Metacognitive Judgments and Control of Study

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ABSTRACT

Recent evidence indicates that people's judgments of their own learning are not epiphenomenal, but rather are causally related to their study behavior. It is argued here that people use these metacognitions in an effort to selectively study material in their own Region of Proximal Learning. They attempt to first eliminate materials that are already well learned. Then they progress successively from studying easier to more difficult materials. Successful implementation of this metacognitively guided strategy enhances learning. The necessary components are, first, that the metacognitions be accurate, and second, that the appropriate choices are implemented for study. With these parts in place, the individual is in position to effectively take control of his or her own learning.

The study of people's metacognition--their knowledge of their own knowledge--is motivated by the assumption that if metacognition were accurate people could take effective control of their own learning. Because of this assumed link to control of learning, whether metacognitive monitoring is or is not accurate has received much attention. In a recent article, Dunlosky and Lipko (2007) showed that, although under many circumstances people's metacomprehension judgments are biased, there are some circumstances under which they make excellent judgments. Similarly, in learning situations -- the focus of the present article--while some methods of eliciting people's judgments produce biases that make these judgments undiagnostic about the difficulty of learning the materials, when people make 'cue-only delayed judgments of learning' their judgments are highly diagnostic of their future performance (Dunlosky & Nelson, 1998). This procedure involves waiting some time after the original study of the to-be-learned materials before eliciting the judgments, and then presenting the cues alone, without the targets. Thus, although there are ways to evoke metacognitive errors (see Bjork, 1994), it is now well established that there are also ways to overcome them. To be a fully self-regulating learner, however, the individual must not only make accurate judgments but must also know how to convert those judgments into strategies for study that will pay off in the best learning gains for the situation at hand. This article, then, is concerned with questions of metacognitively guided control: Do people use their metaknowledge to control their learning? If so, how are the metacognitions used? And, finally, is their use effective?

Is there a causal relation between judgments of learning and study behavior?

The first issue that must be addressed is the possibility that metacognitions are epiphenomenal--feelings, perhaps even compelling feelings, but feelings that may not impact upon behavior. The assumption among researchers that this is not so stems largely from the finding of a negative correlation between people's judgments of learning and the amount of time they allocate for study. People preferentially study items that they believe that they have not learned well. For instance, Son and Metcalfe (2000) found 47 published experiments in which either judgments of learning had been assessed or item difficulty had been varied. Among those taking metacognitive judgments, 13 showed a negative correlation between judgments of learning and study time, while the other 3 showed null results. Among those in which no metacognition was assessed, 23 showed that people allocated more time to the difficult items, and 8 showed null results. There were, at the time, no reversals. Such results invited the interpretation that people were studying strategically, based on their metacognitions.

However, there are other interpretations. Difficult items may simply afford longer study, for instance. Bargh and Williams (2006) demonstrated that people behave automatically in many situations, and illustrated many cases in which external stimuli or events controlled people's behavior without their knowledge or awareness of the causes (and presumably without the intervention of metacognition). The fact that the negative correlation between study time allocation and item difficulty occurred whether metacognitive judgments were made or not might indicate that the judgments were made covertly and controlled study. But it might equally indicate that the judgments were irrelevant and the behavior was automatic.

Furthermore, several experiments have shown even when people appear to be behaving strategically a negative correlation between judgments of learning and study time may not occur. It disappears when people are under time pressure (Metcalfe, 2002; Son & Metcalfe, 2000; Thiede & Dunlosky, 1999) and when the well-learned items are eliminated from the pool of to-be-learned materials (Kornell & Metcalfe, 2006). Given that the negative correlation between study time and judgments of learning can no longer be taken as prima fascie evidence for a causal connection, the question arises as to whether people's metacognitive judgments do influence study behavior.

