Cue familiarity and 'don't know' responding in episodic memory tasks

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Abstract

Metacognitive monitoring and control are two interdependent mechanisms by which people regulate encoding and retrieval processes in memory. While much is known about monitoring, and how the results of monitoring processes affect control at encoding, much less evidence is available for the monitoring–control relationship with respect to the regulation of retrieval. The present study provides information on this point by assessing whether a factor that is known to affect metacognitive monitoring at retrieval, i.e. cue familiarity, affects also metacognitive control at retrieval (i.e. the decision to volunteer or withhold a response in a memory task). In seven experiments cue familiarity was manipulated by having participants make a pleasantness judgment beforehand for half of the critical cues. Results showed that cue familiarity affected not only metacognitive judgments of feeling-of-knowing and retrospective confidence, but also the rate of 'don't know' responses in different recognition tasks. These results demonstrate that a factor known to affect metacognitive monitoring determines also the decision to volunteer or withhold a response (metacognitive control), which in turn shapes participants' performance in a memory task.

Keywords

'Don't know' responding; Metamemory; Monitoring; Control

Introduction

Research in metamemory investigates how people regulate the processes by which information is acquired, retrieved from memory and output in a memory report. This research is based on a conceptual framework proposed by Nelson and Narens (1990), according to which people monitor their own cognitive processes and use the products of monitoring to modify these processes, thus exerting control over their memory performance. Due to this dual monitoring–control perspective on metamemory, research in this area follows two paths. One path is to examine monitoring processes by collecting people's subjective appraisals of a certain memory process. Several of such judgments have been thoroughly investigated with judgments-of-learning (JOLs), feeling-of-knowing judgments (FOK judgments) and confidence judgments (CJs) being the most common ones. The second path of metamemory research is to focus on control processes. The question asked within this line of research is whether the products of monitoring (as assessed by the aforementioned subjective judgments) are related to people's decisions which determine memory performance. The examples of such decisions include the choice to continue or terminate a study episode (e.g., Koriat, Ma'ayan, & Nussinson, 2006), the choice to restudy information (e.g., Metcalfe & Finn, 2008) or the choice to volunteer or withhold retrieved information (e.g., Koriat and Goldsmith, 1994 and Koriat and Goldsmith, 1996). A crucial assumption of all metamemory research, which speaks to the importance of metamemory for our understanding of memory, is that changes in monitoring affect control which determines memory performance.

That metacognitive monitoring and control processes are closely linked is clear from a vast set of studies investigating the process of acquiring information. Research conducted within the metamemory framework and concerned with the regulation of encoding operations demonstrate how manipulations that affect participants' appraisal of the encoding process, as reflected in JOLs, also influence their decisions of how to study, and ultimately lead to changes in the effectiveness of study, as reflected in memory performance (see Finn, 2008, Metcalfe and Finn, 2008 and Rhodes and Castel, 2009, for examples). However, evidence for the monitoring–control relationship is less abundant with respect to the regulation of retrieval. Although two of the most commonly examined metacognitive judgments, FOK judgments and CJs, are thought to reflect subjective appraisals of a retrieval process, the question of whether changes in these judgments are related to changes in regulation of memory retrieval remains, in our view, understudied.

A case of FOK judgments may serve as an example. FOK judgments are judgments of future recognition provided after a retrieval attempt (Hart, 1965). Despite vast knowledge of the factors that determine the magnitude and accuracy of FOK judgments (see Koriat, 2007, for a review), the evidence for their relation to any control elements of memory retrieval remains scarce. There are several studies that indicate how factors that affect FOK judgments determine whether retrieval would be initiated (e.g., Reder, 1987 and Reder and Ritter, 1992) and for how long it would proceed (Barnes et al., 1999 and Singer and Tiede, 2008). However, it remains unclear whether changes in such control decisions translate into changes in memory performance, a vital question for the importance of studies in metamemory. For example, in the case of the length of a memory search, which is the most commonly investigated control aspect of retrieval, the consequences of changes in retrieval latencies remain elusive, with studies showing that longer search associated with higher FOK judgments is largely ineffective (Malmberg, 2008). Moreover, it is also worth noting that FOK judgments are commonly provided after a retrieval attempt is finished, while the control decisions described here take place before or during retrieval. To our knowledge there is no clear evidence linking FOK judgments to any control operations that would be implemented after a retrieval attempt and that would affect memory performance. The aim of the present study is to make a step towards bridging this gap between research on post-retrieval metacognitive monitoring and post-retrieval control.

The relative scarcity of research on control of retrieval processes may be related to a widely held assumption that retrieval processes are largely automatic (e.g., Craik et al., 1996 and Moscovitch, 1992) and hence cannot be easily modified by metacognitive control processes. However, the metacognitive perspective on memory provides a clear example of a control process that has straightforward consequences for memory performance and which is implemented in the retrieval stage of a memory process. This control process is a decision whether certain information should be volunteered or whether a 'don't know' (DK) response should be given instead. Even if the retrieval process itself is automatic and thus not easily malleable by metacognitive control, the process of building a memory report from the products of retrieval is a clear example of metacognitive processes at play. Furthermore, decisions to volunteer a response or to answer DK reflect control processes that have clear implications for the final memory performance. More DK responses translate into less information provided in a memory report, quite commonly decreasing the overall volume of correct information volunteered but at the same time increasing the overall accuracy of volunteered information (Koriat and Goldsmith, 1994, Koriat and Goldsmith, 1996 and Koriat et al., 2000). The question that we investigate in the present study is thus whether factors that affect post-retrieval monitoring affect also metacognitive control of retrieval in the form of decisions on whether to provide the answer to a memory question or to respond DK. We also assessed whether any such control changes affect various measures of memory performance besides the rate of DK responding.

The particular factor that is examined in the present study is cue familiarity. Abundant evidence exists that cue familiarity affects metacognitive monitoring at retrieval (e.g., Liu et al., 2007, Metcalfe et al., 1993, Schwartz and Metcalfe, 1992 and Vernon and Usher, 2003). When participants study cue–target pairs of unrelated words, increasing familiarity of the cues affects metacognitive judgments made at retrieval. Studies have linked cue familiarity to both the magnitude of FOK judgments, that is judgments elicited by the cue alone and concerning the recognizability of the targets (Schwartz & Metcalfe, 1992), and, more recently, to the magnitude of CJs, that is judgments concerning the correctness of the targets endorsed in a recognition test (Chua, Hannula, & Ranganath, 2012). In the present study we investigate whether cue familiarity determines whether retrieved information would be volunteered or whether it would be withheld and a DK response should be emitted instead.

We focus on cue familiarity for one important reason. Changes in the rate of DK responses, the main variable of interest in the present study, may result from changes to either memory or metamemory processes. If the manipulation of a certain factor led to retrieval of more correct answers to memory questions, this could be revealed by a drop in DK responses. However, in this case such a drop would simply reflect increased effectiveness of basic memory processes, and not a change in metacognitive processes. In the present study we are interested in post-retrieval metamemory processes rather than the effectiveness of retrieval. To clearly establish that a factor that determines metacognitive monitoring also affects metacognitive control independently of basic memory processes, we thus focus on a factor that is known to affect metacognitive monitoring without changing the effectiveness of retrieval. Cue familiarity is just such factor.

Changes in cue familiarity have clear effects on metacognitive monitoring, as reflected in higher FOK judgments and CJs for familiar cues, but previous studies indicate that cue familiarity does not affect the effectiveness of basic retrieval processes. Even though varying cue familiarity affects retrieval search times, as described earlier, studies failed to document any changes in recall performance due to manipulations affecting cue familiarity (Benjamin, 2005, Malmberg, 2008 and Schwartz and Metcalfe, 1992). Also, previous studies failed to find any effects of cue familiarity in recognition performance (Chua et al., 2012 and Schwartz and Metcalfe, 1992). Experimentally increased cue familiarity seems to result in a cognitive state that can be described as an ‘illusion of knowledge’. When cues are made familiar in an experimental task, people feel that they would be able to recognize the correct answer (as reflected in FOK judgments) and they feel that the answer they choose is actually correct (as reflected in CJs). However, in reality their ability to retrieve or recognize the answer is unaffected by the cue familiarity manipulation. Thus, if we were to find that cue familiarity affects DK responding, just as it affects metacognitive monitoring at retrieval, we could safely conclude that such a change reflects an effect on metacognitive control rather than a change in the effectiveness of the basic memory processes.

The present study

In the present study we report seven experiments addressing the issue of the effects of cue familiarity on DK responding. Building on the work on metacognitive monitoring at retrieval, we predicted that increasing familiarity of cues will result in an illusion of knowledge and will be reflected in measures of metacognitive monitoring. More importantly, we also predicted that increased cue familiarity will also affect people's decisions in a memory task. Specifically, we predicted that increased cue familiarity will be linked to a reduced rate of DK responses. Finally, we examined if changes in DK responses affect memory performance. The first four experiments were conducted to establish the basic effect of cue familiarity on DK responding, and to disentangle the memory and metacognitive factors responsible for it. The next three experiments aimed at testing the boundary conditions of the effect cue familiarity has on DK responding.

