearsal on a readiness-recall task (i.e., better metacognitive control). The current study also supports the notion that younger students are better at monitoring. Yet other studies have found that older participants have more accurate monitoring abilities (Grimes, 2002; Hertzog et. al. 2010). Therefore, more research is needed to identify the age at which participants are most metacognitively accurate and how age may interact with the experimental task and perhaps first- or other-generation student status.

Investigating differences in monitoring accuracy and response to various interventions in populations like first-generation students allows researchers and educators to understand optimal conditions for learning and retention. Moreover, this understanding makes it possible to apply this knowledge to make pedagogical improvements. In the current experiment and in previous experiments, retrieval practice has been shown to be a positive intervention for metacognitive monitoring accuracy for both first- and other-generation participants. One possible explanation for this finding comes from the subjective experience of attempting to retrieve practice items. For instance, when people experience a
failure to retrieve a portion of the material they have studied, they are able to conceptualize the difficulty of the memory test and think more deeply about the state of their own knowledge, in this experiment – their memory of the foreign language word pairs. Applying the current retrieval practice paradigm could be achieved if, for example, educators used testing procedures in the classroom more often. If a professor used random tests for fewer points, the students would have to monitor what they do and do not know more often which would likely result in increased monitoring accuracy and increased metacognitive control.

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REFERENCES