Three papers have addressed this issue head on. Thiede, Anderson and Therriault (2003) showed that when more accurate judgments of text comprehension were induced, people restudied more strategically, and performed better. They had three conditions: the no keyword, the immediate keyword, and the delayed keyword condition. Only the delayed keyword condition, in which people gave 5 keywords that captured the essence of each text, increased metacomprehension accuracy and it alone also changed people's choices. They chose to restudy texts on which they had performed poorly, whereas people in other conditions chose more randomly. After rereading what they had chosen, people in the delayed keyword condition performed better than did people in the other two groups.

Metcalfe and Finn (2008) also demonstrated that metacognitions had a causal effect on study choice. They used a metacognitive illusion found in a paper investigating an underconfidence bias (Finn & Metcalfe, 2006). Some to-be-learned pairs were presented 5 times and some only once during a first study-test trial. On the second trial the pairs that had been studied 5 times on the first trial were studied once (5-1) , and those studied only once were studied 5 times (1-5), equating performance. However, the judgments of learning on the second trial were higher for the 5-1 pairs than for the 1-5 pairs. This difference in people's metacognitions, even though it was illusory, produced differences in study choices: When people thought they knew the items better, they declined study relative to when they thought they knew them less well. These authors also used Koriat and Bjork's (2005) finding that with associatively asymmetrical pairs recall is higher in the forward (Cat given Kitten) than in the backward direction (Kitten given Cat). But people are metacognitively blind to the difference. Here, too, study choice was affected by people's metacognitions not their recall.

Finally, Finn (2008) asked people for judgments of whether they would *remember* or *forget* an answer. With 'remember' framing, the participants were confident in their memory and tended to decline restudy. With the 'forget' framing, they were less confident and chose to restudy. These three studies indicate that people's metacognitions are not epiphenomenal and underlines the need for accuracy in metacognitive judgments. Fortunately, the cue-only delayed judgment of learning procedure--which produces extremely high accuracy--can be used to elicit these judgments.

How do people use their metacognitions to control study?

Given that people do use their metacognitions to control study, the next question is how? There have been two theories of metacognitively guided study time allocation--the Discrepancy Reduction Model and the Region of Proximal Learning framework. Both--at least under some circumstances-- predict a negative correlation between judgments of learning and study time. The Discrepancy Reduction Model (Dunlosky & Hertzog, 1998) says that people study the most difficult items preferentially, devoting most of their time to reducing the largest discrepancies from their internal learning criterion. The correlation falls out directly of this central postulate of the model. The

Region of Proximal Learning framework (Metcalfe & Kornell, 2004) says that the first thing people do is to eliminate items they believe they have mastered from the pool of potential restudy items. This elimination of high judgment-of-learning items usually results in a negative correlation between study time and judgments of learning.

Once these already-learned items have been eliminated, though, the Region of Proximal Learning framework says that people will choose to selectively study the easiest rather the most difficult items first, turning to more difficult items only once the easier items have been studied, as shown in Figure 1. These easy items are the ones most susceptible to learning efforts and comprise the person's Region of Proximal Learning. This concept of a region in which the person's learning efforts are most likely to be productive draws on concepts such as Vygotsky's Zone of Proximal Development, Piaget's notion of décalage, and Atkinson's 'transitional learning' region.

An emphasis on studying the easiest items should be particularly salient when study time is short. Thiede and Dunlosky (1999; Son & Metcalfe, 2000) showed that people are sensitive to time pressure in just this way. With more time, people should turn to more difficult items, which will, of course, take more time to master (see, Metcalfe, 2002, Metcalfe & Kornell, 2004). The region of proximal learning is tailored to the individual: Experts are more likely than novices to have mastered the easy items in their own domains so their regions of proximal learning should be more towards the difficult items. Metcalfe (2002) and Metcalfe and Kornell (2004) showed this expertise-based shift toward difficult items with bilingual as compared to monolingual speakers learning Spanish-English vocabulary. Children should, and do (Metcalfe & Kornell, 2004), show a bias toward easier items when compared to adults. But the bias toward choosing easier items may be because they know less, rather than because they are children.