Experiments 1, 2 and 3

Experiments 1, 2 and 3 were designed to examine if cue familiarity, a factor known to affect metacognitive monitoring at retrieval, affects the decision to volunteer or withhold responses in a memory test (i.e. if it affects metacognitive control). The priming procedure developed by Schwartz and Metcalfe (1992) was used to manipulate cue familiarity. In the first phase of all three experiments participants provided pleasantness judgments for a long list of words which included half of the cues from the subsequently studied cue–target pairs. In Experiment 1, the effects of this manipulation were examined for DK responding in recall and subsequent free-report recognition as well as the magnitude of FOK judgments (which followed a recall trial but preceded a recognition trial). The FOK judgments were included in Experiment 1 to ensure that our procedure is capable of replicating the already established effect of cue familiarity on metacognitive monitoring. It was thus predicted that increased cue familiarity would be associated with higher FOK judgments. Of main interest was whether increased cue familiarity would also lead to reduced rates of DK responding in recall and recognition. In order to make sure that overt FOK judgments do not affect DK responding in free-report recognition, in Experiment 2 participants were not asked to provide overt FOK judgments and thus only DK responding in recall and recognition was assessed.

Experiment 3 repeated the design of Experiment 2, and thus included recall and free-report recognition tests, but with the addition of a forced-report recognition test which was included to establish if manipulating cue familiarity affects the effectiveness of basic memory processes. If increased cue familiarity leads to a reduction in DK responses, then this effect could be assigned to either changes in metacognitive processes or memory processes. Participants may respond DK on fewer trials either because they are able to retrieve more correct answers (a memory effect) or because they decide to volunteer more responses in a memory report (a metacognitive effect). The use of a forced-report test allows for teasing apart these two different mechanisms. In a forced-report test participants cannot withhold any responses and thus performance in this test in solely dependent on memory processes of encoding and retrieval (cf. Koriat & Goldsmith, 1996). If manipulating cue familiarity affects memory processes, this should be reflected in performance in the forced-report recognition test included in the design of Experiment 3. If manipulating cue familiarity affects only metacognitive processes, no effect of this manipulation on forced-report recognition performance is predicted.

As argued in the introduction, the rate of DK responses has important consequences for the contents of memory reports. Since volunteering a response and responding DK are complementary answers, the change in the rate of DK is equivalent to the change in the volume of volunteered information. Of more interest, however, are measures of the accuracy of a memory report.1 Koriat and colleagues (Koriat and Goldsmith, 1994, Koriat and Goldsmith, 1996 and Koriat et al., 2000) proposed that when a memory test allows participants to withhold answers, two types of accuracy measures should be considered. The input-bound accuracy (IBA) measure is concerned with the quantity of correct information provided in a test. This measure thus relates the quantity of correct volunteered responses to the quantity of to-be-remembered items at input. The most common example of the IBA measure is a proportion of recalled items, which relates the number of volunteered correct items in a recall protocol to all studied items. The output-bound accuracy (OBA) measure is concerned with the quality of information provided in the test. This measure thus relates the number of correct volunteered responses out of all responses volunteered at output. In Experiments 1, 2, and 3, and also in the all remaining experiments reported here, we examine the effects of cue familiarity on IBA and OBA measures of recognition. The IBA measure for recall was also examined, but the OBA measure was not due to the problem of missing cells, as described later.

Method

Participants

Ninety-six undergraduates of the Jagiellonian University participated for partial course credit. Twenty-six took part in Experiment 1, 34 took part in Experiment 2 and 36 took part in Experiment 3.

Materials

Two hundred and eighty-two Polish nouns (4–8 letters long) chosen from the Polish frequency norms (Kurcz, Lewicki, Sambor, & Woronczak, 1990) were used. They were divided into two sets, one consisting of 150 nouns and the other consisting of 132 nouns. The words from the first set were used as fillers in a pleasantness judgment task. The words from the second set were used to create 66 cue–target pairs.

Procedure

The procedure consisted of three phases. In the preliminary pleasantness judgment task participants were presented with 180 words and asked to rate on a scale 1–5 how pleasant those words appeared to them. In this task all 150 words from the first set were used along with 30 words from the second set. In the subsequent study phase participants studied all 66 cue–target pairs for 2.5 s each, with 0.5 s interval. Of the 66 pairs six were used as fillers, three at the beginning of the study phase and three at the end. Of the remaining 60 pairs, 30 pairs were in the Primed condition (cues had been included in the pleasantness judgments task), whereas 30 pairs were in the Unprimed condition (cues had not been included in the pleasantness judgment task). The assignment of pairs to conditions was counterbalanced across participants. Memory for the 60 experimental pairs was tested in the subsequent test phase, which was different in Experiments 1, 2 and 3.

For Experiment 1, in each trial of the test participants were first presented with a cue and asked to recall the appropriate target or to press Enter indicating that they did not know the correct answer (a DK response). Immediately after a recall trial, a FOK judgment trial followed in which participants were presented again with the cue and asked to rate on a 0–100% scale how likely they were to recognize the target in a recognition test. This was done for all 60 items. The recognition trial for each given cue followed immediately the FOK judgment. In the recognition trial, participants were presented again with the cue together with the correct target along with two targets taken from different presented pairs. Participants were asked to indicate the correct target or to respond DK by pressing the spacebar. The instructions for the test discouraged guessing in recognition trials. The time to respond in all tasks was self-paced.

The testing procedure for Experiment 2 was the same as in Experiment 1, except that the overt FOK stage was omitted and a free-report recognition trial immediately followed a recall trial. The testing procedure for Experiment 3 was the same as in Experiment 2, except that after the free-report recognition trial for a given cue this cue was presented again with the same three alternatives and participants were asked to choose one of the alternatives. In this forced-report recognition the DK option was not available. Participants were instructed that if they volunteered an answer in a free-report task, they should repeat the same answer in a forced-report task. However, if in the free-report task they decided to withhold the answer (respond with a DK option), they were required to commit to one of the alternative answers in the forced-report task.

Design

The independent variable in the design of Experiments 1, 2 and 3 was the type of cue (Primed vs. Unprimed), manipulated within participants.

Results and discussion

The means for DK responses, IBA and OBA measures for both recall and recognition for all three experiments are presented in Table 1.

Table 1.

The rates of DK responses and the input-bound and output-bound measures of accuracy in recall and free-report recognition as a function of cue type condition (Primed vs. Unprimed) in Experiments 1–7. The means of OBA for recall were calculated only from cases in which participants provided at least one response other than DK in both primed and unprimed conditions. The standard deviations are given in parentheses.

	Recall						Recognition					
	Primed			Unprimed			Primed			Unprimed		
	DK	IBA	OBA	DK	IBA	OBA	DK	IBA	OBA	DK	IBA	OBA
Experiment 1	.74 (.17)	.17 (.13)	.69 (.28)	.78 (.19)	.14 (.14)	.70 (.29)	.24 (.16)	.62 (.20)	.82 (.19)	.30 (.19)	.58 (.22)	.82 (.19)
Experiment 2	.78 (.22)	.18 (.19)	.77 (.29)	.79 (.23)	.18 (.20)	.81 (.23)	.33 (.20)	.59 (.26)	.85 (.20)	.37 (.24)	.56 (.28)	.86 (.20)
Experiment 3	.73 (.23)	.19 (.18)	.72 (.29)	.77 (.21)	.16 (.16)	.75 (.28)	.29 (.21)	.58 (.23)	.81 (.19)	.35 (.22)	.54 (.24)	.83 (.20)
Experiment 4	.80 (.20)	.11 (.11)	.74 (.28)	.88 (.18)	.06 (.07)	.71 (.40)	.48 (.24)	.38 (.20)	.75 (.21)	.55 (.23)	.32 (.18)	.74 (.22)
Experiment 5												
Two-steps condition	.81 (.20)	.16 (.18)	.82 (.31)	.82 (.19)	.14 (.16)	.78 (.32)	.28 (.22)	.56 (.23)	.78 (.21)	.33 (.24)	.52 (.24)	.79 (.25)
One-step condition	–	–	–	–	–	–	.30 (.21)	.53 (.23)	.77 (.24)	.37 (.25)	.52 (.24)	.81 (.21)
Experiment 6												
Associative recognition	–	–	–	–	–	–	.35 (.24)	.52 (.25)	.77 (.17)	.40 (.26)	.49 (.23)	.83 (.16)
Simple recognition	–	–	–	–	–	–	.33 (.22)	.56 (.23)	.84 (.17)	.38 (.27)	.53 (.27)	.85 (.18)

Experiment 7

Cue reinstatement	–	–	–	–	–	–	.33 (.20)	.57 (.19)	.86 (.13)	.38 (.21)	.54 (.21)	.86 (.15)
No cue reinstatement	–	–	–	–	–	–	.38 (.21)	.51 (.18)	.82 (.14)	.39 (.19)	.50 (.18)	.82 (.14)

Table options

Recall

Experiment 1: The manipulation of cue familiarity had no effect on the rate of omissions (DK responses) in recall, t(25) = 1.90, p = .07. The analysis of IBA-recall (the proportion of studied targets that were volunteered in a memory report) revealed that this measure was likewise unaffected by the priming manipulation, t(25) = 1.76, p > .09. The OBA-recall measure was not analyzed here (it was likewise not analyzed in any of the remaining experiments) due to missing cells. Recall performance was so low that a good number of participants failed to volunteer any responses in at least one of the priming conditions, precluding the analysis of the OBA-recall measure.

Experiment 2: The manipulation of cue familiarity had no effect on the rate of omissions (DK responses) in recall, t < 1. The analysis of IBA-recall revealed that this measure was likewise unaffected by the priming manipulation, t < 1.

