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The Ease-of-Processing Heuristic and the Stability Bias: Dissociating Memory, Memory Beliefs, and Memory Judgments

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Abstract

Judgments about memory are essential in promoting knowledge; they help identify trustworthy memories and predict what information will be retained in the future. In the three experiments reported here, we investigated the mechanisms underlying predictions about memory. In Experiments 1 and 2, single words were presented once or multiple times, in large or small type. There was a double dissociation between actual memory and predicted memory: Type size affected predicted but not actual memory, and future study opportunities affected actual memory but scarcely affected predicted memory. The results of Experiment 3 suggest that beliefs and judgments are largely independent, and neither consistently resembles actual memory. Participants' underestimation of future learning—a stability bias—stemmed from an overreliance on their current memory state in making predictions about future memory states. The overreliance on type size highlights the fundamental importance of the *ease-of-processing heuristic*: Information that is easy to process is judged to have been learned well.

Keywords

memory, judgment, metacognition, stability bias, ease-of-processing heuristic

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The term *metamemory* refers to people's judgments and beliefs about memory. The statement "I'll never forget John Goodman's performance in the movie *The Big Lebowski*" is an example of a judgment about a specific memory; the statement "studying leads to learning" is an example of a general belief. Metamemory judgments play important roles in everyday decision making ("Do I need a shopping list?"), in education ("Do I need to study more for the test?"), and in even more consequential situations ("Can I remember the doctor's instructions?").

The Stability Bias

When explicitly asked, people report the belief that studying leads to learning (Kornell & Bjork, 2009). They respond differently, though, when asked to make item-by-item predictions of how well they will do on a future test. In a previous study, Kornell and Bjork (2009) asked participants to predict their performance on a test that would take place after between one and four study opportunities. The resulting predictions were almost completely insensitive to the number of future study opportunities (although additional study trials did dramatically enhance actual memory performance). That is, although everyone knows that studying enhances learning, and the manipulation of study opportunities was made highly salient, participants predicted that they would learn little from future study trials; this finding is termed the *stability bias*.

Koriat, Bjork, Sheffer, and Bar (2004) discovered a parallel effect by manipulating retention intervals. Separate groups of participants were shown pairs of words; one group was asked to predict the number of pairs they thought they would remember after 10 min, and another group was asked to predict how many they would remember after 1 week. The groups made virtually identical predictions, but displayed large differences in actual memory performance when tested. Although the participants believed that forgetting happens, their judgments about their memory ability were inconsistent with this belief (cf. Kornell, 2010).

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It is possible to make people more sensitive to their own beliefs, however. When Koriat et al. (2004) made the concept of forgetting salient—either by using a within-participants design or by asking participants to predict how much they would forget (cf. Finn, 2008)—predictions became more sensitive to retention intervals. Kornell and Bjork (2009) reported similar findings when they manipulated item repetition on a within-participants basis (as we did in the experiments reported in this article). It appears that beliefs do not affect judgments automatically but can affect judgments when beliefs are made salient.

On the basis of such findings, Koriat et al. (2004; see also Kahneman, 2003; Kelley & Jacoby, 1996) categorized beliefs about memory as theory-based judgments. Other cues, such as word-pair relatedness, were expected to elicit experience-based judgments. Koriat (1997) proposed a related framework for identifying cues that affect judgments. *Intrinsic cues* were defined as information inherent to the items being studied (e.g., cue-target relatedness). *Mnemonic cues* were defined as information related to the learner's experience while performing a task (e.g., memory for a prior test; see Finn & Metcalfe, 2008). *Extrinsic cues* were defined as information not inherent to the learner or the to-be-learned material. This framework has been influential and frequently supported. It predicted, correctly, that extrinsic cues, such as future study opportunities and retention intervals, are often ignored when people make judgments. In general, Koriat's (1997) framework often makes accurate predictions. In the research reported here, our primary aim was to investigate why its predictions are correct—that is, to investigate the processes underlying metamemory judgments.

