Consciousness and Cognition 19 (2010) 251–264

Contents lists available at ScienceDirect

Consciousness and Cognition

journal homepage: www.elsevier.com/locate/concog

Metacognition and mindreading: Judgments of learning for Self and Other during self-paced study

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ARTICLE INFO

Article history:
Received 6 August 2009
Available online 21 January 2010

Keywords:
Metacognition
Mindreading
Judgments of learning
Theory of mind
Monitoring and control

ABSTRACT

The relationship between metacognition and mindreading was investigated by comparing the monitoring of one's own learning (Self) and another person's learning (Other). Previous studies indicated that in self-paced study judgments of learning (JOLs) for oneself are *inversely* related to the amount of study time (ST) invested in each item. This suggested reliance on the memorizing-effort heuristic that shorter ST is diagnostic of better recall. In this study although an inverse ST–JOL relationship was observed for Self, it was found for Other only when the Other condition followed the Self condition. The results were interpreted in terms of the proposal that the processes underlying experience-based metacognitive judgments are largely unconscious. However, participants can derive insight from observing themselves as they monitor their own learning, and transfer that insight to Other, thus exhibiting a shift from experience-based to theory-based judgments. Although different processes mediate metacognition and mindreading, metacognition can inform mindreading.

1. Introduction

There has been extensive research and discussion in both philosophy and psychology on the processes underlying the knowledge of other minds. The ability to infer another person's mental state has been assumed to represent a basic social capability that enables explaining and predicting the behavior of others (Barr & Keysar, 2005). One of the central issues concerns the relationship between metacognition – knowing one's mind – and mindreading – understanding other minds (Carruthers, 2009; Dimaggio, Lysaker, Carcione, Nicolò, & Semerari, 2008). The present study explores this question in a circumscribed area of research – the monitoring of learning during the study of new materials. In many situations in everyday life people need to monitor their own learning and comprehension of the studied material (metacognition). In other conditions, however, they must also monitor the learning and understanding of another person (mindreading). Sometimes, as in a conversation involving several people, each of them engages in both types of monitoring, often "reading" different clues that disclose others' metacognitive states (Brennan & Williams, 1995; Koriat, Ben-Zur, & Druch, 1991). We examined the question whether the processes underlying this ability are the same as those engaged in the on-line monitoring of one's own learning.

In studies of metacognitive monitoring during learning (see Dunlosky & Metcalfe, 2009; Koriat, 1997), participants typically study a list of paired associates and make a judgment of learning (JOL) at the end of each study trial reflecting the likelihood that they will recall the target word at test when probed with its corresponding cue word. In many such studies

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doi:10.1016/j.concog.2009.12.010

learners' JOLs were found to be moderately accurate in predicting which items will be recalled and which items will not (Dunlosky & Nelson, 1994). Furthermore, under self-paced conditions, learners use their JOLs as a basis for allocating study time to different items (e.g., Lockl & Schneider, 2003; Mazzoni, Cornoldi, & Marchitelli, 1990; Metcalfe, 2009). These results have been interpreted in terms of a Monitoring → Control model (Nelson & Leonesio, 1988; Son & Schwartz, 2002) according to which learners monitor on-line the degree of learning of each item, and regulate the allocation of study time on the basis of their monitoring (Dunlosky & Hertzog, 1998).

More recently, Koriat, Ma'ayan, and Nussinson (2006) proposed to consider a second general model of the relationship between metacognitive monitoring and metacognitive control. According to this, Control → Monitoring model, metacognitive monitoring may be based also on the feedback from control operations and thus follows rather than precedes control processes. They proposed that in self-paced learning study time allocation is basically data driven rather than goal driven: Learners spend whatever amount of time is called for by the item. Study time then informs the learners about the subjective encoding difficulty of the item, and is used by them as a basis for JOLs under the memorizing-effort heuristic. According to this heuristic, easily encoded items are more likely to be remembered than items that require greater effort to study. That is, it is not that learners necessarily judge an item as difficult and choose deliberately to invest relatively more time in studying it. Rather, it is by investing a great deal of time studying an item that learners realize that the item is difficult and will probably not be recalled.

