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Breakdown in the metacognitive chain: Good intentions aren't enough in high school

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ABSTRACT

Two experiments examined the effects of a metacognitive betting implementation in high school Biology students. The results showed that people were generally good at monitoring their own knowledge in that students performed better on items judged with high bets than items judged with low bets. We also found that those who were required to make bets, as compared to those who did not, had higher intentions of studying for longer periods of time, prior to the test. However, there were no differences in *actual* study time. Nor was there a difference in final performance, as one would expect, between the betters and the non-betters. In summary, we found indication of (1) good intentions when using the betting procedure, but (2) breakdown in the metacognitive chain during control. That is, while requiring students to make deliberate judgments improves their intentions to study, they, unfortunately, fail to carry out those intentions.

1. Introduction

During study, the learner is confronted with two major challenges: (1) to determine how well learned information is, and (2) to acquire the knowledge they may still be lacking. Neither of these is a simple problem. It is not uncommon for students to believe that they know the information, only to find out, during the test, that they don't. Unfortunately, when students have such misconceptions – or breakdowns in *metacognition*—they are likely to cease further study, resulting in the surprise poor performance. The goal of this research was to examine the spontaneous metacognitive processes of high school students, and to also explore the idea that deliberate thinking might improve learning.

Metacognition is the ability to assess accurately what one knows and does not know, and how to best acquire unknown information (Dunlosky & Metcalfe, 2009). A common judgment is the judgment of learning (JOL), which is an assessment that is made during study, about one's future test performance (Dunlosky & Lipko, 2007; Metcalfe, 2009; Metcalfe & Finn, 2008), which can be used to guide study (e.g. Bargh & Williams, 2006; Son & Kornell, 2008, 2009; Son & Simon, 2012). It is not clear, however, whether people monitor their study spontaneously. The current research focused on whether requiring JOLs would instigate a "metacognitive chain", where requiring JOLs would lead to improved study strategies, and finally, relatively high performance.

There is some evidence that suggests that requiring judgments would improve performance. Because retrieval is likely to occur when a judgment is made, the act of making the judgment becomes a unique learning opportunity (Reder, 1987; Reder & Ritter, 1992; Reder & Schunn, 1996). However, retrieval need not always occur. For instance, Son and Metcalfe (2005) demonstrated that participants who were asked to make JOLs, but without any retrieval instructions demonstrated impaired recall performance (see also Kelemen, 2000). This suggests that while monitoring can be beneficial because it encourages the learner to retrieve the item, the process of retrieval is hit or miss – if the individual is not told explicitly to monitor their learning, then monitoring, to its fullest potential, need not occur.

In the laboratory, participants are typically asked to give their metacognitive judgments via a verbal numeric scale (Benjamin, Bjork, & Schwartz, 1998; Perfect & Hollins, 1996). A challenge that we faced was to implement – in real-world study – such an explicit metacognitive procedure without being unnecessarily obtrusive. We decided on a behavioral paradigm borrowed from the animal literature, where subjects were asked to make confidence bets with

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tokens that could be traded for food (Kornell, Son, & Terrace, 2007; Terrace & Son, 2009). Previously, Sussan and Son (2007) explored the use of the betting paradigm in children, ages 5–6, and whether monitoring is more accurate with explicit instruction. The results showed that while young children can and do monitor their memories accurately, when given explicit instructions about how to monitor, appropriate decisions were achieved at a faster rate and continued to obtain for subsequent and novel tasks. A more recent study also showed that applying a betting procedure led to better monitoring in both younger and older adults (McGillivray & Castel, 2011). Thus, while metacognitive processes may not require explicit awareness, explicit instructions seem to give rise to more accurate monitoring. We here sought whether improved monitoring would, in turn, lead to more efficient study strategies, as described below.

Researchers have found that metacognitive judgments can be used to control study strategies such as study time allocation, and that people often follow a *discrepancy-reduction* rule – the rule that states that time allocation will be related to how far away the item is from its desired learned state (Dunlosky & Hertzog, 1998). In other situations, for example when time pressure is high or expertise level changes, however, people may follow a different rule, such as the *region of proximal learning* (RPL) strategy, where items of middle-level difficulty are given the most priority (e.g. Kornell & Metcalfe, 2006). When people are effectively regulating their study, such systematic strategies seem apparent. However, very young children, in elementary and middle school, are prone to making sub-optimal – i.e. random – study decisions (Metcalfe, Kornell, & Son, 2007; Schneider & Lockl, 2002; Son, 2005). For example, Metcalfe et al. (2007) demonstrated that although children in grades 3–5 were aware of what they knew and didn't know, they studied items randomly. Taken together with the adult data, this suggests that somewhere between Grade 3 and adulthood, people appear to develop the ability to control study strategically, systematically, and consequently, effectively. Our main interest was to see whether monitoring might lead to a more systematic strategy, for example, an apparent discrepancy-reduction allocation of study time.