Ease of Processing

Like Kornell and Bjork (2009), Rhodes and Castel (2008) discovered a surprising result regarding metacognitive judgments. They manipulated the type size that words were studied in (e.g., either 18 or 48 point) and asked participants to predict future memory performance. Type size had almost no effect on actual memory, but predicted memory was higher for words that were presented in larger type than in smaller type.

This finding was explained with the ease-of-processing heuristic: Large type made processing subjectively seem more fluent than small type did, thus affecting predictions but not actual memory (see also Rhodes & Castel, 2009). Previous research has shown that perceived ease, or fluency, of processing reliably affects judgments of future remembering (and judgments more generally; see Alter & Oppenheimer, 2009; Kelley & Rhodes, 2002; Oppenheimer, 2008). Information that is easy to encode (encoding fluency) and retrieve (retrieval fluency) tends to produce high metacognitive judgments. This is true even when encoding fluency (e.g., Castel, McCabe, & Roediger, 2007) and retrieval fluency (e.g., Benjamin, Bjork, & Schwartz, 1998; Kelley & Lindsay, 1993) do not accurately predict future memory performance.

The Current Experiments

In the experiments reported here, we investigated the relationship, or lack thereof, between judgments about memory, beliefs about memory, and actual memory performance. In doing so, we hoped to elucidate when, and to what degree, metacognitive judgments rely on (a) relatively automatic, heuristic processes (such as the ease-of-processing heuristic); (b) people's beliefs about memory; and (c) people's current subjective memory states, irrespective of future events. To do so, we took the novel approach of directly comparing the influence of two different types of cues—type size and the promise of future study trials—on metamemory judgments.

Single words were presented for study once or twice in Experiment 1 and once or four times in Experiment 2. Each word was presented in type that was either large or small. We predicted a double dissociation between memory and metamemory. That is, we predicted that type size would affect judgments about memory but not memory itself, whereas the number of study trials would affect actual memory but not judgments about memory. In Experiment 3, we examined participants' beliefs about the effects of both variables to understand the relationship between beliefs and judgments. Again, we predicted that beliefs would be largely independent of both actual memory and judgments about memory, a finding that would have considerable bearing on the veracity of metacognitive judgments.

Experiment 1

In Experiment 1, participants studied a list of words and predicted the likelihood of recalling each word on an upcoming test. The words were presented in either small or large type, and each word was presented either once or twice. To give participants every opportunity to make accurate predictions, we made the manipulations of type size and the number of study trials abundantly clear. Moreover, both variables were manipulated within participants, a procedure that has been shown in previous research to make participants more sensitive to the number of study repetitions (Kornell & Bjork, 2009).

Method

Participants. Eighty-three participants (50 female, 33 male; mean age = 29 years, range = 17–67 years) were paid $1.00 for completing the experiment, which took 10 min. They were recruited via Amazon's Mechanical Turk, a Web site that allows users to complete small tasks for pay. All participants lived in the United States.

Materials. The materials consisted of 36 nouns (e.g., *mustard*, *reverend*, *tooth*) taken from the norms established by Kucera and Francis (1967). Their frequency ranged from 20 to 21 occurrences (average = 20.5) in a corpus of 1,014,000 written words; the nouns had an average of 5.9 letters and 2.0 syllables.

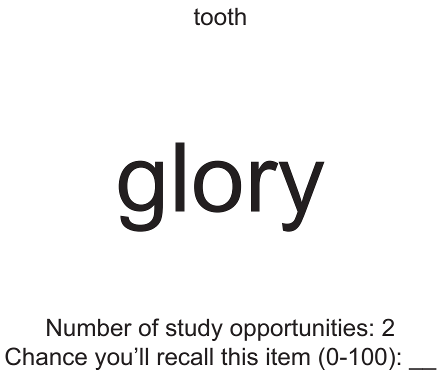
Design. The study design featured two independent variables—type size (small and large) and number of study trials (one or two)—manipulated within participants. The two dependent variables were actual recall and predicted recall.