If the already-learned items were eliminated from the study choices the Region of Proximal Learning framework says that people should choose first the easiest remaining items rather than the most difficult remaining items. These easy but as-yet-unlearned items are likely to yield a near-certain payoff for the small investment of study time needed to propel them into a learned state. The discrepancy reduction model, by contrast, predicts that even when the already-learned items are eliminated from the choice possibilities, people should still tend to choose the most difficult items. Metcalfe and Kornell (2005) found that when items that were correct on a test were eliminated, people chose for restudy items assigned high judgments of learning rather than low judgments of learning, consistent with the Region of Proximal Learning framework.

These two models also speak to people's perseverance once an item is chosen for study. Both specify a stop rule. The Discrepancy Reduction model says that the person will persevere until the item reaches an internal criterion of being (sufficiently) learned. One problem with this stop rule is that people could study a difficult item for an unreasonably, possibly even infinitely, long time. The Region of Proximal Learning framework says that people stop studying an item when their perceived <u>rate</u> of learning approaches zero, as shown in Figure 2. An easy item is learned quickly with no further perceived learning; the rate accordingly goes to zero quickly. More study time is predicted for medium-difficulty items if people perceive themselves to be making progress. However, people may stop quickly on extremely difficult items if they do not feel themselves to be making progress.

This stop rule has implications for whether people should choose to mass or space their learning. First, they should choose to not study at all items with extremely high judgments of learning (because these are thought to be already mastered). They should defer study until a later time --choosing spaced practice-- on items with very high judgments of learning, because these easy items will very quickly produce no increases in perceived learning, and, the stop rule will indicate that further immediate study should stop. They should mass practice on difficult (but not impossible) items, because when the perceived rate of learning has not yet gone to zero the stop rule will indicate that the person should simply persist in studying. In a experiment looking at the relation of judgments of learning and spacing choices, this is exactly what college students did (Son, 2004).

Son (2005) also investigated children's spacing choices. Unlike adults, children mostly chose to mass their practice--a strategy with limited benefit for long-term learning--and they did so indiscriminately over the range of their judgments of learning. Schneider and Lockl (2002) suggested that while young children may have accurate metacognitions, they may nevertheless fail to translate their metaknowledge into effective study strategies.

Is Self-Determined Study Time Allocation Efficacious?

Given that people's metacognitions result in systematic study choices (at least for adults), we can ask the final question of whether such metacognitively guided study enhances learning? Thiede et al's (2003) metacomprehension study, described above, suggests an affirmative answer. To further address this question Kornell and Metcalfe (2006) developed the honor/dishonor paradigm, in which, after making judgments of learning, people are allowed to make their own study choices. These choices, though, may be either honored or dishonored in what the experimenter presents for restudy. The logic is that if people perform better when they are allowed to restudy the items that they chose rather than those they declined, then their choices were the right ones.[i] Experiments using this paradigm have consistently shown that honoring the person's choices resulted in superior performance. This occurred when no items were eliminated from the pool, and people's choices tended to be low judgment-of-learning items. It also occurred when the items that were correct on an intervening test were eliminated from the choice pool and people's choices tended to be high judgment-of-learning items.

Conclusions and Future Directions

These early results are encouraging. Even so, they beg further elaboration and scrutiny. The connections among metacognition, control strategies, and learning are only starting to be understood. Payoffs in a learning situation should affect strategy, but these have not yet been explored nor implemented in any models to date. Individual differences, including not only gross deficits in metacognitive monitoring or the implementation of strategies, but also differences in other cognitive capabilities such as working memory (e.g., Griffin, Wiley, & Thiede, 2008), attention, motivation, perseverance, and individual goals, are all likely to be crucial both in metacognition about learning and the attendant control processes these allow.

The further development of theory on what processes, concepts and learning materials are in an individual's Region of Proximal Learning, may allow us to pinpoint inadequacies in the learners' monitoring or choice strategies that lead to learning difficulties. The locus of impairments will have consequences for intervention, of course.

