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Feeling-of-knowing and restudy choices

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Abstract

Feeling-of-knowing judgments (FOK-Js) reflect people's confidence that they would be able to recognize a currently unrecallable item. Although much research has been devoted to factors determining the magnitude and the accuracy of FOK-Js, much less work has addressed the issue of whether FOK-Js are related to any form of metacognitive control over memory processes. In the present study, we tested the hypothesis that FOK-Js are related to participants' choices of which unrecallable items should be restudied. In three experiments we showed that participants tend to choose for restudy items with high FOK-Js, both when they are explicitly asked to choose for restudy items that can be mastered in the restudy session (Experiments 1a and 2) and when such specific instructions are omitted (Experiment 1b). The study further demonstrates that increasing FOK-Js by priming cues affects restudy choices even though it does not affect recall directly. Finally, Experiment 2 shows the strategy of restudying unrecalled items with high FOK-Js to be adaptive as the efficacy of restudy is greater for these items than for items with low FOK-Js. Altogether, the present findings underscore an important role of FOK-Js for the metacognitive control of study operations.

Keywords: Metacognition, Feeling-of-knowing, Restudy

Feeling-of-knowing and restudy choices

Research in metamemory is focused on how people's knowledge about their memory processes affects performance in memory tasks. While performing a task of either encoding or retrieval, people monitor the progress of memory processes and use the results of monitoring to guide control decisions that ultimately shape memory performance. The monitoring component of metamemory processing is tapped by metamemory judgments elicited in the course of a memory task, such as judgments-of-learning (JOLs) or feeling-of-knowing judgments (FOK-Js). The crucial tenet of the metamemory approach is that these judgments are linked to metamemory control processes and through them to memory performance. For example, a number of studies have shown that the magnitude of JOLs is reliably linked to such control decisions as for how long to study a given item (e.g., Metcalfe, 2002) or which items to restudy (e.g., Thiede & Dunlosky, 1999), which have important consequences for the ultimate memory performance. In the present study our focus is on the FOK-Js and their link to metacognitive control in the form of restudy choices.

FOK-Js are collected in the paired-associates paradigm in which participants study pairs of unrelated cue-target words and subsequently attempt to recall targets in response to cues. Whenever a participant fails to provide a target for a given cue, s/he is asked to assess whether s/he would be able to recognize this target from among several foils. This judgment has been linked to two types of control decisions that participants make in the course of a memory task. First, the magnitude of FOK-Js is related to the duration of memory search (e.g., Singer & Tiede, 2008). When the magnitude of FOK-Js is manipulated, commonly by varying cue familiarity, participants search memory longer for cues which elicit higher FOK-Js. However, this type of control seems to have no consequences for memory performance as longer time spent on searching memory does not result in additional retrievals (Malmberg, 2008). Second, a recent study from our group documented that the magnitude of FOK-Js is related to volunteer/withhold decisions in a subsequent recognition task (Hanczakowski, Pasek, Zawadzka, & Mazzoni, 2013). However, in this study the manipulation of cue familiarity, used to vary FOK-Js, affected also retrospective confidence judgments in the recognition task which are known to be related to volunteer/withhold decisions. This study thus does not demonstrate a unique contribution of FOK-Js to shaping of control decisions.

FOK-Js are commonly collected for items that are not recalled. In such a case, people can make two control decisions. They can continue to search memory, a control decision which is related to FOK-Js but does not modify memory performance (Malmberg, 2008). Alternatively, they can decide to restudy items they cannot retrieve. In contrast to the search duration, restudy choices are important for subsequent memory performance. Kornell and Metcalfe (2006) showed that memory performance benefits most if people choose for restudy items which are in their region of proximal learning (RPL): they are not entirely learned but can be learned with relatively small effort. Although much is known about how people assess which items belong to the RPL during study (e.g., Metcalfe & Finn, 2008a), currently it is unknown how people decide which items should be restudied when this decision is made not during study but only after a failed retrieval attempt. We hypothesize here that the monitoring process reflected in FOK-Js alerts people that a certain item remains in the RPL and thus should be chosen for restudy.