Procedure. The experiment took place online. After signing in, participants read the following instructions:

> In this experiment you will study 36 words. As you study, we will ask you to estimate your chance of recalling each word on a later test. For example, if you think you have a 50% chance of recalling a word, you would type in 50. The words will be presented in differing font sizes. Also, after you study all of the words once, you'll get 1 additional chance to study some of the words (without making recall estimates). When you make your recall estimates, you'll be told whether you'll be getting 1 or 2 total chances to study each word. After you are done studying you will be asked to recall as many of the words as you can.

After reading these instructions, participants began to study. They were shown a word in either large or small type for 4 s. The exact size of the type (and the specific font in which it appeared) depended on the default settings of the user's Web browser and the size of his or her monitor, but the larger type was always four times bigger than the smaller type (e.g., 64 point vs. 16 point; see Fig. 1). Words were assigned randomly but evenly to two conditions for each participant: one study trial and two study trials.

After each study word had appeared on screen for 4 s, a prediction prompt appeared beneath the word. The prompt told participants whether they would have an additional opportunity to study that word before being tested. Participants then entered an estimate indicating the chance that they would recall this item (0–100%) on the test. There was no time limit for making the prediction. After participants made a prediction for all 36 items, the 18 items in the two-study-trials condition were presented again, in the same type size as the first time, for 4 s each in a new random order. The prediction prompt did not appear during the restudy phase. When the study and restudy phases ended, participants were given 2 min to type as many words as they could remember.



tooth

glory

Number of study opportunities: 2
Chance you'll recall this item (0-100): __

Fig. 1. Sample stimuli and prediction prompt used in Experiments 1 and 2. Participants saw a single word displayed either in small type (top row) or in type four times larger than the small type (middle row). After 4 s, a prediction prompt (bottom row) appeared beneath each word (on its first appearance only). The prompt listed the number of study opportunities: one or two in Experiment 1, and one or four in Experiment 2. Participants estimated the chance that they would recall this item (0–100%) on a subsequent recall test.

Results and discussion

Predicted recall was significantly higher for words presented in large type than in small type, $F(1, 82) = 39.89$, $p < .0001$, $\eta_p^2 = .33$ (Fig. 2). It was also higher when participants were told they would have two study trials than when they were told they would have one, $F(1, 82) = 4.62$, $p < .05$, $\eta_p^2 = .05$. The interaction between the number of study trials and type size was not significant, $F < 1$. The actual effect of studying on recall dwarfed the predicted effect. Actual recall was significantly higher following two study trials than following one, $F(1, 82) = 111.06$, $p < .0001$, $\eta_p^2 = .58$ (Fig. 2). Actual recall was not affected by type size, $F(1, 82) = 1.19$, $p = .28$, nor did type size interact with the number of study trials, $F(1, 82) = 0.62$, $p = .43$.

