Consciousness and Cognition 42 (2016) 41–50

Contents lists available at ScienceDirect

Consciousness and Cognition

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

The influence of retrieval practice on metacognition: The contribution of analytic and non-analytic processes

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ARTICLE INFO

Article history:
Received 22 July 2015
Revised 4 March 2016
Accepted 6 March 2016

Keywords:
Metacognition
Overconfidence
Retrieval practice
Inferential processes

ABSTRACT

People may change their memory predictions after retrieval practice using naïve theories of memory and/or by using subjective experience – analytic and non-analytic processes respectively. The current studies disentangled contributions of each process. In one condition, learners studied paired-associates, made a memory prediction, completed a short-run of retrieval practice and made a second prediction. In another condition, judges read about a yoked learners' retrieval practice performance but did not participate in retrieval practice and therefore, could not use non-analytic processes for the second prediction. In Study 1, learners reduced their predictions following moderately difficult retrieval practice whereas judges increased their predictions. In Study 2, learners made lower adjusted predictions than judges following both easy and difficult retrieval practice. In Study 3, judge-like participants used analytic processes to report adjusted predictions. Overall, the results suggested non-analytic processes play a key role for participants to reduce their predictions after retrieval practice.

1. Introduction

Metacognition refers to people's awareness, knowledge, and control of their cognitive abilities (Flavell, 1979). Metacognitive awareness, or monitoring, can be measured in a variety of ways (e.g., Nelson & Narens, 1990). For example, the ability to monitor one's memory can be measured using prospective judgments, in which the person makes a prediction about future memory performance, and using retrospective judgments, in which the person makes a judgment about past performance (Arbuckle & Cuddy, 1969; Hart, 1965). In both cases, the accuracy of these metacognitive monitoring judgments can be assessed by determining how well these judgments correspond with past or future performance using difference scores, gamma correlations, and receiver operating characteristics among other measures (Cheng, 2010; Fleming & Lau, 2014; Nelson, 1996). What is more difficult to determine, though, is how people make these judgments and what information they use to assess how well they will or have performed on a cognitive test (for one account of what information people use to make monitoring judgments see Nelson & Dunlosky, 1991; for a review see Schwartz, 1994).

The cues people use to make monitoring judgments can be broadly categorized as either analytic (or theory-based) or nonanalytic (experience-based; Koriat, Bjork, Sheffer, & Bar, 2004; Kelley & Jacoby, 1996). Kelley and Jacoby suggested that analytic cues arise from people's beliefs or theories about memory and the factors that influence memory performance, whereas nonanalytic cues arise from people's subjective experiences of performing the task. Similarly, Koriat (1997) offered

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http://dx.doi.org/10.1016/j.concog.2016.03.010
1053-8100/

a framework for describing the types of cues that affect memory predictions. Intrinsic cues were defined as ones that are inherent to the studied items, such as the relationship between studied associates (e.g., nurse–doctor). Extrinsic cues were defined as ones that are not inherent to the studied items that could include a variety of factors such as people's lay theories of memory (e.g., how repetition influences memory). Mnemonic cues were defined as those that are related to the person's experience studying the information (thoughts about the items, reminiscence about prior related experiences, etc.). Of course, people likely use all of these types of cues to make monitoring judgments. For example, a person could study a distinctive item (an item printed in large font amongst other small font items), and use the item features and the fluent processing experience, along with a theory about distinctive items or fluent processing being well remembered, to inform their prediction about whether an item will be remembered at a later point. In this paper we will focus on the distinction between analytic and nonanalytic processes.