Experiment 3: The manipulation of cue familiarity had no effect on IBA-recall, t(35) = 1.63, p > .10, but it did affect the rate of omissions (DK responses) in recall, t(35) = 2.30, SE = .02, p = .03, d = 0.37 .

Combined analysis of recall: A 3 (Experiment: 1, 2, and 3) × 2 (type of cue: Primed vs. Unprimed) mixed ANOVA on IBA-recall measure revealed a significant effect of priming, F(1, 93) = 4.04, MSE = .01, p = .05, $\eta_p^2 = .04$, with better recall for primed cues (M = .18) than for unprimed cues (M = .16). The effect of Experiment and the interaction were both not significant (Fs < 1). The same 3 (Experiment) × 2 (type of cue) mixed ANOVA on the proportion of omissions (DK responses) revealed a significant effect of priming, F(1, 93) = 6.41, MSE = .01, p = .01, $\eta_p^2 = .06$, with fewer omissions for primed cues (M = .75) than for unprimed cues (M = .78). The effect of Experiment and the interaction were not significant (F < 1 and F(2, 93) = 1.2, p > .30, respectively).

Although the effects were very small and significant only in the combined analysis of Experiments 1–3, the priming manipulation seemed to affect the proportion of volunteered correct items and the proportion of DK responses in recall. There are three ways in which priming can lead to such a pattern of results. The first two refer to memory processes. Priming can affect encoding processes, making encoding of pairs which contain primed cues more effective and leading to more items recalled for primed cues and a parallel reduction in DK responses. Second, priming can affect the efficacy of retrieval. It is well known that participants search memory for longer when cues are familiar (e.g., Singer & Tiede, 2008). To check if the same effect can be found in our data, we performed the analysis of the DK response latencies in recall for the combined data set from Experiments 1–3. A 3 (Experiment) × 2 (type of cue) ANOVA yielded only a significant effect of type of cue, with longer latencies to a DK response for primed cues (M = 4.18 s) compared to unprimed cues (M = 3.68 s), F(1, 93) = 8.66, MSE = 1.29, p = .004, $\eta_p^2 = .09$, consistent with the results already present in the literature. Although it has been argued that such prolonged search does not lead to substantial gains in recall (Malmberg, 2008), it is possible that occasionally additional items are retrieved for primed cues, leading to small effects of priming on recall observed here.

There is however a possible third mechanism. As argued throughout the present paper, a metacognitive mechanism can also be responsible for these result. Priming can affect metacognitive processes in recall making participants more inclined to volunteer responses. Unfortunately, the present methodology cannot differentiate between these three hypotheses. To compare the two memory hypotheses (more effective encoding or retrieval) with the metacognitive hypothesis (more liberal reporting), a forced-report recall test would have to be used. Only forced-report testing allows us to examine memory performance without the influence of metacognitive processes (cf. Koriat & Goldsmith, 1996). However, given very small differences in DK responses in recall tests obtained with our procedure, we did not pursue this goal. Future studies could employ procedures that would exacerbate the effects obtained in recall and then disentangle memory and metacognitive processes.

Feeling-of-knowing

FOK responses in Experiment 1 were provided on a 0–100% scale and the mean of FOK judgments was computed for all cues in the test. Although in many FOK studies it is common to compute the average of FOK judgments only for cues for which targets were not recalled, here we examined FOK judgments for all cues, independently of recall performance. This approach follows directly from our considerations on the issue of memory reporting. Although metacognitive researchers often assume that an omission error in recall can be equated with a failed recall attempt, in reality it is impossible to determine from omissions whether a target was not recalled or was recalled but was not volunteered. Further theoretical arguments concerning this issue are discussed by Koriat (1993).

The comparison between Primed and Unprimed conditions revealed a higher magnitude of FOK judgments for Primed (M = 50.83) compared to Unprimed (M = 42.96) cues, t(25) = 4.81, SE = 1.64, p < .001, d = 0.98. These results replicate previous studies examining the effect of manipulating cue familiarity on the magnitude of FOK judgments (e.g., Schwartz & Metcalfe, 1992) and demonstrate how cue familiarity guides metacognitive monitoring at retrieval.

Free-report recognition

Experiment 1: Participants were less likely to answer DK in the Primed condition compared to the Unprimed condition, t(25) = 2.83, SE = .02, p = .009, d = 0.53. Thus, more familiar cues led participants to volunteer more responses in the recognition task. The analysis of OBA-recognition revealed that this change in the rate of DK responses failed to affect the accuracy of volunteered responses, t < 1. In other words, although more responses were volunteered for cues in the Primed condition, the accuracy of the volunteered responses was not worse than the accuracy of the responses in the Unprimed condition. The analysis of IBA-recognition also failed to reveal any differences between conditions in the proportion of correct answers volunteered, t(24) = 1.62, p > .10.

Experiment 2: Participants were less likely to answer DK in the Primed condition compared to the Unprimed condition, t(33) = 2.05, SE = .02, p = .05, d = 0.37. The analysis of OBA-recognition revealed that this change in the rate of DK responses failed to affect the accuracy of volunteered responses, t < 1. The analysis of IBA-recognition failed to reveal any differences between the conditions in the proportion of correct answers volunteered, t(33) = 1.61, p > .10.

Experiment 3: Participants were less likely to answer DK in the Primed condition compared to the Unprimed condition, t(35) = 3.06, SE = .02, p = .004, d = 0.49. The analysis of OBA-recognition revealed that this change in the rate of DK responses failed to affect the accuracy of volunteered responses, t(35) = 1.92, p = .06. The analysis of IBA-recognition failed to reveal any differences between conditions in the proportion of correct answers volunteered, t(35) = 1.53, p > .10.

Combined analysis of free-report recognition: A 3 (Experiment) × 2 (type of cue) mixed ANOVA on proportion of DK responses in recognition revealed a significant effect of priming, F(1, 93) = 20.87, MSE = .01, p < .001, $\eta_p^2 = .18$, with fewer DK responses for primed cues (M = .29) than for unprimed cues (M = .34). The effect of Experiment and the interaction were not significant, F(1, 93) = 1.20, p > .30 and F < 1, respectively. The same 3 (Experiment) × 2 (type of cue) mixed ANOVA on OBA-recognition measure failed to produce any significant results, with similar OBA for primed (M = .83) and unprimed (M = .84) cues (F(1, 93) = 2.40, p = .12, for the main effect of type of cue; Fs < 1 for the main effect of Experiment and the interaction). The same 3 (Experiment) × 2 (type of cue) mixed ANOVA on the IBA-recognition measure revealed a significant main effect of type of cue, F(1, 93) = 7.41, MSE = .01, p = .008, $\eta_p^2 = .07$, with more correct answers produced for primed cues (M = .59) than for unprimed cues (M = .56). The effect of Experiment and the interaction were not significant, Fs < 1.

Forced-report recognition

The analysis of the forced-report performance in Experiment 3 revealed no differences between Primed (M = .69) and Unprimed (M = .68) conditions, t < 1. This null effect replicates the results obtained with simple (rather than associative) recognition by Schwartz and Metcalfe (1992; see also Chua et al., 2012). This result indicates that the effect of manipulating cue familiarity for DK responses in free-report recognition cannot be assigned to changes in memory processes of encoding and retrieval.

Altogether, the results of Experiments 1, 2 and 3 are consistent in showing that cue familiarity affects DK responding in recognition. The fact that these effects on DK responses are observed despite the fact that priming does not affect performance in a forced-report recognition test (in Experiment 3) lends support to the hypothesis of changes in metacognitive control. Priming elevates cue familiarity which alters the process of metacognitive monitoring and leads to an illusion of knowledge, expressed in participants' decisions to volunteer more answers in a free-report recognition test.

The results further reveal that the change in DK responding in free-report recognition does not lead to significant changes in the OBA measure of accuracy of a memory report. In other words, although participants volunteer more responses for primed cues, these additional responses seem to be of similar quality to responses volunteered for unprimed cues. Interestingly, the pattern of results concerning IBA-recognition was different at the level of individual experiments, where IBA was not affected by priming, and at the level of combined analysis, where a small effect of priming on IBA was detected. Why this pattern of results emerged is easily understandable when one considers the quality of additional responses volunteered for primed cues. The memory reports from free-report recognition tests consist of a mixture of correct and incorrect responses, with OBA well below perfect. Thus, even when participants are free to withhold responses, they are unable to restrict reporting solely to correct responses. If increased cue familiarity leads to more liberal reporting, as our results indicate, then additional answers volunteered for primed cues also constitute a mix of correct and incorrect responses. So although some additional correct responses are volunteered for primed cues, they constitute only part of all additionally volunteered responses. Their effect on IBA-recognition constitutes only a fraction of the much larger effect cue priming has on DK responses. In effect, clear changes in DK responses due to a priming manipulation may lead to only small changes in IBA-recognition, which may not be detectable in a single experiment but are revealed with a more powerful combined analysis.

On a final note in this discussion, it is worth noting that Koriat and Goldsmith (1996) argued that the IBA and OBA measures should trade off and thus an increase in IBA should be accompanied by a decrease in OBA. Such a trade-off was not observed here for recognition (although the means were generally in the direction consistent with such a trade-off). This is in line with some recent studies analyzing DK responses in eyewitness scenarios, revealing that IBA and OBA measures are not always subjected to a trade-off (Perfect and Weber, 2012 and Weber and Perfect, 2012). Although discussing the relationship between these two types of measures is beyond the scope of the present work, it is perhaps worth noting that in the present study the changes in the rate of DK responses were very slight. Koriat and Goldsmith documented the aforementioned trade-offs using a strong manipulation of the report criterion with different payoff matrices. It is seems likely that changes in metacognitive bias documented in the present study were simply too subtle to reveal such trade-offs and with larger changes in the rate of DK responses, a decrease in OBA would become apparent.