Advances in the field of metacognition now allow us to elicit highly accurate judgments of learning from people as young as kindergarten children.   But even with excellent metacognition, this knowledge may not be implemented appropriately to allow effective study strategies--suggesting an obvious point of intervention and remediation. Further research should be directed at isolating the conditions that produce optimal learning in people of different ages, the metacognitive and control processes they use, and whether or not these are effective.   Doing so will put psychologists in a better position to intervene, when necessary, but also, and ultimately, to foster the individual's own effective control over their learning.

Suggestions for Further Reading:

Nelson, T. O., & Narens, L. (1990). Metamemory: A theoretical framework and new findings. In G. H. Bower (Ed.), *The psychology of learning and motivation* (Vol. 26, pp. 125–141). New York: Academic Press.

A classic paper that influenced all subsequent research on metacognition and on the connections between metacognition, control, and learning. This paper discusses metatheoretical and philosophical implications of metacognition.

Kuhn, D, & Dean, D., Jr. Metacognition: A bridge between cognitive psychology and educational practice. *Theory into Practice, 43*, 268-273.

A fascinating study on how the mechanisms of metacognition, investigated by cognitive psychologists, may be applied in education, and can provide a bridge between educational practitioners and academic researchers, resulting in a cross fertilization that may greatly foster the educational goal of critical thinking so valued in our society.

Dunlosky, J. & Metcalfe, J. (2008). *Metacognition.* San Francisco: Sage.

A comprehensive textbook providing a thorough grounding in all aspects of human metacognition, both theoretical and applied.

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Dunlosky, J., & Hertzog, C. (1998). Training programs to improve learning in later adulthood: Helping older adults educate themselves. In D. J. Hacker, J. Dunlosky, & A. C. Graesser (Eds.), *Metacognition in educational theory and practice* (pp. 249–275). Mahwah, NJ: Erlbaum.

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Koriat, A., & Bjork, R. A. (2005). Illusions of competence in monitoring one's knowledge during study. *Journal of Experimental Psychology: Learning, Memory and Cognition, 31*, 187-194.

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Metcalfe, J. (2002). Is study time allocated selectively to a region of proximal learning? *Journal of Experimental Psychology: General*, *131*, 349-363.

Metcalfe, J. & Finn, B. (2008). Evidence that judgments of learning are causally related to study choice. *Psychonomic Bulletin Review*, *15*, 174-179.

Metcalfe, J. & Kornell, N. (2003). The dynamics of learning and allocation of study time to a region of proximal learning. *Journal of Experimental Psychology: General*, *132*, 530-542.

Metcalfe, J., & Kornell, N. (2005). A region of proximal learning model of study time allocation. *Journal of Memory and Language*, *52*, 463-477.

Schneider, W., & Lockl, K. (2002). The development of metacognitive knowledge in children and adolescents. In T.J. Perfect & B.L. Schwartz (Eds.), *Applied metacognition* (pp. 224-257). Cambridge, UK: Cambridge University Press.

Son, L.K. (2004). Spacing one's study: Evidence for a metacognitive control strategy. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *30*, 601-604.

Son, L.K. (2005). Metacognitive control: Children's short-term versus long-term study strategies. *The Journal of General Psychology*, *132*, 347-363.

Son, L. K., & Metcalfe, J. (2000). Metacognitive and control strategies in study-time allocation. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *26*, 204-221.

Thiede, K. W., Anderson, C. M., & Therriault, D. (2003). Accuracy of metacognitive monitoring affects learning of texts. *Journal of Educational Psychology, 95,* 66-75.

Thiede, K.W., & Dunlosky, J. (1999). Toward a general model of self-regulated study: An analysis of selection of items for study and self-paced study time. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *25*, 1024-1037.