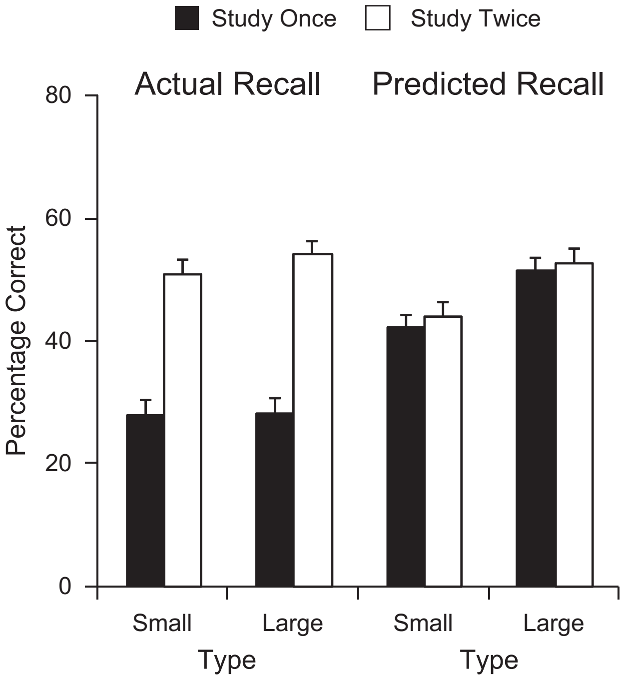


Fig. 2. Results from Experiment 1: mean percentage of words that participants predicted they would recall and that they actually recalled as a function of type size and number of study opportunities. Error bars show 1 *SEM*.

Table 1 displays the main effects of each manipulation on actual and predicted recall. Effects were calculated by subtracting the average recall percentage for words presented in small type or on fewer study trials from the average recall percentage for words presented in large type or on more study trials, respectively. For instance, the overall effect of studying words written in large type was an increase of 1.8 percentage points in actual recall compared with studying words written in small type. As Table 1 shows, additional study enhanced actual recall but had little effect on predicted recall. Large type robustly affected predicted recall but not actual recall.

These data appear to show a double dissociation: Type size affected only predicted recall, whereas the number of study trials affected only actual recall. This dissociation does not suggest that predicted and actual memory are independent in all situations. It does, however, provide strong evidence that memory judgments are made on the basis of immediate subjective impressions (e.g., the ease of processing produced by large type) rather than beliefs about memory (e.g., studying results in learning) or actual memory strength.

Experiment 2

Participants' predictions in Experiment 1 were breathtakingly inaccurate. We became concerned that perhaps participants had discounted the effect of the number of study trials because there was only one additional study trial (the large memory benefit of the extra study trial notwithstanding). To make the benefit of the number of study trials more salient, we compared the effects of one with four study trials in Experiment 2 but kept all other characteristics of Experiment 1 constant.

Table 1. Effect of Large Type and Additional Study Trials on Actual and Predicted Recall in Experiments 1 Through 3

	Actual recall		Predicted recall	
Experiment and effect	*M*	*SD*	*M*	*SD*
Experiment 1				
Large type (vs. small type)	1.8	15.2	9.1	13.1
Two study trials (vs. one study trial)	24.6	21.2	1.7	7.0
Experiment 2				
Large type (vs. small type)	1.4	14.0	8.0	12.2
Four study trials (vs. one study trial)	38.2	22.5	6.5	12.8
Experiment 3				
Large type (vs. small type)	1.8	15.2	14.0	14.7
Two study trials (vs. one study trial)	24.6	21.2	18.5	15.7

Note: Effects were calculated by subtracting the average recall percentage for words presented in small type or on fewer study trials from the average recall percentage for words presented in large type or on more study trials, respectively. Actual recall scores were not collected in Experiment 3; they were estimated on the basis of actual recall in Experiment 1. Predicted recall in Experiment 3 was calculated as the amount by which predictions exceeded 40%, which was the overall percentage of items recalled in Experiment 1.

Method

Participants. Eighty-four participants (54 female, 30 male; mean age = 29 years, range = 18–58 years) were recruited via Amazon's Mechanical Turk. All participants lived in the United States.

Procedure. The materials and design were the same as in Experiment 1. Two sentences of the instructions were modified, in accordance with the new procedure, to read as follows: "Also, after you study all of the words once, you'll get 3 additional chances to study some of the words (without making recall estimates). When you make your recall estimates, you'll be told whether you'll be getting 1 or 4 total chances to study each word." After all predictions had been made, 18 of the 36 items were presented for restudy, three times, in random order each time.