The present study employs the methodology of Schwartz and Metcalfe (1992; see also Hanczakowski et al., 2013). The procedure involves study of paired-associates and a cued recall test, in which participants are asked to provide FOK-Js. Cue familiarity is manipulated via a priming procedure. A pre-study phase is included in which participants provide pleasantness judgments for a long series of words which include half of the words later used as cues for the paired-associates procedure. In this paradigm, the magnitude of FOK-Js is increased for primed (vs. unprimed) cues. We supplemented this basic procedure with a requirement to provide restudy choices following failed recall attempts. Specifically, after providing FOK-Js for unrecalled items, participants were asked to decide whether they want to restudy a given item. We predicted that increased cue familiarity will inflate FOK-Js, leading to an increased number of items chosen for restudy. In other words, we predicted that FOK-Js will alert participants that a given item is in the RPL and thus should be restudied. We tested this hypothesis in two experiments. Experiment 1a used restudy instructions which specifically asked participants to choose for restudy items from the RPL to ascertain whether FOK-Js and the perceived ease of subsequent learning are indeed related. Experiment 1b examined if the same pattern of restudy choices would occur with relaxed restudy instructions not suggesting any particular strategy for making restudy choices.

Experiments 1a and 1b

Method

Participants. Twenty-two undergraduates from Cardiff University participated in Experiment 1a and 30 in Experiment 1b.

Materials. Two hundred and seventy words of medium frequency were chosen from the MRC database. The words were divided into two subsets, one consisting of 150 words and the other consisting of 120 words. The words from the first subset were used as fillers in the pleasantness judgment task. The words from the second subset were randomly paired to create 60 cue-target pairs.

Procedure and design. Participants were tested in small groups of up to four people on individual computers. They were first asked to complete the pleasantness judgment task. In this task, individual words were presented and participants were asked to rate how pleasant a presented word is. Out of the 180 words presented, 150 words were fillers and 30 words were subsequently used as cues in the paired-associates task. The pleasantness judgment task was self-paced.

The study phase immediately followed the pleasantness judgment task. In the study phase, 60 cue-target pairs were presented for study. Each pair was displayed for 2.5 seconds with 500 ms interval. Half of the pairs contained cues which were primed in the pleasantness judgment task. The assignment of cues to the primed and unprimed conditions was counterbalanced.

The test phase immediately followed the study phase. On each trial, participants were first presented with one of the cues from study and asked to recall the target. Time for recall was not limited. When a participant provided any response (whether it was correct or not), the procedure moved to the next cue. When a response was not provided, the procedure moved to the FOK-J stage. The same cue was presented again and the participant was asked to judge how likely it is that s/he would recognize the target (on a scale 0-100). After providing the FOK-J, the participant was asked to indicate whether s/he would like to restudy the pair which contained the given cue. No details about the conditions of the future restudy phase were provided.

In Experiment 1a the instructions for the restudy choice made it clear that participants should choose for restudy only pairs which are in their RPL. The specific instructions were as follows:

> Try to choose for restudy only pairs that you think you will be able to learn successfully in the second study phase. If you think you will not be able to learn a pair successfully in the second study phase, do not choose it for restudy, as doing so would result in failed recall later.

After the test, a second study phase for items chosen for restudy was given, followed by the test of the restudied items. This was done to give the sense of closure to the procedure and the data from the second recall was not analyzed.

In Experiment 1b participants were asked to choose any 12 items for restudy. Twelve items were allowed because this was the average number of items chosen for restudy in Experiment 1a (exactly 12.23), which was conducted earlier. To make sure that participants follow the instructions, we included a counter showing how many items remained that could be chosen for restudy. After the counter reached zero, the question about restudy was no longer asked. No second study phase and no second test were included.

Results and discussion

The descriptive statistics are presented in Table 1.

Experiment 1a. The comparison of the proportion of correctly recalled targets between primed and unprimed conditions was not significant, $t(21) = 1.281$, $SE = .023$, $p = .21$. The comparison of FOK-Js between these conditions revealed a significant difference, $t(21) = 5.468$, $SE = 1.29$, $p < .001$, with higher FOK-Js for primed cues. This latter result replicates numerous observations that cue familiarity determines the magnitude of FOK-Js (e.g., Schwartz & Metcalfe, 1992).