The Monitoring → Control model and the Control → Monitoring model make different predictions regarding the relationship between study time (ST) and JOL. The signature of the Monitoring → Control model is a positive ST–JOL relationship: Assuming that JOLs reflect the level of mastery that the learner attempts to attain by regulating ST, then JOLs should increase with increasing ST. In contrast, the signature of the Control → Monitoring model is a negative ST–JOL relationship: The more ST a learner invests in an item, the lower his or her JOL should be. The results of Koriat and Bjork (2006; see also Koriat, 2008b) provided evidence in support of the Control → Monitoring model: Under self-paced instructions, JOLs made at the end of each study trial *decreased* with increasing ST, suggesting reliance on the memorizing-effort heuristic in making JOLs. Furthermore, the validity of this heuristic was supported by the finding that actual recall was *inversely* related to ST. In a recent study, the inverse relationships between ST, on the one hand, and JOLs and recall, on the other hand, were obtained even for 9-year-old children (Koriat, Ackerman, Lockl, & Schneider, 2009b).

The idea that recall should decrease with the amount of self-paced ST is counterintuitive. It contrasts with the general belief that memory improves with the amount of time allocated during study. In fact, even 4-year-olds have been found to hold the belief that increased effort will lead to increased recall (O'Sullivan, 1993; Wellman, Collins, & Glieberman, 1981). Nevertheless, the results just mentioned suggest that learners' metacognitive judgments incorporate the implicit assumption that longer ST is diagnostic of poorer recall.

The present study extended investigation of the ST–JOL relationship to a situation in which a person makes recall predictions for another learner. Given that the monitoring of one's own learning (Self) is characterized by a negative ST–JOL relationship, would the same relationship be exhibited in making predictions for a target learner (Other)? Consider the situation of a teacher who is watching a student studying a list of items. Would she also apply the memorizing-effort heuristic, expecting recall to decrease with the amount of ST invested by the student? Or would she, perhaps, expect recall to *increase* with ST as would be predicted from many experimental findings (e.g., Cooper & Pantle, 1967; Dunlosky & Thiede, 1998; Koriat, 1997). Both types of relationship were observed in studies in which participants were asked to guess the feeling-of-knowing (FOK) ratings made by other target persons who attempted to answer general-information questions (Brennan & Williams, 1995; Jameson, Nelson, Leonesio, & Narens, 1993). When the target persons provided an answer, longer response latencies led observers to guess lower FOK ratings. In contrast, when the target persons failed to respond, longer "Don't know" latencies led observers to guess higher FOK ratings. In both cases observers' predictions accorded with the FOK ratings made by the target participants themselves. The results suggested that in addition to response latency, observers based their FOK guesses on paralinguistic features of the target's utterances such as pauses, intonation and interjections.

The question of how people predict Other's knowledge has bearing on the general issue in Theory of Mind (ToM) of how we attribute mental states to others in order to explain or predict their behavior. Questions about ToM have been investigated in several fields of research, notably developmental psychology, animal behavior and special populations (Baron-Cohen, Leslie, & Frith, 1985; Corcoran, Mercer, & Frith, 1995; Langdon, Coltheart, & Ward, 2006; Perner, 1991; Smith, Shields, & Washburn, 2003). The present study, in contrast, involves normal human adults. We address the question: Do we apply similar processes in knowing others as we use in knowing ourselves? Several theoretical frameworks would seem to suggest little difference between interpreting one's own behavior and interpreting others' behavior. According to the *Simulation theory* of ToM, when we observe other persons' behavior, we simulate their actions in our minds. We model how they feel and act, and by using our own mental mechanisms we replicate or emulate their mental states in a process that is an extended form of empathy (Dimaggio et al., 2008; Gallese & Goldman, 1998; Goldman, 2006; Harris, 1992). Simulation theory implies that mindreading relies on metacognition and that this ability increases as children grow older. That is, the attribution of mental states to others depends upon our access to our own mental states (Goldman, 1992; see Nickerson, 1999). If so, perhaps observers who watch another person struggling to master study materials can empathize with the amount of effort he or she invests in different items, and would expect recall probability to decrease with increased ST, as they do for themselves.

Results consistent with this possibility were reported by Kelley and Jacoby (1996; see also Kelley, 1999; Nussinson & Koriat, 2008). Participants who were asked to predict how difficult it would be for others to solve different anagrams, were quite accurate in their predictions. Presumably they relied on their own experience attempting to solve those anagrams