Results and discussion

As in Experiment 1, predicted recall was significantly higher for words presented in large type than in small type, $F(1, 83) = 35.91$, $p < .0001$, $\eta_p^2 = .30$ (Fig. 3). Predicted recall was also higher when participants were told they would have four study trials than when they were told they would have one, $F(1, 83) = 21.48$, $p < .001$, $\eta_p^2 = .21$. However, although the predicted effect of additional studying was dwarfed by the actual effect, the predicted effect in Experiment 2 was larger than it was in Experiment 1. For reasons that are unclear, the interaction between the number of study trials and type size was significant, $F(1, 83) = 5.63$, $p < .05$, $\eta_p^2 = .06$. Actual recall was significantly higher following four study trials than following one, $F(1, 83) = 242.73$, $p < .0001$, $\eta_p^2 = .75$, but was unaffected by type size, $F(1, 83) = .89$, $p = .35$ (Fig. 3). The interaction between type size and the number of study trials was close to being significant, $F(1, 83) = 3.77$, $p = .06$, $\eta_p^2 = .04$.

Table 1 displays the effects of the manipulations of type size and number of study trials on predicted and actual recall. The pattern was similar to our findings in Experiment 1: Participants overestimated the importance of large type and underestimated the importance of additional study trials. In fact, they expected type size to have a slightly larger effect than number of study trials.

Items that were studied once were recalled at a lower rate in Experiment 2 than they were in Experiment 1, presumably because there was more interference from other items in Experiment 2. We did not expect participants to account for differences in interference—a subtle cue—in their judgments (see Maki, 1999; Rhodes & Castel, 2008). However, repetition is not a subtle cue, and the striking finding is that participants

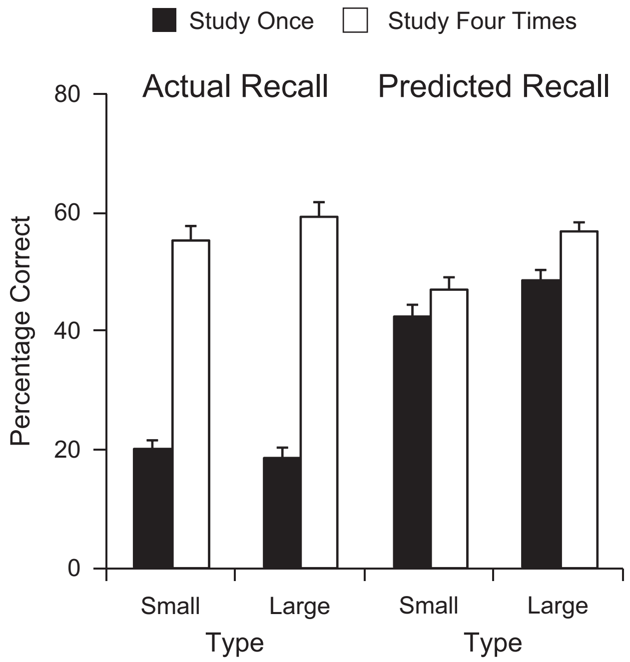


Fig. 3. Results from Experiment 2: mean percentage of words that participants predicted they would recall and that they actually recalled as a function of type size and number of study opportunities. Error bars show 1 *SEM*.

greatly underestimated the effect of repetitions and overestimated the effect of type size.

Experiment 3

In the first two experiments, the number of study trials was manipulated within participants. Past research has shown that subjects are more sensitive to their beliefs in within-participants designs than they are in between-participants designs (e.g., Koriat et al., 2004). Our participants were somewhat sensitive to the number of study trials, but only to a small degree. This raised the question: Did our participants actually believe that additional study trials would enhance their learning? The same question could be asked about type size. Everyone knows that studying leads to learning, but whether type size affects learning is less obvious. The fact that important or memorable words are often written in large type, for example, in headlines and advertisements, might lead people to believe that words presented in larger type are more memorable.