Turning to restudy choices, participants chose for restudy 32% of items for which the restudy questions had been asked (which in turn constituted 68% of all test trials). We first analyzed whether FOK-Js correlated with restudy choices. The average *gamma* between FOK-Js and restudy choices was .92, significantly different from zero, $t(20) = 31$, $p < .001$, indicating that restudy choices are related to FOK-Js. This correlation does not, however, speak directly to whether restudy choices depend on FOK. It is possible that restudy choices are based directly on retrievability of targets, a factor which is also known to affect FOK-Js via retrieval of partial information concerning targets (Koriat, 1993). In our procedure, priming of cues spuriously inflates FOK-Js without affecting target retrievability. If thus restudy choices track retrievability but not FOK, then priming manipulation should not affect them. However, if high FOK is a reason why people choose a certain pair for restudy, then priming should affect restudy choices. We compared the proportions of items chosen for restudy out of all items for which restudy question had been asked for primed and unprimed conditions. This comparison was significant, $t(21) = 3.316$, $SE = .035$, $p = .003$, indicating that participants more often chose for restudy items for which FOK-Js had been spuriously inflated by cue priming. This result is crucial, as it shows how metamemory processes can be affected by a manipulation that does not alter memory processing itself. In conclusion, the present results indicate that FOK-Js are related to the control decision concerning restudy choices after a failed recall attempt.

Experiment 1b. The comparison of the proportions of correctly recalled targets between primed and unprimed conditions was not significant, $t(29) = 1.03$, $SE = .019$, $p = .31$. The comparison of FOK-Js between primed and unprimed conditions revealed a significant difference, $t(29) = 4.057$, $SE = 1.37$, $p < .001$, with higher FOK-Js for primed cues. Turning to restudy choices, we again computed gamma correlations between FOK-Js and restudy choices (*gamma*s could not be computed for three participants). Just as in Experiment 1a, this gamma correlation was positive (.74), and significantly different from zero, $t(26) = 10.89$, $p < .001$. Even more importantly, a comparison of the proportions of items chosen for restudy out of all items for which restudy question had been asked revealed a significant difference between primed and unprimed conditions, $t(29) = 2.08$, $SE = .032$, $p = .046$. Replicating the main result of Experiment 1a, participants chose for restudy more items for primed (vs. unprimed) cues.

In Experiment 1a we showed that after failed recall attempts participants instructed to choose for restudy items that can be mastered in a subsequent study session base their restudy choices on FOK-Js. In other words, when participants are directed towards choosing items from the RPL, they use FOK to ascertain which unrecalled items remain in their RPL.

Experiment 1b extended these findings to a situation in which participants were not directed towards choosing items from the RPL. Despite complete freedom in choosing any 12 items they wished, participants still preferred to restudy items with high FOK-Js. Previous studies suggested that participants may not be willing to choose for restudy items according to the RPL unless the instructions ask them to do it. Thiede and Dunlosky (1999) showed that when participants needed to decide in a sequential fashion whether they would like to restudy a given item immediately after this item's presentation for study, they tended to pick difficult items (as assessed by JOLs), which is the opposite of the predictions derived from the RPL framework (although a different pattern of results emerged when participants chose simultaneously from an array of items). In a follow-up study, Dunlosky and Thiede (2004) showed that this pattern of results stemmed at least partially from the fact that participants failed to develop an appropriate plan of choosing easy items in the sequential format. In contrast to these studies, the results of the present Experiment 1b indicate that people are able to develop the plan of choosing for restudy items from the RPL even when restudy choices are collected sequentially.

