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The relationships between monitoring, regulation and performance

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ABSTRACT

The articles in this Special Issue reflect the growing interest in applying laboratory-based research to educational settings. These articles highlight the contribution of metacognitive monitoring and self-regulation to effective learning and performance. At the same time, they illustrate the methodological and theoretical challenges involved in bringing metacognitive research to the real world, using meaningful learning materials. In particular, the assumption of a linear causal chain from monitoring through regulation to performance represents a useful working hypothesis, but more complex interactions between these three components of self-regulated learning need to be considered.

1. Introduction

Recent years have seen a growing interest in applying laboratory-based findings on metacognition to real-world educational settings. Although research on metacognition has been flourishing in different domains, there has been little cross-talk between the different groups of researchers, particularly between developmental psychologists, educational practitioners, and experimental, cognitive scientists. The articles in this special issue illustrate some of the theoretical and practical benefits that can ensue from the combination of ideas, questions and methodologies from different strains of metacognitive research. All four articles examine the intricate relationships between monitoring, regulation and performance using materials, populations and contexts that have a certain degree of ecological validity.

2. Monitoring accuracy and its effects on learning and memory

The study reported by Dunlosky and Rawson (2012) as well as that of Redford, Thiede, Wiley, and Griffin (2012) examine the implications of monitoring accuracy for effective learning and memory. Whereas Dunlosky and Rawson focus on calibration or absolute accuracy, Redford et al. focus on resolution or relative accuracy. Calibration (over/underconfidence) is expected to affect the overall amount of learning that a student allocates to the study of the material. An overconfident student who is preparing for an exam may quit studying prematurely and feel surprised when s/he does poorly on the exam. Indeed, Dunlosky and Rawson provide evidence that miscalibration in the form of overconfidence may result in underachievement. Overconfidence is ubiquitous. As noted by Koriat and Bjork (2005), the monitoring of one's own learning typically occurs in the presence of information that is absent but solicited during testing. The failure to discount the effects of that information when assessing one's learning can instill a sense of competence during learning that proves unwarranted during testing. Thus, instructors should find ways to help students accurately monitor their degree of learning and avoid illusions of competence. One technique that proved effective in the study of Dunlosky and Rawson was the idea-unit procedure: Before self-scoring their response to each question, participants were shown their response along with the idea units contained in the correct answer, and were asked to identify which idea units were contained in their response. Another helpful technique is self-testing. It is of interest to examine the relative effectiveness of different techniques for different people and for different conditions and materials.

Dunlosky and Rawson also relied on individual differences in testing the idea that overconfidence leads to underachievement. In their study, individuals who exhibited overconfidence during learning yielded poorer performance in the final test. However, Dunning, Johnson, Ehrlinger, and Kruger (2003), who examined individual differences in performance on an exam, noted that the skills needed to produce a correct response are virtually identical to those needed to evaluate the accuracy of that response. Therefore, poor performers are doubly cursed: They do not know and do not know that they do not know (see also Koriat, in press).

Redford et al., in turn, focused on interventions that should improve resolution or relative monitoring. These interventions help students discriminate between information that is well-learned

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and information that requires additional study. Their work specifically concerned metacomprehension. It draws upon ideas and findings from two disparate theories: theories of metacognitive monitoring and theories of text comprehension. Metacomprehension accuracy was operationalized as the within-individual correlation across texts between a participant's metacomprehension rating and his/her test performance. Their study was based on the assumption that metacomprehension accuracy can be improved by educational techniques that focus participants on the situation model of a text when judging comprehension. Indeed, writing summaries of the text after a delay, generating keywords after a delay, constructing a concept map and self-explanation of the text have all been found to improve metacomprehension accuracy. Some of these techniques require a certain degree of cognitive sophistication and it is not clear that they can be effective with children (but see de Bruin, Thiede, Camp, & Redford, 2011). In the study reported by Redford et al., the construction of concept maps was found to yield some improvement in metacomprehension accuracy in 7th graders. Although the results were not clear cut, they are certainly promising.

The idea that metacomprehension accuracy can be improved by drawing participants' attention to more valid cues is interesting. This idea also underlies the use of delayed judgments of learning (JOLs; Dunlosky & Nelson, 1992). Results suggest that young adults' JOLs are based on a flexible and adaptive utilization of different mnemonic cues according to their relative validity in predicting memory performance (Koriat & Ma'ayan, 2005). Sometimes, however, illusions of competence may result precisely from participants' reliance on invalid cues that lead metacognitive judgments astray (e.g., Benjamin, Bjork, & Schwartz, 1998).

3. Self regulation as it relates to monitoring and performance

The difficulties involved in bringing metacognitive research to the real world are all the more prominent in the study by Pieschl, Stahl, Murray, and Bromme (2012). This study undertook the investigation of the three main components of self-regulated learning: monitoring, regulation and performance. In general, there has been a great deal of research testifying to the ability of participants to monitor their performance. Less work has been done on the ability of participants to implement the output of their monitoring toward the regulation of cognitive processes and behavior. Much less work still has been concerned with the possible benefits that ensue from monitoring-based regulation (see Koriat & Goldsmith, 1996; Rhodes & Tauber, 2011). The study of Pieschl et al. focuses on this issue, which has been referred to as the fifth question in metacognitive research (Koriat, 2007): How do the metacognitive processes of monitoring and control affect actual performance? An important merit of this study is that it was conducted in authentic real-life environment using rich educational materials. The methodological challenges that the authors faced illustrate some of the difficulties involved in investigating important issues in their naturalistic settings.