Experiment 3 was designed to assess participants' beliefs about their memories. Participants read a description of Experiment 1 and made predictions about how beneficial it would be to study twice versus once, or about how beneficial it would be to study words written in large type versus in small type.

Method

Participants. Seventy-eight participants (50 female, 28 male; mean age = 35 years, range = 18–81 years) were recruited via Amazon's Mechanical Turk. All participants lived in the United States.

Procedure. Because explaining all four conditions in Experiment 1 seemed confusing, we asked participants in Experiment 3 to read a simplified description of Experiment 1. Thirty participants read about the type-size manipulation; 48 participants read about the manipulation involving additional study trials. (The number of participants differed as a result of random assignment.) Participants were then asked to predict how well they would have performed in the experiment they read about. In the type-size condition, for example, the instructions read as follows:

> Assume you recalled 40 percent of the words that were presented in the smaller font. What percentage of the words that were presented in the larger font do you think you'd be able to recall?
>
> Percentage of the words presented in the smaller font that I'd recall: 40
>
> Percentage of the words presented in the larger font that I'd recall: ___

The instructions in the study-trial condition were similar, but they asked about the two conditions that differed in the number of study trials (one or two). In both cases, participants were asked to assume that they had recalled 40% of the items correctly in the baseline condition, because 40% was the overall percentage of items recalled in Experiment 1.

Results and discussion

As Table 1 shows, participants believed that memory would be better if they studied twice instead of once, $t(47) = 25.74$, $p < .0001$, $d = 1.17$. They also believed that memory would be better if they studied words written in large type instead of small type, $t(29) = 21.64$, $p < .0001$, $d = 1.02$. There was no significant difference between the two-study-trial condition and the large-type-size condition, $t(76) = 1.29$, $p = .20$.

Compared with participants in Experiment 1, participants in Experiment 3 were more sensitive to the number of study trials by a factor of 10. They still underestimated their learning, however. Participants also predicted a larger effect of type size than participants in Experiment 1 did, but this made their predictions less accurate. Combined, these two results suggest that the predictions in Experiment 3, which were based on beliefs, bore little relationship to the predictions in Experiment 1, which do not appear to have been based on beliefs. The predictions in Experiments 1 and 3 did have something in common, though, which is that neither bore much resemblance to actual memory performance.

As previously noted, we attempted to avoid confusion in Experiment 3 by asking participants to make a single prediction. As in Experiments 1 and 2, participants were told about both levels of the manipulated variable (e.g., one study trial or two study trials), a procedure that past research has shown makes people sensitive to the manipulation (Koriat et al., 2004). However, we manipulated two variables (type size and study trials) in Experiments 1 and 2, but only queried participants about one variable in Experiment 3 (type size or study trials). Thus, we ran an additional experiment ($n = 50$) that was identical to Experiment 3, with the exception that participants made predictions regarding the influences of both type size and study trials. The pattern of results confirmed the findings of Experiment 3: Predictions significantly exceeded 40% in the type-size condition (50%, $p < .0001$) and in the study-trials condition (51%, $p < .0001$), but the difference between conditions was not significant, $t(49) = 0.38$, $p = .70$. This finding supports the results of other research, in which attempts to minimize alternative bases for judgment did not meaningfully affect the stability bias (Kornell, 2010).

General Discussion

Experiment 1 produced a double dissociation between actual memory and predicted memory: The number of times a word was studied affected actual memory, but it hardly affected predicted memory. Type size affected predicted memory but not actual memory. In Experiment 2, a stronger manipulation of study repetition produced the same basic result; participants' judgments relied too much on type size and not enough on repetitions of study trials. Experiment 3 showed that people believed, incorrectly, that words presented in larger type would be more memorable than words presented in smaller type. It also showed that people believe they learn by studying, contrary to their predictions in Experiment 1.