A subset of previous studies examining the link between JOLs and restudy choices also showed that even in the sequential format participants choose for restudy preferentially the easiest items (Metcalfe & Kornell, 2005, Experiment 6; Kornell & Metcalfe, 2006, Experiment 3a). A difference between our study and both the studies by Metcalfe and Kornell (2005) and Kornell and Metcalfe (2006) on the one hand, and Thiede and Dunlosky's (1999) study on the other, is that the latter study examined restudy choices for all items included in the test, whereas our study and the work by Metcalfe and Kornell focused on items that were not correctly recalled on the initial test. This was necessarily the case for our study as we were interested in restudy choices in relation to FOK-Js, which are collected only for unrecalled items. However, in both studies by Metcalfe and Kornell, an initial recall test was also included and items correctly recalled were screened from the restudy choice phase. The reason for this screening was that, as argued by Metcalfe and Kornell, the predictions of the RPL are most pertinent to items that have not been learned. The inclusion of already learned items in the restudy choice phase creates a situation in which the easiest, already learned items (characterized by highest JOLs) are not chosen for restudy. This may in turn lead to a preference for difficult items, which are in this context simply items that are not yet mastered.

One outstanding question concerning the link between FOK-Js and restudy choices is whether the strategy of using FOK to pick items for restudy is adaptive. Are items characterized by higher FOK-Js truly easier to learn in a later study phase than items with lower FOK-Js? If this is the case, then participants are right to choose these items for restudy in order to maximize future memory performance. In order to assess this issue, we conducted Experiment 2, in which we included an additional restudy/test cycle for all items for which restudy question was asked in the first test. The additional restudy/test cycle allowed for answering two related questions. First, the correlation analysis of FOK-Js given in the first test and subsequent recall in the second test speaks to whether FOK-Js serve as a good basis for choosing items from the RPL. Second, the comparison of recall performance for items initially chosen and not chosen for restudy speaks to whether participants restudy choices for unrecalled items are adaptive.

In Experiment 2 we again included the priming manipulation to replicate the results of Experiments 1a and 1b. However, priming, by influencing restudy choices, can potentially undermine the effectiveness of participants' restudy choices. To control for this problem, we also included a control group without the priming manipulation.

Experiment 2

Method

Participants. Fifty-six undergraduates from Cardiff University participated in this experiment, 28 in the priming group and 28 in the control group.

Materials, procedure and design. The experimental procedure for the priming group was the same as in Experiment 1a, except that after the first test a new study phase was administered for items unrecalled on the first test, followed by a cued recall test for these items. The procedure of these novel phases was identical to the first study and test, except that no FOK-Js or restudy questions were asked in the test. The procedure for the control group was the same, except that no cues were primed in the pleasantness judgment phase, in which a novel set of 30 words were used as substitutes for cues.

Results and discussion

The descriptive statistics are presented in Table 1. The results from the priming group replicated the results of Experiment 1a. Recall performance was equal between the primed and unprimed conditions, $t < 1$, and FOK-Js were higher in the primed than in the unprimed condition, $t(27) = 3.86$, $SE = 1.42$, $p = .001$. The gamma correlation between FOK-Js and restudy choices (one participant excluded) was .80, significantly different from zero, $t(26) = 11.18$, $p < .001$. Finally, a comparison of the proportions of items chosen for restudy out of all items for which restudy question had been asked revealed a significant difference between primed and unprimed conditions, $t(27) = 2.10$, $SE = .028$, $p = .045$. We also computed gammas between FOK-Js and restudy choices in the control group (two participants excluded) and it was again positive and significantly different from zero, *gamma* = .82, $t(25) = 19.51$, $p < .001$.

To assess the main issues of interest, we computed gamma correlations between FOK-Js on the first test and recall performance on the second test. These *gamma*s were positive and reliably different from zero in both the priming group, *gamma* = .26, $t(27) = 3.33$, $p = .003$, and in the control group (one participant excluded), *gamma* = .19, $t(26) = 2.84$, $p = .009$. These two *gamma*s were not reliably different, $t < 1$. Overall, these results indicate that FOK-Js are related to the efficacy of subsequent learning as items receiving high FOK-Js are better learned than items receiving low FOK-Js. In other words, FOK-Js serve as an indicator whether unrecalled item remains in the RPL. The lack of differences between groups suggests that the priming manipulation, which did change the pattern of FOK-Js, was not potent enough to disrupt the relation between FOK-Js and subsequent learning.