The study of Pieschl et al. highlights some of the theoretical issues facing researchers in metacognition. Theories of self-regulated learning generally imply a sequential architecture: Monitoring → regulation → performance. However, the processes involved in self-regulated learning are probably much more interactive and iterative. Consider the following metaphor: Assume that you are driving on an undulating road. As you drive, you apply more gas (or change gears) when driving uphill but remove your foot from the gas pedal when driving downhill. Where is the monitoring component in this self-regulated driving? Possibly, what is being monitored is performance: The velocity of the car. When driving is smooth and relatively automatic, the pressure on the gas pedal is adjusted to the conditions of the road, maintaining more or less the same velocity. This is analogous to the process investigated by Pieschl et al., in which learning is adjusted to task complexity. In both cases possibly little planning or deliberate regulation are involved. The regulation is *data driven* (Koriat, Ma'ayan, & Nussinson, 2006), adjusted to the intrinsic demands of the task. Thus, in studying different pieces of information, you invest in each piece what it "calls for". There is no preliminary monitoring that drives regulation. Rather, what is being monitored is performance (e.g., comprehension).

When is regulation *goal driven*? Imagine that while you are driving you take a look at your watch and realize that it is getting late, and then decide to speed up. In that case, there is "planning" and deliberate regulation. Similarly, when preparing for an exam, a student may realize that there is no way s/he can go over the entire reading material, and therefore chooses to focus only on the easier parts of the material or those parts that are likely to figure in the exam. In these cases, it is monitoring that indeed drives and guides controlled self-regulation.

It is important to distinguish between data-driven and goal-driven regulation because the two types of regulation differ in their expected consequences (Koriat et al., 2006). However, this distinction is very difficult to apply in real-life situations like those investigated by Pieschl et al. In some cases, students may monitor task difficulty in advance and translate the output of their monitoring to self-regulation (monitoring-based control). In other cases, they may simply allocate to each task as much effort and time as it calls for, and it is by spending a great deal of effort attempting to master a certain task that they realize that that task is difficult (control-based monitoring). The distinction between these two types of regulation has implication for how we answer the question whether adaptation to task complexity is really beneficial to performance. In the case of control-based monitoring, efficient learners should respond appropriately to the intrinsic demands of each task, investing more effort in the more difficult tasks. Their ultimate performance might also disclose the same differentiation – better memory for the easier tasks. In the case of monitoring-based control, in contrast, the greater effort invested in the more difficult/complex tasks can be seen to reflect a deliberate attempt on the part of the student to compensate for differences in the a-priori difficulty of different tasks, as posited by the discrepancy-reduction model (Dunlosky & Hertzog, 1998). In that case, the signature of efficient self-regulated learning should be a more-or-less similar memory performance across tasks that differ in complexity or difficulty.

4. Monitoring and self-correction

Moving next to the article by Metcalfe and Finn (2012), they examined the self-correction processes that presumably occur when people learn new information that departs from what they have assumed all along. Learning involves not only the acquisition of new information but also the updating and revision of previously acquired information. What is interesting is that monitoring processes, and perhaps regulation processes as well, are involved in the revision of information. The hypercorrection effect that was investigated in this article refers to the phenomenon that errors endorsed with higher confidence are more likely to be corrected on a final test than are errors endorsed with lower confidence. In their study, Metcalfe and Finn found that even Grade 3–6 children exhibit a hypercorrection effect. This observation is quite surprising because the hypercorrection effect itself is counterintuitive: We might have expected that the errors that are endorsed with high confidence should be particularly resistant to change. The finding of a hypercorrection effect in children suggests that children are quite competent metacognitively. Like adults, after being given the correct answers to their high-confidence errors, the children reported that they knew the correct answers all along. Unlike young adults, however, the children showed only slight evidence of actually knowing all along the correct answers to the high-confidence errors.

The results of Metcalfe and Finn are relevant to the growing interest in the beneficial effects of testing. The concern about using testing to enhance learning is that it is liable to imprint erroneous responses. The hypercorrection findings with children mitigate that concern. Thus, testing and self-testing can be safely used with children when they are provided with feedback about their responses. Testing is a powerful tool not only for enhancing learning and memory but also for educating subjective experience and mending metacognitive illusions (Koriat & Bjork, 2006).

5. The developmental outlook on metacognition

The extension of metacognitive research from young adults to children has important practical and theoretical merits. Historically, the investigation of metacognitive processes has proceeded along two almost entirely separate lines. On the one hand, there has been extensive research in developmental psychology, spurred by the work of Flavell (1979). On the other hand, within cognitive psychology, there has been an upsurge of interest in laboratory-based investigation of basic processes in metacognition, spurred primarily by the work of Tom Nelson (see Nelson & Narens, 1990). There are some fundamental differences between these two lines of research both in the questions investigated and in the methodologies employed (see Koriat & Shitzer-Reichert, 2002) and great benefits accrue from combining insights from the two lines of investigation. Indeed, recent years have seen a rapprochement between the two research groups.

The extension of research from young adults to children has yielded several interesting findings. On the one hand, many findings, like those reported by Metcalfe and Finn, indicate that children exhibit very similar metacognitive phenomena to those of adults. Some of these findings have practical implications that should be brought to the attention of educational practitioners. Other results, however, have yielded interesting developmental trends that are theoretically informative. For example, a central tenet in models of self-regulated learning is that monitoring accuracy is an important determinant of efficient learning. However, research with children has highlighted the fact that monitoring does not always carry over to regulation. Thus, children sometimes fail to translate their accurate monitoring into efficient behavioral strategies and regulation (Dufresne & Kobasigawa, 1989; Koriat, Ackerman, Lockl, & Schneider, 2009). This "implementation deficit" (Metcalfe, 2009) allows researchers to dissociate monitoring from regulation, and invites a deeper understanding of the conditions that contribute to effective learning and performance.

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