Taken together, these data suggest that actual memory, beliefs about memory, and judgments about memory were largely independent of one another in the current study. We argue that the ease-of-processing heuristic plays a central role in metamemory judgments. We also argue that the stability bias occurs because people frequently make judgments on the basis of their immediate subjective experience, rather than by applying beliefs about events that have not yet occurred.

The ease-of-processing heuristic

When information seems easy to process, it is rated as easy to remember. We refer to this rule as the ease-of-processing heuristic (following Begg, Duft, Lalonde, Melnick, & Sanvito, 1989). The finding that large type affects judgments about memory but not actual memory is among the strongest metacognitive evidence available for the ease-of-processing heuristic. Like most good heuristics, ease of processing is usually accurate, but it can also produce errors. Retrieval fluency is one example: If you remember who wrote *Cars and Trucks and Things That Go* quickly and easily, you will be confident that your memory is accurate even when it is not (see Benjamin et al., 1998; Kelley & Lindsay, 1993). Encoding fluency is another example: The longer you feel it takes to encode something, the less well you think you have learned it (Hertzog, Dunlosky, Robinson, & Kidder, 2003; Miele, Finn, & Molden, 2011). Another example is cue familiarity: Familiarity with a question can make you relatively confident that you know the answer, even if the answer does not come to mind (see Koriat & Levy-Sadot, 2001; Metcalfe, Schwartz, & Joaquim, 1993; Reder & Schunn, 1996). Yet another example is that spacing study trials apart, rather than massing them together, decreases the ease of processing of the second (and subsequent) presentations but enhances learning in a manner that people often do not appreciate (e.g., Kornell & Bjork, 2008; Kornell, Castel, Eich, & Bjork, 2010; Simon & Bjork, 2001).

People appear to apply the ease-of-processing heuristic automatically, both in the experiments reported here and more generally. If you recall a memory easily, you do not pause to consider why you are sure but simply answer with confidence (e.g., Richard Scarry wrote *Cars and Trucks and Things That Go*). Moreover, ease of processing appears to be difficult to override—an essential characteristic of automatic processes. For example, Rhodes and Castel (2008) reported that participants continued to regard larger words as more memorable than smaller words even when they were told explicitly to ignore type size. Thus, ease of processing appears to play a central role in a variety of metacognitive judgments, including judgments of learning, feeling of knowing, and confidence.

The stability bias

When people make metamemory judgments, ease of processing is readily apparent. By contrast, beliefs about memory must be applied independently of immediate experience. For example, large type may elicit an immediate feeling of fluency, whereas study trials that will happen in the future have no immediate effect on the learner's experience. Making an accurate prediction about the future, therefore, can be contingent on divorcing judgment from current processing (cf. Rhodes & Tauber, 2011), and this is difficult to do during encoding.

Metacognition researchers have distinguished between analytic processes, which can involve applying a belief about memory, and nonanalytic processes, which are more automatic (see, e.g., Kelley & Jacoby, 1996; Koriat & Levy-Sadot, 1999). The results of our experiments suggest that participants failed to apply their beliefs. Instead, they appeared to make judgments about the future on the basis of their immediate experiences. In doing so, they demonstrated a stability bias, acting as if future events would have little effect on their memories. This finding fits with other findings demonstrating that people are sometimes insensitive to important differences between the conditions that prevail during encoding and those that will be present during retrieval (e.g., the foresight bias; Koriat & Bjork, 2005).

Conclusion

On the basis of the findings we have reviewed and those reported in this article, we suggest that ease of processing is a fundamental heuristic in metacognition that guides, and biases, judgments about memory. In particular, participants in the present experiments overestimated the effect of type size on future memory performance and underestimated or overlooked the importance of the number of times they would be able to study an item. These biased estimates led participants to make remarkably inaccurate judgments, which can have considerable implications for how people approach studying and learning. Witnesses who are testifying, students who are learning, and anyone who is trying to judge the accuracy of his or her memories would benefit from being aware that the heuristics that guide (or fail to guide) memory judgments are often accurate, but also create biases.

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Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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