Type-2 SDT analysis

The inclusion of forced-report recognition in Experiment 3 provides an opportunity for a closer examination of the metacognitive effects of manipulating cue familiarity with the help of type-2 signal detection theory (type-2 SDT). Type-2 SDT is a model that has been recently applied to research on metacognition (Higham, 2002, Higham and Tam, 2005, Higham, 2007 and Lueddeke and Higham, 2012) and which allows for the examination of metacognitive processes based on actual reporting decisions participants make in a memory task (without the need to collect confidence judgments).2 This model assumes that responding in a free-report test requires distinguishing between one's own correct and incorrect candidate responses. These candidate responses are placed along the dimension of confidence in correctness, as depicted in Fig. 1. Because correct responses are on average held with higher confidence, the distribution of correct candidate responses is shifted to the right of the distribution of incorrect candidate responses. It is also assumed that in most cases the distributions of correct and incorrect candidate responses overlap. The model further postulates a criterion that partitions the distributions in two. Responses to the right of the criterion are reported whereas responses to the left of the criterion are withheld.

A type-2 SDT model. The two distributions placed along the dimension of ...

Fig. 1.

A type-2 SDT model. The two distributions placed along the dimension of confidence in correctness are the distributions of correct and incorrect candidate responses. The vertical line represents a criterion value of confidence which is used to decide whether a candidate response should be volunteered. Responses with confidence equal to or higher than the criterial value are included in a memory report whereas responses with confidence lower than the criterial value are withheld and a DK response is given instead.

Figure options

The type-2 SDT model allows for deriving two indices that characterize metacognitive processes in memory reporting. First, indices of metacognitive discriminability, such as d', which reflect the distance between distributions of correct and incorrect candidate responses, describe how well participants are able to distinguish between their own correct and incorrect candidate responses. Second, indices of metacognitive bias, such as c, which reflect a distance between the criterion and the intersection point of distributions, describe participants' overall propensity to report their candidate responses. Crucially, these indices of metacognitive discriminability and bias can be computed when both free- and forced-report tests are included in the experimental design. These two tests allow for establishing a metacognitive hit rate, which is the proportion of correct volunteered responses out of all correct candidate responses (volunteered and withheld) and a metacognitive false alarm rate, which is the proportion of incorrect volunteered responses out of all incorrect candidate responses (volunteered and withheld). The measures of metacognitive discriminability and bias are computed from metacognitive hit and false alarm rates with the usual SDT formulas (see Macmillan & Creelman, 2005).

We have argued throughout the present paper that our manipulation of cue familiarity affects DK responding via the illusion of knowledge which is participants' increased general propensity to believe that they know the correct answer and thus also a general propensity to volunteer candidate responses. Our description of the mechanism of a change in DK responding maps onto a type-2 SDT formulation of metacognitive bias. Thus, we predict that the type-2 SDT analysis of the effect of cue familiarity would reveal the change in the measure of metacognitive bias. There is, however, one caveat: because in SDT bias is measured in relation to the intersection point of distributions, changes in the measure of bias could arise in several distinct ways that reflect different psychological mechanisms. Here we discuss two of such mechanisms and we discuss the third one in Experiment 4.

The changes in metacognitive bias may either arise in the absence of changes in metacognitive discriminability or they may be directly caused by changes in metacognitive discriminability. The first scenario is a case in which changes in metacognitive bias reflect a general illusion of knowledge that arises for both correct and incorrect candidate responses alike. When the illusion concerns both correct and incorrect candidate responses, people's ability to distinguish between correct and incorrect candidate responses should not be affected, preserving the level of metacognitive discriminability (the distance between distributions) and leading to selective effects on metacognitive bias (a change in the placement of a report criterion in relation to the intersection point of distributions).

The more complex scenario arises when changes in metacognitive bias are caused by changes in metacognitive discriminability. Imagine, for example, that increasing cue familiarity selectively affects only confidence in incorrect candidate responses. This scenario is a plausible one for the case of associative recognition described here. Performance in the associative recognition task is known to be dependent on both recollection of the correct responses and on familiarity of individual items (Kelley and Wixted, 2001 and Malmberg and Xu, 2007). If it is assumed that while confidence assigned to correct candidate responses is based predominantly on diagnostic recollection, confidence assigned to incorrect candidate responses is based on non-diagnostic familiarity of the cues and of the chosen alternatives, then increasing cue familiarity may selectively increase confidence associated with incorrect responses. In terms of type-2 SDT, such a selective increase in confidence for incorrect candidate responses would result in a shift of the distribution of these responses to the right, leading simultaneously to a shift in the intersection point of both distributions and, crucially, to a reduction in the measure of metacognitive discriminability. As mentioned before, the change in the intersection point would also affect the measure of metacognitive bias which is a distance of criterion from the intersection point. Such a scenario would suggest that the illusion of knowledge described in the present work is limited to incorrect candidate responses.

The analysis of indices of metacognitive discriminability and bias with the help of type-2 SDT in Experiment 3 allows for establishing if the illusion of knowledge documented in the previous analyses is of a general nature, concerning both correct and incorrect candidate responses, or whether it selectively concerns incorrect candidate responses. In the former case, we would predict a change in the measure of metacognitive bias but no change in metacognitive discriminability, whereas in the latter case we would predict a change in the measures of both metacognitive bias and metacognitive discriminability.

For the purpose of the present analyses, the measure of metacognitive hit rate was created by dividing the number of correct responses volunteered by each participant in the free-report test of Experiment 3 by the number of correct responses provided by this participant in the forced-report test in this experiment.3 The measure of metacognitive false alarm rates was created by dividing the number of incorrect responses volunteered by each participant in the free-report test of Experiment 3 by the number of incorrect responses provided by this participant in the forced-report test in this experiment. The metacognitive hit and false alarm rates were used to obtain an index of metacognitive discriminability, d′, and a measure of bias, c.4

The analysis of d′ failed to reveal a difference between the Primed (d′ = 1.02) and Unprimed (d′ = 1.10) conditions, $t < 1$. Thus, participants' ability to distinguish between their own correct and incorrect candidate responses was not affected by the manipulation of cue familiarity. The analysis of c revealed that participants in the Primed condition were more liberal (c = −0.35) than participants in the Unprimed condition (c = −0.09), $t(31) = 3.71$, SE = .07, $p < .001$, d = 0.70. Thus, the effect of cue familiarity was limited to the measure of metacognitive bias. These results indicate that the illusion of knowledge caused by manipulating cue familiarity is a general phenomenon that concerns correct and incorrect responses alike.

Experiment 4

Type-2 SDT modeling of the data from Experiment 3 was used to gain further insight into the nature of the effect cue familiarity has on DK responding in recognition. The results of this modeling indicated that changes in cue familiarity affect correct and incorrect candidate responses alike, creating a general illusion of knowledge, as reflected by a change in metacognitive bias accompanied by preserved metacognitive discriminability. However, some authors have postulated an even more detailed analysis of changes in metacognitive bias. Goldsmith (2011) has argued that a change in a metacognitive bias measure in type-2 SDT in the face of preserved metacognitive discriminability may reflect two different effects. One effect is a 'true' criterion shift by which a manipulation leads participants to volunteer responses held with a lower level of confidence. We will refer to this scenario as a strategic effect on metacognitive bias. The other effect is a 'perceived' criterion shift by which a manipulation does not change participants' criterial level of confidence but instead increases levels of confidence for all candidate responses. We will refer to this scenario as a monitoring-induced effect on metacognitive bias. In terms of the SDT analysis, these scenarios map onto a shift of criterion in relation to both distributions and the underlying dimension (a strategic effect) and to a concordant shift of both distributions in relation to a criterion and the underlying dimension (a monitoring-induced effect). Both of these effects lead to the same pattern of results for the SDT measure of metacognitive bias because bias in SDT is measured as the distance of the criterion from the intersection point of distributions and thus this measure does not distinguish between shifts in criterion and concordant shifts of distributions.

If this double, 'strategic and monitoring-induced effects' perspective is adopted, then our results so far do not allow for establishing if participants strategically decide to volunteer answers held with a lower level of confidence when cues are primed or they become more confident for answers for which cues are primed. Our illusion of knowledge account straightforwardly suggests that it is a monitoring-induced effect that is at play when a priming manipulation is used. From the double-effect perspective, our illusion of knowledge account postulates that participants become more confident for their correct and incorrect candidate responses when cues are primed (a metacognitive monitoring effect), which translates into more liberal reporting (a metacognitive control effect). However, although the possibility that participants strategically adjust criterion between primed and unprimed cues seems very unlikely, it cannot be excluded a priori. The framework developed by Koriat and Goldsmith (1996) provides tools for disentangling the strategic and monitoring-induced effects on metacognitive bias (see also Kelley and Sahakyan, 2003 and Rhodes and Kelley, 2005). In the methodology developed by Koriat and Goldsmith, both free- and forced-report tests are included and CJs are collected which allows for computing the average level of confidence between conditions and also for establishing the criterial level of confidence which warrants volunteering a candidate response in each of the experimental conditions. In the present experiment, this methodology is applied to gain further insight into the nature of the effects documented in Experiments 1–3.