We further analyzed recall performance for items participants chose and did not choose for restudy. Three participants (two from the control and one from the priming group) were excluded due to missing cells. A 2 (group: priming vs. control) x 2 (item type: chosen vs. not chosen for restudy) mixed ANOVA on the proportion of items correctly recalled on the second test yielded only a significant main effect of item type, $F(1, 51) = 18.16$, $MSE = .025$, $p < .001$, as participants learned more effectively items chosen for restudy, $M = .52$, $SD = .30$, than items not chosen, $M = .39$, $SD = .23$. These results indicate that participants were able to effectively choose for restudy items that had the highest chances of being mastered in a subsequent study phase. The lack of interaction, $F(1, 51) = 1.63$, $MSE = .025$, $p = .207$, suggests that the priming manipulation, which did change the pattern of restudy choices, was again not potent enough to disrupt the efficacy of subsequent learning in the priming group.

General Discussion

The experiments reported in the present paper document a novel control function of FOK. The process of metamemory monitoring reflected in FOK-Js was found to be related to restudy choices. FOK-Js were positively correlated with restudy choices and the factor that spuriously inflated FOK-Js, increased cue familiarity, changed also the pattern of items that were chosen for restudy. Moreover, it was found that FOK-Js are positively related to the efficacy of subsequent learning of unrecalled items, indicating that participants are correct in relying on FOK to drive their restudy choices. Overall, these findings document the important role that FOK plays in regulating learning: it alerts people to the fact that some of the unrecalled items are closer to being learned, which in turn makes these items the prime subjects of further encoding operations.

The present study was conceived from the tenets of the RPL framework (Metcalfe, 2002), according to which people concentrate their encoding efforts on the easiest and as yet unlearned items. This framework has been extensively researched in reference to JOLs, with the prime finding that participants do in fact preferentially study unlearned items assigned high JOLs. However, at least some of the studies on the RPL asked for restudy choices not during study (when JOLs are made) but only after the initial test used to screen out the already learned items (e.g., Metcalfe & Kornell, 2005). In these studies decoupling JOLs and restudy choices, it was unclear how participants established which of the items remained in the RPL. The present study suggests that the role served by JOLs at study may be taken over by FOK-Js after the failed recall attempt. It has to be noted, however, that the present studies asked for restudy choices immediately after failed recall, when FOK could easily incorporate information accessed during retrieval attempts. The issue of whether FOK-Js remain related to restudy choices when these are made after a delay could be assessed with further studies.

In the metacognitive literature it is sometimes argued that JOLs and FOK-Js at least partially rely on the same processes. In this case our findings are close to the extensive literature on the relationship between JOLs and restudy choices. However, it is also possible that JOLs and FOK-Js are dissociable. For example, as shown by Metcalfe and Finn (2008), cue familiarity, a factor manipulated in the present study, affects delayed JOLs. However, in their Experiment 3 only JOLs made to a deadline were affected by cue familiarity, whereas unspeeded JOLs were not. This contrasts with the pattern observed for FOK-Js, which are affected by cue familiarity also under unspeeded conditions. Given that cue familiarity affected restudy choices in the present study, it seems likely that FOK-Js capture some processes responsible for restudy preferences that delayed JOLs do not. The issue of differences between FOK-Js and JOLs in reference to restudy choices awaits further research.

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Table 1. Mean proportions of correctly recalled items, means of FOK-Js, and mean proportions of items chosen for restudy out of the number of times the restudy question was asked presented as function of the cue priming condition (primed vs. unprimed) in Experiments 1a, 1b, and 2 for the priming groups and also for the control group tested in Experiment 2 only. Standard errors of the means are given in parentheses.

	Priming groups		Control group
	Primed cues	Unprimed cues	
Experiment 1a			
Correct recall	.20 (.04)	17 (.03)	-
FOK-Js	34.97 (3.22)	27.92 (2.84)	-
Restudy choices	.38 (.04)	.26 (.03)	-
Experiment 1b			
Correct recall	.09 (.02)	.11 (.02)	-
FOK-Js	25.62 (2.77)	20.08 (2.54)	-
Restudy choices	.37 (.04)	.31 (.04)	-
Experiment 2			
Correct recall	.20 (.03)	.19 (.03)	.16 (.03)
FOK-Js	30.50 (2.58)	25.03 (2.80)	28.27 (2.37)
Restudy choices	.32 (.03)	.26 (.03)	.34 (.04)