Metacognitive regulation has not been investigated widely in those younger age groups and the data that exist focus on metacomprehension accuracy during reading comprehension tasks. Bruin, Thiede, Camp, and Redford (2011) conducted a novel study that examined how monitoring affects self-regulation of study in elementary and middle school aged children. They found that generating keywords from the text improved students' regulation of study, but only for 6th and 7th graders. Those that generated keywords were more likely to ask to restudy texts rated as low in comprehension rather than high. In another study, Redford, Thiede, Wiley, and Griffin (2012) demonstrated that having seventh graders create concept maps of texts – as opposed to merely re-reading – improved their ability to make accurate predictions of how they would perform on a test of their comprehension. The current study, while also examining the benefits of monitoring, went beyond these previous studies in that it (1) provided students with the opportunity to make study decisions prior to testing, which may be more representative of real educational settings, and (2) employed a (betting) task that might be used for all academic disciplines, as a way of testing for general monitoring consequences.

There has been little to no focus on the monitoring-control-performance chain, in the classroom, and particularly at the high school level. A few findings have shown that people who are less accurate about what they do and do not know perform worse on achievement tests (Romainville, 1994; Schraw, 1997; Tobias & Everson, 1996). Other studies have shown that improvement in metacognitive skills may lead to some improvement in academic achievement (Elawar, 1992; Maki & Berry, 1984; Silver, 1987), precisely by regulating study more effectively (Nelson, Dunlosky, Graf, & Narens, 1994; Thiede, Anderson, & Therriault, 2003). But surprisingly, there have been only a handful of studies that address the issue of how to implement strategies for improving self-assessment and thus, combating illusions (Hamman, Berthelot, Saia, & Crowley, 2000; Schraw, Crippen, & Hartley, 2006; Tobias, Everson, & Laitusis, 1999). And largely, unfortunately, evaluations of the strategies implemented by teachers have been either observational (Moley et al., 1992) or through self-reports (MSLQ).

One quasi-experiment conducted by Michalsky, Mevarech, and Haibi (2009) showed that fourth grade science students "taught" metacognitive strategies outperformed those who were not taught, on a final test (see also Cleary, Platten, & Nelson, 2008; Huff & Nietfeld, 2009; Zohar & David, 2008). Still, the training of such strategies within a classroom setting has not been highlighted. And yet, the *Common Core State Standards*, developed in 2009, were established to promote problem solving and higher order thinking skills for all students in the country. The genesis of such standards was a response to many who felt that graduating high school students were under-prepared for college and career expectations, mainly due to their deficiency in higher-order thinking skills. Our study, therefore, aimed to examine the potential benefits of implementing an explicit metacognitive strategy in early high school students.

1.1. The current research

The crucial objective of the current study was the following: Will requiring 9th graders to monitor their study, by placing bets, lead to better study strategies – in this particular case, more appropriate time allocation, where items that are judged to be more difficult allocated greater study? We hypothesized that if students are required to deliberate about what they know vs. what they don't know, they will then be better able to make systematic, and beneficial study decisions. As a result, a more effective metacognitive chain – monitoring, control, and eventual performance – would occur.

2. Experiment 1

2.1. Methods

2.1.1. Participants

The participants in this study were 113 ninth grade high school students ranging from ages 14–16, at an inner-city public high school. The school consists of a 50/50 ratio of boys to girls and is made up of 47% Hispanic, 29% Caucasian-American, 13% African-American, 10% Asian-American, and 1% American-Indian. Students were recruited from their *Living Environment* (Biology) science classes. In order to participate, parents read and signed a consent form explaining all of the procedures, risks, and benefits of the study, adhering to the APA guidelines. No sure incentives were offered to the students, except for being told that whoever received the highest number of points at the conclusion of the experiment would be eligible for a prize.

2.1.2. Materials and design

The materials were 26 Biology concepts taken from the New York State *Living Environment* curriculum standards for the *immunology* and *circulatory* system units. Twenty-six corresponding multiple-choice questions (13 pertaining to immunology and 13 pertaining to circulatory system) were taken from prior New York State *Living Environment* Regent exams (See Appendix A). The main between-subject variables were *Bet*, or whether or not students made confidence bets, and *Topic*, whether students studied the immune system or the circulatory system. *Intention*, or how