Participants

Thirty-two undergraduates of the Cardiff University participated for partial course credit.

Materials and procedure

The present experiment, which was suggested by the reviewers of the earlier version of our paper, was conducted with a different sample of participants. Thus, for the purpose of conducting it, all instructions were translated from Polish to English. A new set of words was chosen from the MRC Psycholinguistic Database. The procedure was the same as in Experiment 3 except for one change in a final test. Specifically, a forced-report recognition question was followed by an additional question in which participants were asked to provide a CJ concerning the correctness of their forced-report recognition response. They were asked to provide their judgment on a scale 33–100% and the instructions described that 33% is a chance level of getting the answer right by guessing.

Design

The independent variable in the design was the type of cue (Primed vs. Unprimed), manipulated within participants.

Results and discussion

The means for DK responses and IBA and OBA measures are presented in Table 1.

Recall

The manipulation of cue familiarity had a significant effect on IBA-recall, $t(31) = 3.84$, $SE = .01$, $p < .001$, $d = 0.73$, with more correct items volunteered for primed cues. It also affected the rate of DK responses, $t(31) = 4.52$, $SE = .02$, $p < .001$, $d = 0.83$, with fewer DK responses for primed cues. These results differ from the results of Experiments 1–3. However, they remain consistent with the results of the analysis of the combined dataset from these experiments.

Free-report recognition

Participants were less likely to answer DK in the Primed condition compared to the Unprimed condition, $t(31) = 2.77$, $SE = .02$, $p = .009$, $d = 0.53$. The analysis of OBA-recognition revealed that this change in the rate of DK responses failed to affect the accuracy of volunteered responses, $t < 1$. The analysis of IBA-recognition revealed a significant difference caused by the priming manipulation, $t(31) = 2.74$, $SE = .02$, $p = .01$, $d = 0.50$, indicating that more correct responses were volunteered for primed cues than for unprimed cues. Again, this last result differs from the results of Experiments 1–3 but it remains consistent with the results of the analysis of the combined dataset from these experiments.

Further analyses for recognition

The present experiment included both free- and forced-report recognition tests and thus enabled computing the same indices as Experiment 3.[5] The analysis of the forced-report performance revealed no differences between Primed ($M = .58$) and Unprimed ($M = .55$) conditions, $t(31) = 1.58$, $p > .12$. This null effect replicates the result from Experiment 3 and again rules out the possibility that a difference in DK responding in free-report recognition could be assigned to differences in the effectiveness of basic memory processes. The analysis of d′ also failed to reveal a difference between the Primed ($d' = .95$) and Unprimed ($d' = .94$) conditions, $t < 1$. Thus, participants' ability to distinguish between their own correct and incorrect candidate responses was not affected by the manipulation of cue familiarity. Finally, the analysis of c revealed that participants in the Primed condition were less conservative in their reporting behavior ($c = 0.10$) than participants in the Unprimed condition ($c = 0.26$), $t(31) = 2.35$, $SE = .07$, $p = .03$, $d = 0.39$. Thus, the effect of cue familiarity was limited to a measure of metacognitive bias, replicating Experiment 3 and providing partial support for the general illusion of knowledge account of our results concerning DK responding in recognition.

Turning to the framework proposed by Koriat and Goldsmith (1996), inclusion of CJs in the design of the present experiment allows for computing several novel indices that capture participants' behavior in a free-report recognition task. We focus here on two indices that are most relevant for the purpose of our experiment. First, the average value of CJs concerning responses in forced-report recognition was larger for the Primed (M = 60.27) compared to the Unprimed (M = 55.40) condition, $t(31) = 3.76$, SE = 1.30, $p < .001$, $d = 0.67$. Second, the method for establishing the criterial level of confidence for reporting a candidate response (Prc) was adopted from Koriat and Goldsmith. Each decimal point of a confidence scale was considered as a potential criterion and numbers of hits (responses with a confidence value equal to or higher than a considered criterion value and volunteered in the free-report test) and correct rejections (responses with a confidence value lower than a considered criterion value and withheld in the free-report test) were computed for each confidence value considered. The criterial level of confidence was established by finding the upper end of an interval of confidence judgments which maximized the combined proportion of hits and correct rejections. The comparison of Prc failed to reveal a significant difference between Primed (M = 65.63) and Unprimed (M = 62.81) conditions, $t(31) = 1.22$, $p > .23$.

The present experiment replicated several findings from Experiments 1–3, most importantly the effect of manipulating cue familiarity on the rate of DK responses in recognition. The type-2 SDT analysis of the recognition results revealed also in Experiment 4 that cue familiarity affects metacognitive bias but not metacognitive discriminability. The novel insights were provided by data obtained by collecting CJs concerning participants' decisions in forced-report recognition and by the adoption of the framework of Koriat and Goldsmith (1996). These results indicate that participants were on average more confident in their responses for primed cues and that a criterial level of confidence they adopted for deciding whether to report a candidate response (Prc) was the same whether cues were primed or not. These results point to a monitoring-induced effect of cue familiarity on metacognitive bias rather than a strategic effect. In terms of type-2 SDT, these results point to a concordant shift of both incorrect and correct candidate responses distributions caused by increasing cue familiarity. Because both distributions shift to the right when cue familiarity is increased but the criterion remains fixed against the underlying dimension of confidence, the criterion becomes distanced from the intersection point of distributions, which is reflected in the SDT measure of metacognitive bias. In psychological terms, these results support the illusion of knowledge account, ruling out the hypothesis of strategic origins of changes in DK responding.

Some theoretical notes concerning the use of the SDT model and the framework developed by Koriat and Goldsmith (1996) are necessary here. It is apparent that these two frameworks provide opposing results concerning the issue the effect of cue familiarity on report criterion. Whereas the SDT model documents that a change in cue familiarity affects the placement of a report criterion (c), the framework by Koriat and Goldsmith finds the report criterion (Prc) unaffected. This discrepancy is, however, more apparent than real as it reflects merely the fact that these two models measure the placement of criterion in a different way. The SDT model measures the placement of criterion against the intersection of the correct and incorrect candidate responses distributions whereas the model by Koriat and Goldsmith measures it against the assigned confidence scale values.

The different methods of the measurement of a criterion placement translate into different psychological interpretations of the measure of criterion placement in the discussed models. In the SDT model, the measure of metacognitive bias is always affected if either criterion moves against the underlying confidence scale or if any of the two distributions (of correct and incorrect candidate responses) moves against the underlying scale. In this way, the type-2 measure of bias encompasses both monitoring-induced and strategic effects in reporting behavior. When it is the criterion that moves against the underlying dimension, the change in metacognitive bias reflects a strategic effect. When it is one (or both) distribution that moves against the underlying dimension, the change in the measure of metacognitive bias reflects a monitoring-induced effect. Although type-2 SDT has no tools for distinguishing between these two types of effects, the advantage of this approach is that any change in the rate of DK responses caused by metacognitive factors is reflected in a change in the measure of metacognitive bias, allowing for a clear interpretation of this measure in terms of the metacognitive framework of monitoring and control. The measure of metacognitive bias in type-2 SDT becomes a parameter which is sensitive to all changes in metacognitive control, whether they result from changes in metacognitive monitoring (as in the case of our results) or they result from a deliberate change in control policy triggered by situational demands.6

The additional parameters in the framework developed by Koriat and Goldsmith (1996) allow for distinguishing between monitoring-induced and strategic effects on metacognitive bias. This, however, comes, in our view, at a certain cost in terms of the clarity of the theoretical interpretation of the model's parameters. If metacognitive control is defined as the people's decisions concerning information that should be included in a memory report, then the measure of criterion placement (Prc) in this model captures only a subset of effects on metacognitive control. The model allows for a situation in which the proportion of DK responses is affected by a certain manipulation targeting metacognition (a change in metacognitive control by our definition), yet the measure of criterion placement is not affected, as shown in our results. This occurs whenever a change in metacognitive control is induced by a change in metacognitive monitoring rather than a strategic change in reporting policy. Thus, in our view, one has to be careful in theoretical interpretations of the parameters provided by the model of Koriat and Goldsmith and not to identify Prc with metacognitive control in general but only with a strategic component of metacognitive control.7

Experiment 5

The purpose of the remaining three experiments was to examine the generalizability of the main experimental finding from Experiments 1–4, namely the effect cue familiarity has on DK responding in recognition. In Experiments 1–4 the free-report recognition trials were always preceded by a recall attempt. The question that is examined is Experiment 5 is whether a recall attempt preceding free-report recognition is necessary to demonstrate that increasing cue familiarity reduces the number of DK responses in recognition.

The illusion of knowledge account does not assign any specific role to recall attempts in shaping reporting behavior in recognition. In its simple form, this account postulates that increased familiarity of a cue leads participants directly to claim that the answer to a question is known, which shapes their reporting decisions. However, a closer look at the literature on FOK judgments suggests that the story may be more complicated. Koriat and Levy-Sadot (2001) proposed an interactive model of FOK judgments in which cue familiarity affects FOK in the early stages of memory retrieval, when a person decides whether retrieval should be attempted at all, but once retrieval processes start, FOK is shaped by the volume of accessed information. When a recall trial always precedes free-report recognition, it is possible that cue familiarity plays its role during the recall trial only, by determining whether recall will be attempted or not. When cue familiarity is high, recall is attempted and information concerning the possible answer is accessed. When cue familiarity is low, recall is abandoned and no information is accessed. In this scenario, DK responding in subsequent free-report recognition is shaped by the volume of information accessed during a recall trial and thus cue familiarity is only indirectly related to DK responding in this test.