There have been a few attempts to assess the separate contributions of analytic and nonanalytic processes to metacognitive judgments. For example, research shows that participants judge that they will remember words printed in larger fonts better than they will remember words printed in smaller fonts (Rhodes & Castel, 2008; see also Kornell & Bjork, 2009; Kornell, Rhodes, Castel, & Tauber, 2011). In the Rhodes and Castel study, participants made a judgment of learning (JOL) after studying words that were printed in large and small fonts and were later asked to recall these words. Results showed that participants gave higher JOLs for words presented in large fonts compared to those presented in small fonts, whereas recall was not affected by font size. Thus, the authors concluded that the perceptual font information lead to an illusion of memory. One explanation for this illusion is that the font manipulation influenced participants' non-analytic (or experience-based) processing. The idea is that participants interpreted the relative ease of reading or processing words printed in large font as a benefit for later memory performance. The assumption is that participants have different subjective experiences for larger compared to smaller font words and that they use these experiences as cues to make judgments about the future memorability of these items. But, it could be that people gave higher JOLs to items printed in larger fonts than those printed in smaller fonts because they believed that more salient perceptual features would benefit memory performance, an analytic (or theory-based) process. Recently, evidence has emerged that provides evidence against the non-analytic account—that large fonts are processed more fluently—and supports the analytic interpretation instead (Mueller, Dunlosky, Tauber, & Rhodes, 2014). Mueller et al. showed that items presented in large fonts were not processed more fluently than the items presented in small fonts, as evidence by similar lexical decision and study times for large and small font items, despite being assigned higher JOLs. Further, they found that people predicted that others would recall more large- than small-font items. Here, the possibility of using non-analytic (or experience-based) processes to inform recall predictions was eliminated and yet font size affected predictions, suggesting that people use analytic (theory-based) processes when predicting performance. Finally, participants gave higher JOLs to large-font relative to small-font items before they even saw the items (using a pre-study JOL paradigm; Castel, 2008), again suggesting that people used analytic processes to make JOLs for large and small font items. Thus, this study provided evidence for the role of analytic processes for making JOLs that are based on perceptually salient cues.

There have been other attempts to estimate the separate contributions of analytic and non-analytic processes by preventing access to one process. One way to do this is to use a method similar to the one used by Mueller et al. (2014) in which participants make a judgment about another participant's recall, thus preventing the use of non-analytic (experience-based) processes from contributing to their judgments(e.g., Matvey, Dunlosky, & Guttentag, 2001; Vesonder & Voss, 1985). In this paradigm some participants are assigned to be *learners*, and experience the full range of experimental tasks potentially using both analytic and non-analytic processes to assess their learning. Other participants are assigned to be *judges,* and are simply given information about the learners' performance, and are asked to make a future performance prediction. By design, the judges can only use analytic processes to make judgments about the learner's experience and performance, while the learners can use either or both types of processes. In the Matvey et al. (2001) study, learners studied cue-target pairs for a later recognition memory test and were either asked to read the cue and the target item, or generate a rhyming target in response to the cue (e.g., cave - s _ _ _, for cave - save). After each item, learners made a JOL about their future memory performance for that item. Judges saw the outcome of a learner's attempt to generate the rhyming target (thus removing the experience of attempting to generate the rhyming word, a nonanalytic process), and then made a prediction about how likely the learner would be able to recognize the target. For learners, the longer it took them to generate the target in the rhyme condition the less likely they were to predict that they would recognize the target on a later memory test. Their subjective experience of generating the targets served as a cue for the monitoring judgment. In contrast, the JOLs judges reported for the learners were not influenced by the learner's time to produce the target item at study. The results demonstrate a case in which people use nonanalytic processes to make JOLs.

Thus, there is good evidence from a variety of paradigms showing that participants can use both types of processes to make future memory predictions. In the Mueller et al. study described earlier, participants who relied on analytic cues gave similar monitoring judgments to learners (who used both analytic and non-analytic processes). On the other hand, in the Matvey et al. study, participants who only used analytic processes gave JOLs that were significantly different than the learners' JOLs. More recently research using item-by-item JOLs indicates that subsequent predictions are affected primarily by non-analytic processes (Serra & Ariel, 2014). Serra and Ariel suggest that participants use a *memory for past test* (MPT) strategy whereby they make JOLs based on their previous performance on the same to-be-remembered items. Taken together, these studies show that people can use both analytic and non-analytic processes to make JOLs and that the contribution of the two inferential processes can be separated.