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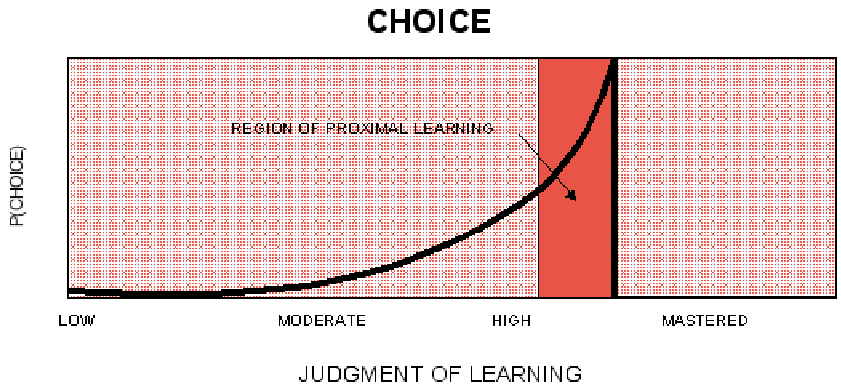
Figure Captions

Figure 1. The relation between judgments of learning and study choice that are postulated by the Region of Proximal Learning framework**.**

Figure 2. Study perseverance in the Region of Proximal Learning framework. The stop rule used in this model indicates that study stops when the perceived rate of learning approaches zero. The inset boxes show the functions, over time, of the person's perceived rates of learning for very difficult, fairly difficult, slightly difficult and easy items. The triangles in each inset indicate the time at which the perceived learning function goes to zero, and, hence, the time at which study will stop for that particular level of item difficulty. As is shown in the large bottom panel, the result is that the time to stop as a function of item difficulty varies, but not necessarily in a monotonic way. For extremely difficult (unlearnable) items the time to stop may be quite short, because the perceived rate of learning reaches zero quickly.


CHOICE
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P(CHOICE)
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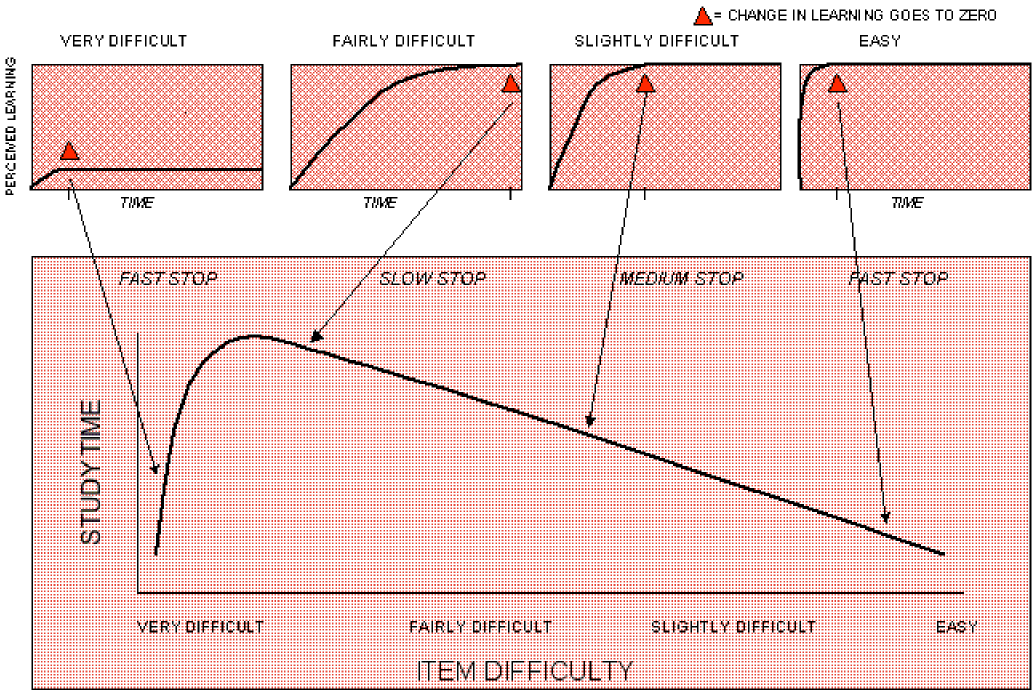

Footnote

[i] This paradigm does not permit differentiation between 'choicefulness,' that is, a benefit that accrues because the person makes the choice himself or herself, from a benefit that results from study of the right items, unless the person chooses the wrong items. No experiments in which people had their wrong choices dishonored in favor of the correct choices have been published.