Experiment 5 tested whether the link between cue familiarity and DK responding in recognition is direct or indirect (via recall) by comparing a condition in which recall was included (as in Experiments 1–4) with a condition in which recall trials were eliminated. If cue familiarity directly leads to the illusion of knowledge in a recognition test, we predict the replication of the effect of cue familiarity on DK responses in both testing conditions. If cue familiarity effects in recognition are mediated by recall attempts, we predict the replication of our main result only when recall trials are present in the experimental design.

Participants

Forty-eight undergraduates of the Jagiellonian University participated for partial course credit.

Materials

Three hundred and six Polish nouns were used. Additional words were chosen from the same frequency norms that were used for Experiments 1–3 (Kurcz et al., 1990). The words were divided into two sets, one consisting of 138 nouns and the other consisting of 168 nouns. The words from the first set were used as fillers in a pleasantness judgment task. The words from the second set were used to create 84 cue–target pairs.

Procedure

The procedure consisted of three phases. The pleasantness judgment task was the same as in previous experiments, except for the fact that 42 cues were primed in this phase and 138 words were presented as fillers (for a total of 180 trials). The subsequent study phase was the same as in the previous experiments, except for the fact that 84 pairs were presented for study, with half of the cues primed in the previous phase. The fillers at the beginning and the end of the study phase were not included in this experiment. The final test was divided into two separate blocks. In one block, in which 42 pairs were tested, a recall test for a given cue (conducted in the same way as in Experiments 1–4) always preceded free-report recognition for the given cue (a two-step test condition). In the other block, in which the remaining 42 pairs were tested, recall trials were eliminated and participants were given only free-report recognition (a one-step test condition). The assignment of pairs to the priming condition, the order of the test conditions and the assignment of pairs to the type of test were all counterbalanced across participants.

Design

There were two independent variables in the design, type of cue (Primed vs. Unprimed) and type of test (Two-steps vs. One-step), both manipulated within participants.

Results and discussion

The means for DK responses and IBA and OBA measures are presented in Table 1.

Recall

The recall results were analyzed for the Two-step test condition. The analysis revealed no difference between priming conditions in the IBA-recall, $t(47) = 1.03$, $p > .30$, and no difference in the rate of omission errors, $t < 1$.

Recognition

The proportion of DK responses was subjected to a 2 (type of cue) × 2 (type of test) within-participants ANOVA. The significant main effect of type of cue revealed that participants were less likely to answer DK in the Primed compared to the Unprimed condition, $F(1, 47) = 11.83$, $MSE = .01$, $p = .001$, $\eta_p^2 = .20$. The main effect of type of test condition and the interaction were not significant, $F(1, 47) = 2.02$, $p > .10$ and $F < 1$, respectively. The non-significant interaction suggests that cue priming had the same effect on DK responding, irrespective of whether recognition trials were preceded by recall trials or not. Indeed, separate t-tests confirmed that priming exerted its influence on DK responding in both the Two-steps test condition, $t(47) = 2.18$, $SE = .16$, $p = .03$, $d = 0.30$, and the One-step test condition, $t(47) = 2.18$, $SE = .20$, $p = .03$, $d = 0.34$.

A similar ANOVA on OBA-recognition revealed no significant effects ($F < 1$ for the main effect of type of test, $F(1, 47) = 1.70$, $p > .10$, for the main effect of type of cue, and $F(1, 47) = 2.00$, $p > .10$, for the interaction). The analysis of IBA-recognition also failed to reveal any significant effects ($F < 1$, for the main effect of type of test, $F(1, 47) = 1.59$, $p > .20$, for the main effect of type of cue, and $F < 1$ for the interaction).

In the present experiment we assessed whether the effects of cue familiarity on DK responding in a free-report recognition test revealed in Experiments 1–4 were mediated by information retrieved during retrieval attempts in recall trials which always preceded the free-report recognition trials. This hypothesis was not supported, as in the present experiment cue familiarity affected DK responding even when recall trials did not precede free-report recognition trials. This result indicates that increased cue familiarity directly leads to the illusion of knowledge in a recognition test which reduces the number of DK responses.

Experiment 6

Experiments 1–5 consistently showed that cue familiarity affects DK responding in a free-report recognition test. However, all these experiments used a quite specific type of a recognition task, namely an associative recognition task. Experiment 6 aims at assessing if the effect of cue familiarity on DK responding generalizes to a simple recognition task in which new words serve as foils.8

It is conceivable that the effects of cue familiarity on DK responding reported in previous experiments are specific to the associative recognition test, which would severely limit the scope of our conclusions. In the associative recognition test, a cue is indispensable for correct responding which involves matching cues to appropriate targets. In contrast, correct responding in simple recognition can be driven by processes that do not utilize cues. Specifically, participants can respond in a simple recognition test by assessing the relative familiarity of alternatives provided in each test trial, as the correct alternative should be more familiar than foils not presented in other phases of the procedure. It is possible that in such a task participants do not pay attention to cues and hence familiarity of these cues does not affect their performance. In other words, it could be hypothesized that cue familiarity affects metacognitive bias only in the tasks that specifically require participants to utilize cues. In this case cue familiarity should not affect DK responding in a simple recognition task.

On the other hand, it seems likely that participants use cues provided to them to aid their memory performance even if these cues are not indispensable for correct answering, as it occurs in the case of a simple recognition task. Some recent studies report that re-establishing local context at test aids memory performance even in a simple recognition task (Cohn et al., 2008, Cohn et al., 2009 and Cohn and Moscovitch, 2007). We predict, thus, that participants in the simple recognition test will pay attention to cues presented at test, and that the familiarity of these cues will affect their propensity to volunteer responses.

A secondary objective of the present experiment was to replicate the results of Experiment 5 showing the effect of cue familiarity on DK responding when associative recognition trials are not preceded by recall. Thus, the present experiment contrasted a one-step test from the previous experiment (now referred to as an associative recognition condition) with a simple recognition test with novel foils (referred to as a simple recognition condition). The novel foils used in the simple recognition test were chosen from the same semantic category from which targets were taken to ensure a sufficiently low level of recognition performance while obtaining a sizeable proportion of DK responses.

Participants

Twenty-nine undergraduates of the Jagiellonian University participated for partial course credit.

Materials

Three hundred and forty-two Polish words were used for the pleasantness judgment and study phases of the procedure. One hundred and eight of these words were chosen from 54 semantic categories, two words from each category, to serve as targets.9 From the rest of the words, 126 served as fillers in the pleasantness judgment task and 108 words served as cues. For the test, additional 108 words from the chosen categories (two from each) were taken to serve as foils in a simple recognition test. More pairs were used in the present experiment compared to Experiment 5 to increase the power of the design.

Procedure

The procedure of the present experiment was the same as the procedure of Experiment 5, except for a few changes. First, 108 pairs were used at study and consequently 54 cues were primed in the pleasantness judgment task. Second, different blocks of tests were used. In the Associative recognition condition, a cue in each test trial was presented together with a correct target and two targets taken from different pairs. Each target on this test was from a different semantic category. In the Simple recognition condition, a cue in each test trial was presented together with a correct target and two foils from the same semantic category. Again, each target on this test was from a different semantic category. The assignment of cues to the priming conditions, the order of the block tests and the assignment of pairs to a type of test were all counterbalanced across participants.

Design

There were two independent variables in the design, type of cue (Primed vs. Unprimed) and type of test (Associative recognition vs. Simple recognition), both manipulated within participants.

Results and discussion

The means for DK responses and IBA and OBA measures are presented in Table 1. The proportion of DK responses was subjected to a 2 (type of cue) × 2 (type of test) within-participants ANOVA. A significant main effect of type of cue revealed that participants were less likely to answer DK in the Primed condition (M = .34) compared to the Unprimed condition (M = .39), F(1, 28) = 7.11, MSE = .01, p = .01, $\eta_p^2 = .20$. The main effect of type of test and the interaction were not significant (both Fs < 1). The non-significant interaction suggests that cue priming had the same effect on DK responding in the associative and simple recognition tests. Indeed, separate t-tests confirmed that priming exerted its influence on DK responding in both associative recognition, t(28) = 2.23, SE = .13, p = .03, d = 0.38, and simple recognition, t(28) = 2.22, SE = .12, p = .04, d = 0.43.

The similar analysis of the OBA measure revealed no significant effects (F(1, 28) = 3.81, p = .06 for the main effect of type of test, F(1, 28) = 3.45, p = .07 for the main effect of type of cue, and F(1, 28) = 2.48, p > .10 for the interaction). The analysis of IBA also failed to reveal significant effects (F(1, 28) = 2.27, p > .10 for the main effect of type of test, F(1, 28) = 3.27, p = .08 for the main effect of type of cue, and F < 1 for the interaction).

The results of Experiment 6 are twofold. First, the results from the Associative recognition condition replicated the results of the One-step condition of Experiment 5. Thus, the effect of cue familiarity on DK responding in recognition, which we demonstrate throughout this paper, is not constrained to a situation in which recall directly precedes recognition. Second, the novel finding of the present experiment is that the effects of cue familiarity on DK responding are also present in a simple recognition test. In such a test a cue is no longer indispensable for correct responding. Responding can be achieved by assessing the relative familiarity of presented alternatives. The clear effect of cue familiarity suggests, however, that cues are still used and their familiarity also affects metacognitive bias in a simple recognition task.

Experiment 7

The effect of cue familiarity on DK responding proved to be fairly robust, occurring in Experiment 6 even in a simple recognition task in which cues were not necessary for correct responding. In the final experiment we sought to find a boundary condition for this effect. In this experiment cues were primed as in all previous experiments, but then they were not presented at test (No cue reinstatement condition). We reasoned simply that features of cues not present at retrieval should not affect metacognitive processes of handling the products of this retrieval process. A secondary objective of the present experiment was to assess the role of local context reinstatement in the simple recognition task. If cues provided at test aid simple recognition performance, as previous studies would suggest (e.g., Cohn & Moscovitch, 2007), then eliminating these cues from a test should result in impaired memory performance. To test this hypothesis we contrasted performance in a No cue reinstatement condition with performance in a Cue reinstatement condition, which replicated the Simple recognition condition used in Experiment 5, predicting that the elimination of cues would affect the measures of accuracy of a memory report.

Participants

Forty-eight undergraduates of the Jagiellonian University participated for partial course credit.

Materials

The same words as in Experiment 6 were used for pleasantness judgment and study phases of the present experiment. Additional 216 words from 54 semantic categories used as a source of targets were chosen (four from each category) to serve as foils in two simple recognition tests.

Procedure

The procedure of the present experiment was the same as the procedure of Experiment 6, except for the change in one of the test blocks. Specifically, Associative recognition condition from Experiment 6 was replaced with a No cue reinstatement condition in which a simple recognition test was used. In this test participants were asked to choose a studied word from three presented alternatives, out of which two were foils from the same semantic category. The cues were not presented in this condition.

Design

There were two independent variables in the design, type of cue (Primed vs. Unprimed) and type of test (Cue reinstatement vs. No cue reinstatement), both manipulated within participants.

Results and discussion

The means for DK responses and IBA and OBA measures are presented in Table 1. The proportion of DK responses was subjected to a 2 (type of cue) × 2 (type of test) within-participants ANOVA. Only a main effect of type of cue was significant, with fewer DK responses in the Primed condition ($M = .36$) compared to the Unprimed condition ($M = .39$), $F(1, 47) = 4.80$, $MSE = .01$, $p = .03$, $\eta_p^2 = .09$. The main effect of type of test was not significant, $F(1, 47) = 1.37$, $p > .20$, and neither was the interaction, $F(1, 47) = 2.71$, $p = .11$. Although the interaction was not significant, we conducted planned comparisons between Primed and Unprimed conditions separately for both types of test to directly address the main question posed for this experiment. The comparison in the Cue reinstatement condition was significant, $t(47) = 2.52$, $SE = .13$, $p = .02$, $d = 0.39$, with fewer DK responses for the Primed than for the Unprimed condition. However, the comparison for the No cue reinstatement condition failed to reveal a significant difference, $t < 1$.

A similar analysis of the OBA measure revealed a significant main effect of type of test, F(1, 47) = 8.71, MSE = .01, p = .005, $\eta_p^2 = .16$, with better accuracy of output in the Cue reinstatement condition (M = .86) than in the No cue reinstatement condition (M = .82). The main effect of type of cue and the interaction were not significant (both Fs < 1). The analysis of the IBA measure likewise revealed a main effect of test, F(1, 47) = 5.54, MSE = .03, p = .02, $\eta_p^2 = .11$, with more correct information volunteered in the Cue reinstatement condition (M = .56) than in the No cue reinstatement condition (M = .50), but no effect of type of cue, F(1, 47) = 2.94, p = .09, and no interaction, F(1, 47) = 1.62, p > .20.

Experiment 7 produced several noteworthy results. First, the results from the Cue reinstatement condition replicate the results of the Simple recognition condition in Experiment 6, once again showing that cue familiarity affects DK responding in a recognition test in which cues are not indispensable for correct performance. Second, the results from the memory reporting measures indicate that although cues may not be necessary for correct responding in a simple recognition task, if they are provided at test, they are still used to aid performance. This benefit of cue reinstatement is reflected in higher OBA and IBA measures compared to a condition in which cues are not presented at test. Although, as argued throughout this paper, OBA and IBA cannot be taken as pure measures of memory, the fact that cue reinstatement leads to a simultaneous increase in both measures without any effect on DK responding is highly suggestive of a memory effect. It is consistent with a scenario in which some of the answers that would be incorrect in the No cue reinstatement condition are transformed into correct responding due to a positive effect of cue reinstatement on memory retrieval. Third, the lack of a significant effect of priming in the test in which cues were not reinstated, as revealed by a planned comparison, suggests, as predicted, that cue familiarity exerts the influence only when this cue is actually re-presented, and also quite likely used to aid performance at test.

General discussion

The present paper demonstrated that at least one factor, namely cue familiarity, that affects post-retrieval metacognitive monitoring affects also the control process of deciding on the contents of a memory report. It is well-established in the metacognitive literature that cue familiarity affects people's feeling that the information sought is present in the memory storage (e.g., Koriat and Levy-Sadot, 2001, Metcalfe et al., 1993, Reder, 1987 and Schwartz and Metcalfe, 1992) and also people's confidence that a chosen answer is correct (Chua et al., 2012). In seven experiments we revealed that cue priming affected not only metacognitive monitoring, as captured by post-retrieval FOK judgments and CJs, but also, and more importantly for the aim of this study, DK responding in a recognition test. Furthermore, we demonstrated that changes in cue familiarity affect the number of correct responses provided in a recognition test, thus shaping the accuracy of a memory report.

Although in five out of our seven experiments we used both recall and recognition tests, the results from recall tests proved less robust than the results from recognition tests, with significant changes in DK responses due to the priming manipulation revealed only in Experiment 4 and the combined analysis of Experiments 1–3. Thus, in contrast to the robust findings in recognition, the contribution of memory and metacognitive process to changes in DK responding could not be properly investigated for recall. Why could the illusion of knowledge play a smaller role in recall than in recognition? We hypothesize here that this different sensitivity of recall and recognition to metacognitive effects could stem from different levels of metacognitive discriminability usually obtained with these two testing formats. Recall of unrelated pairs of words is most likely highly dependent on a recollective process which provides participants with correct and very confidently held responses. This in turn leads to high levels of metacognitive discriminability which may preclude strong effects of changes in metacognitive bias. If participants are very well aware of which of their candidate responses are correct and which are incorrect, then subtle changes in cue familiarity are perhaps unlikely to create the illusion of knowledge and convince participants to modify their reporting behavior. In contrast, recognition is much more dependent on familiarity processes, which makes performance in this type of test sensitive to spurious feelings evoked by foils. In our experiments we used either an associative recognition test with targets from different pairs serving as foils, or a recognition test in which foils were taken from the same semantic category as targets. In both kinds of tests, foils were characterized by high levels of familiarity, either due to the fact that they were studied, or due to the semantic overlap with the studied materials. We suggest that these choices of foils secured an optimal level of metacognitive discriminability in recognition which allowed for detecting clear effects of cue familiarity on DK responding.

Our hypothesis concerning apparent differences between recall and recognition suggests that DK responding in recall could be more sensitive to the effects of cue familiarity if a procedure is used that would result in impoverished metacognitive discriminability. A way to reduce metacognitive discriminability in recall could include, for instance, the use of either very similar cues or very similar targets, which would increase the contribution of non-recollective processes to recall performance (cf. Brainerd & Reyna, 2010). With such materials, participants would presumably be less able to identify whether their candidate response for a given cue was actually paired with that cue. In this case small changes in response criterion could lead to consistent changes in the rate of DK responses.

The results of a recent study conducted by Aue, Criss, and Fischetti (2012) can be used to substantiate these hypotheses. In their Experiment 1, participants studied face-word pairs in two lists. Importantly, some pairs from the second list were composed from rearranged faces and words used in the first list, whereas some pairs were composed from novel faces and words. In a subsequent cued recall test participants were presented with faces and asked to recall words paired with them in the second list. Aue et al. observed that faces presented in both lists produced higher levels of both correct recall and intrusions, when compared to faces presented only in the second list. This finding is akin to our findings in recognition tests if one assumes that the presentation of a face in the first list increased its familiarity. Indeed, in their general discussion, Aue et al. point to a possible role of cue (face) familiarity and changes in report criterion in producing the aforementioned result. We would like to note here that the use of faces as stimuli could be responsible for the effect of cue familiarity in cued recall documented by Aue et al., which is commonly absent when pairs of words are used as materials. It seems likely that using faces – stimuli with higher degree of similarity to each other compared to words (Kinnell & Dennis, 2012) – as cues for recall led to impoverished metacognitive discriminability, allowing the effects in metacognitive control to be revealed. This issue awaits further research.

The present study focused on cue familiarity as one of the factors that affect metacognitive monitoring. As discussed earlier, the choice of cue familiarity as a focus of our study was dictated by the need to limit the interpretation of the results to metacognitive factors. The decision to volunteer or withhold the answer in a memory task is a result of a complex interplay of both memory and metamemory processes, as demonstrated by both the conceptual framework of Koriat and Goldsmith (1996) and the type-2 SDT model, which were both applied to our findings. By manipulating cue familiarity we were able to show that decisions to volunteer or withhold answers in a memory test and consequently the contents and accuracy of a memory report may depend on metacognitive processes that are unrelated to basic processes of encoding and retrieval of relevant information from memory. However, it is vital to stress that presumably memory and metacognitive processes are linked and thus our study most likely presents a special case in which metacognitive monitoring and control are dissociated from basic memory processes. We suggest thus that future studies should further explore this complexity by examining the role of other factors beyond cue familiarity on both memory and metamemory processes in memory reporting. One obvious candidate for such further examination is the volume of information accessed during retrieval, a factor that is clearly related to the efficacy of the retrieval process and is at the same time known to be linked to the process of metacognitive monitoring (e.g., Brewer et al., 2010, Koriat, 1993, Koriat, 1995 and Thomas et al., 2011). A careful study of this particular factor could shed further light on how memory and metamemory processes interact.

On a final note, we would like to stress the importance of research concerning post-retrieval metacognitive control as reflected in DK responses. There is a great abundance of studies on metacognitive judgments (like FOK judgments or CJs), which are assumed to reflect metacognitive monitoring, but the issue of how these judgments are linked to participants' actual behaviors in cognitive tasks is often neglected. We would like to stress that the purpose of examining metacognitive monitoring in memory tasks is first and foremost to understand how the controlled process of remembering develops and thus all findings concerning metacognitive judgments should ultimately be linked to actual control decisions that shape performance in a cognitive task.

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1 We use the term 'accuracy of a memory report' rather than 'memory accuracy' to stress that these measures refer to the accuracy of information provided by participants in their memory reports rather than to the accuracy of memory retrieval. The accuracy of a memory report depends not only on the accuracy of memory retrieval but also on the processes of metacognitive monitoring and control.

2 Type-2 SDT differs in some crucial respects from the more commonly used type-1 SDT used to model old/new recognition performance. Type-1 SDT assumes distributions of targets and foils along a dimension of memory evidence and a criterion placed along the dimension of memory evidence that partitions the distributions into items called 'old' and 'new'. Type-2 SDT described here uses the same logic as type-1 SDT but is concerned with distributions of correct and incorrect candidate responses, the dimension of confidence in correctness and criterion between reporting and withholding candidate responses, as described in the text. The full discussion of differences between type-1 and type-2 models is beyond the scope of the present work and interested readers can find such a discussion in Higham, Perfect, and Bruno (2009).

3 Participants were instructed to repeat the answers they previously volunteered in the forced-choice test. On rare occasions (7 trials, constituting 0.3% of all test trials) such answers were changed. The items for which a different alternative was endorsed on free- and forced-report tests were excluded from the analyses.

4 Degrees of freedom for the SDT analyses differ from previous analyses because four participants had to be excluded due to their perfect forced-report recognition performance in one of the conditions. Additionally, a correction advocated by Snodgrass and Corwin (1988) was applied to avoid HRs or FARs that equal 0 or 1 which precludes the calculations of a d' index.

5 The items for which a different alternative was endorsed on free- and forced-report test (4 trials, constituting 0.2% of all test trials) were excluded from all analyses.

6 A cautionary note is needed here. Traditionally, the inability to distinguish between a shift in criterion and a concordant shift in both distributions have been seen as a problem in the literature on type-1 SDT, the model that the readers may be more familiar with (see Rotello & Macmillan, 2008, for a thorough discussion of this issue). In this literature, shifts in distributions reflect memory effects whereas shifts in criterion reflect non-memory effects. Given that the purpose of applying type-1 SDT is to distinguish between memory and non-memory effects, the inability to separate criterion shifts from distribution shifts has been mentioned as major drawback of this methodology as it defies the main theoretical purpose of applying this method. However, in our view this argument is specific to type-1 SDT, which is not employed in the present study, and similar arguments should not be applied automatically to type-2 SDT. The reason for it is that in type-2 SDT both shifts in distributions and shifts in criterion reflect metacognitive processes and thus separating these two effects is simply not the main purpose of applying this method, which we would prefer to see in the opportunity type-2 SDT provides to derive the indices of metacognitive processing from participants' decisions in a memory task rather than their subjective judgments concerning such decisions (cf. Higham, 2002).

7 It is perhaps worth noting that Koriat and Goldsmith (1996) note in their seminal paper that: "The control decision is assumed to depend on the monitoring output as well as functional incentives and situational demands" (p. 493)", indicating that also according to these authors metacognitive control is not limited to strategic effects as it also encompasses monitoring-induced effects.

8 Technically, the test in which participants need to establish which of the presented alternatives was paired with a cue is always an associative recognition test, independently of whether foils are taken from other pairs or are novel words. However, in the present study we use the term associative recognition only to refer to the test with recombined foils and we refer to the test with novel foils as simple recognition to clearly disentangle the case in which information contained in a cue is indispensable for correct responding from the case in which it is not.

9 The categorized words were chosen from category norms published by Van Overschelde, Rawson, and Dunlosky (2004) and translated into Polish. The rest of the words were chosen from the Polish frequency norms (Kurcz et al., 1990).

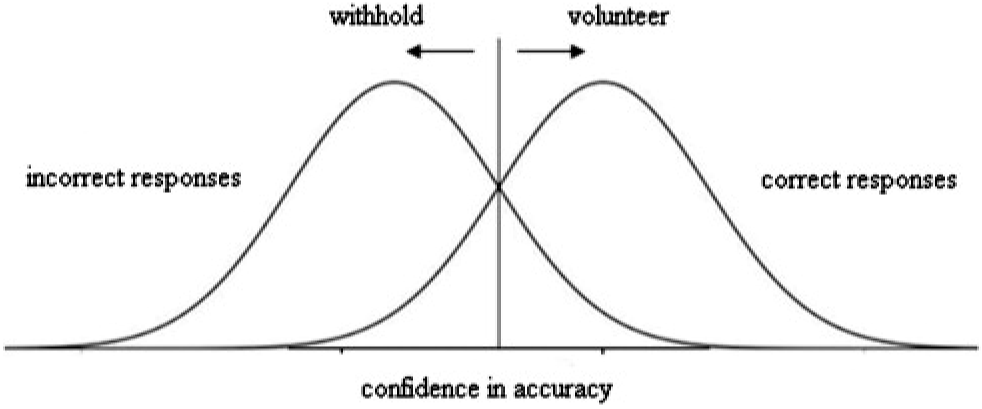

Fig. 1.
A type-2 SDT model. The two distributions placed along the dimension of confidence in correctness are the distributions of correct and incorrect candidate responses. The vertical line represents a criterion value of confidence which is used to decide whether a candidate response should be volunteered. Responses with confidence equal to or higher than the criterial value are included in a memory report whereas responses with confidence lower than the criterial value are withheld and a DK response is given instead.

Table 1.
The rates of DK responses and the input-bound and output-bound measures of accuracy in recall and free-report recognition as a function of cue type condition (Primed vs. Unprimed) in Experiments 1–7. The means of OBA for recall were calculated only from cases in which participants provided at least one response other than DK in both primed and unprimed conditions. The standard deviations are given in parentheses.

	Recall						Recognition					
	Primed			Unprimed			Primed			Unprimed		
	DK	IBA	OBA	DK	IBA	OBA	DK	IBA	OBA	DK	IBA	OBA
Experiment 1	.74 (.17)	.17 (.13)	.69 (.28)	.78 (.19)	.14 (.14)	.70 (.29)	.24 (.16)	.62 (.20)	.82 (.19)	.30 (.19)	.58 (.22)	.82 (.19)
Experiment 2	.78 (.22)	.18 (.19)	.77 (.29)	.79 (.23)	.18 (.20)	.81 (.23)	.33 (.20)	.59 (.26)	.85 (.20)	.37 (.24)	.56 (.28)	.86 (.20)
Experiment 3	.73 (.23)	.19 (.18)	.72 (.29)	.77 (.21)	.16 (.16)	.75 (.28)	.29 (.21)	.58 (.23)	.81 (.19)	.35 (.22)	.54 (.24)	.83 (.20)
Experiment 4	.80 (.20)	.11 (.11)	.74 (.28)	.88 (.18)	.06 (.07)	.71 (.40)	.48 (.24)	.38 (.20)	.75 (.21)	.55 (.23)	.32 (.18)	.74 (.22)
Experiment 5												
Two-steps condition	.81 (.20)	.16 (.18)	.82 (.31)	.82 (.19)	.14 (.16)	.78 (.32)	.28 (.22)	.56 (.23)	.78 (.21)	.33 (.24)	.52 (.24)	.79 (.25)
One-step condition	–	–	–	–	–	–	.30 (.21)	.53 (.23)	.77 (.24)	.37 (.25)	.52 (.24)	.81 (.21)

	Recall						Recognition					
	Primed			Unprimed			Primed			Unprimed		
	DK	IBA	OBA	DK	IBA	OBA	DK	IBA	OBA	DK	IBA	OBA
Experiment 6												
Associative recognition	–	–	–	–	–	–	.35 (.24)	.52 (.25)	.77 (.17)	.40 (.26)	.49 (.23)	.83 (.16)
Simple recognition	–	–	–	–	–	–	.33 (.22)	.56 (.23)	.84 (.17)	.38 (.27)	.53 (.27)	.85 (.18)
Experiment 7												
Cue reinstatement	–	–	–	–	–	–	.33 (.20)	.57 (.19)	.86 (.13)	.38 (.21)	.54 (.21)	.86 (.15)
No cue reinstatement	–	–	–	–	–	–	.38 (.21)	.51 (.18)	.82 (.14)	.39 (.19)	.50 (.18)	.82 (.14)