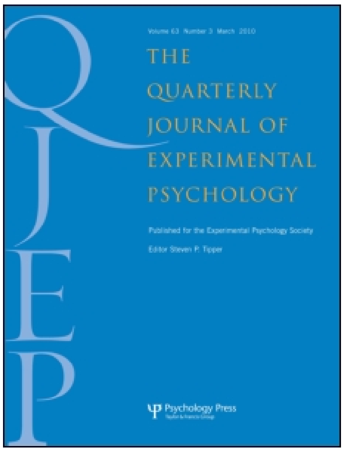

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Two dissociable aspects of feeling-of-knowing: Knowing that you know and knowing that you do not know

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Short article

Two dissociable aspects of feeling-of-knowing: Knowing that you know and knowing that you do not know

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Feeling-of-knowing judgement is traditionally regarded as a unitary cognitive process. However, recent research suggests that knowing that you know (positive feeling-of-knowing) and knowing that you do not know (negative feeling-of-knowing) have different neural substrates (Luo, Niki, Ying, & Luo, 2004). In the present study, we used a paradigm adapted from Koriat and Levy-Sadot (2001) to examine whether positive feeling-of-knowing and negative feeling-of-knowing were mediated by distinct cognitive processes. We found that positive and negative feeling-of-knowing were dissociated during immediate feeling-of-knowing judgements (i.e., preliminary feeling-of-knowing) and delayed feeling-of-knowing judgements (i.e., postretrieval feeling-of-knowing). At the judgement intervals, positive feeling-of-knowing was based on partial recovery of the nonrecalled targets, whereas negative feeling-of-knowing was determined by familiarity with the retrieval cues. Our results suggest that feeling-of-knowing is a heterogeneous process.

What is the capital of Cambodia? Although you may not recall the name of the city, you may be sure that the answer is available in your memory and can be recalled or recognized in the future. This phenomenon is termed as feeling-of-knowing, which has been investigated by cognitive psychologists as a branch of metacognition research (Hart, 1965). Theories that focus on the trace-access mechanisms (Nelson, Gerler, & Narens, 1984), such as the target retrievability hypothesis, suggest that the

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feeling-of-knowing judgements are based on partial retrieval of information about the unrecalled target (Schwartz & Metcalfe, 1992). On the other hand, theories that focus on inferential mechanisms, such as the cue-familiarity hypothesis (Metcalfe, Schwartz, & Joaquim, 1993; Reder & Ritter, 1992), suggest that familiarity with the retrieval cue or other nontarget information results in feeling-of-knowing.

Basically, there are two types of feeling-of-knowing. One is the positive feeling-of-knowing that refers to the situation that subjects know a yet-to-be retrieved item. The other is the negative feeling-of-knowing that refers to the situation that subjects feel they do not know (Glucksberg & McCloskey, 1981; Klin, Guzman, & Levine, 1997). Although both of them are metamemory judgements and can be dissociated from actual memory outcome (e.g., negative feeling-of-knowing can be followed by correct retrieval), we do not know whether the same cognitive mechanism supports these two types of feeling-of-knowing. In the present study, we aimed to study whether there would be any dissociation of the cognitive mechanisms of positive and negative feeling-of-knowing. Specifically, we focused on how much these two types of feeling-of-knowing might rely on target trace-access and cue familiarity.

Some preliminary studies have shown that positive feeling-of-knowing and negative feeling-of-knowing may be mediated by distinct neural processes (Luo & Niki, 2000; Luo, Niki, Ying, & Luo, 2004). Using the recall–judgement–recognition (RJR) paradigm introduced by Hart (1965), Luo and Niki (2000) found that accurate positive feeling-of-knowing, but not accurate negative feeling-of-knowing, activated several regions of the prefrontal cortex. Moreover, Luo et al. (Luo, Kazuhisa, & Luo, 2003; Luo, Niki & Luo, 2002) further demonstrated that the right ventral prefrontal cortex and the insula were specific to the accurate negative feeling-of-knowing, whereas most prefrontal regions were more specific to the accurate positive feeling-of-knowing (Luo et al., 2003; Luo et al., 2002). The differences in neural activation by positive and negative feeling-of-knowing suggest that these two types of feeling-of-knowing might be dissociable from each other neuroanatomically. Based on the roles of the right ventral prefrontal cortex and the insula in cue retrieval, Luo et al. (Luo et al., 2003; Luo et al., 2002; Luo et al., 2004) further proposed that negative feeling-of-knowing might rely more on cue familiarity than positive feeling-of-knowing did. However, because this inference was primarily based on the assumed functions of various prefrontal regions, its validity warrants further well-controlled studies.

The current study tested the hypothesis that positive feeling-of-knowing and negative feeling-of-knowing might be mediated by distinct cognitive processes. In particular, positive feeling-of-knowing might rely on partial recovery of nonrecalled targets, whereas negative feeling-of-knowing might rely on familiarity with the retrieval cues. Given the previous findings of the distinction between a feeling-of-knowing prior to any retrieval attempt (known as "preliminary feeling-of-knowing") and a feeling-of-knowing following a memory retrieval failure (known as "postretrieval feeling-of-knowing"; Koriat & Levy-Sadot, 2001; Miner & Reder, 1994; Nhouyvanisvong & Reder, 1998), we also hypothesized that the dissociation might apply to both preliminary feeling-of-knowing and post-retrieval feeling-of-knowing. In so doing, we varied target retrievability, cue familiarity, and feeling-of-knowing judgement timing in a factorial design.

Method

Participants

A total of 56 undergraduate students (24 males and 32 females) between 18 and 23 years old participated in this experiment. All participants had normal or corrected-to-normal visual acuity. Each participant was tested individually on a computer for about 40 minutes. Written consent was obtained from each participant before the experiment.

Design
We manipulated target retrievability (low vs. high, within subject), cue familiarity (low vs. high, within subject), and feeling-of-knowing judgement timing (immediate vs. delayed, between subject) in a 2 ×2 × 2 mixed design. Target retrievability was varied by instructing participants to remember the target words either once or three times. We used a priming procedure to manipulate the familiarity of the cue words. Response timing was varied to create preliminary feeling-of-knowing and postretrieval feeling-of-knowing: In the immediate condition, participants were asked to make a metamemorial judgement as soon as a cue was presented on the screen; in the delayed condition, participants made a metamemorial judgement after a 10-s delay. A total of 28 participants were tested in the immediate-feeling-of-knowing condition, and others were tested in the delayed-feeling-of-knowing condition.

Materials
A total of 60 unrelated word pairs were used as major materials, which were taken from the Modern Chinese Frequency Dictionary (Beijing Language Institute, 1986). Each pair contained two Chinese characters, with the left word being a low-frequency cue word and the right word being a high-frequency target word. We used a low-frequency word as the cue word because the familiarity of low-frequency characters could be effectively increased by priming (e.g., Metcalfe et al., 1993; Reder, 1987; Reder & Ritter, 1992; Schwartz & Metcalfe, 1992). We used a high-frequency word as the target word because they tend to induce more accurate feeling-of-knowing judgements than do low-frequency targets (Liu, Su, & Xu, 2005). These 60 pairs were equally assigned to four conditions that differed in cue familiarity and target retrievability: 15 high-familiarity/high-retrievability pairs, 15 high-familiarity/low-retrievability pairs, 15 low-familiarity/high-retrievability pairs, and 15 low-familiarity/low-retrievability pairs. A total of 8 filler pairs and 300 distractor words were also included.

The high-frequency characters occurred between 10,010 and 20,900 per million (mean 14,667 per million), whereas low-frequency items ranged in frequency from 500 to 720 per million (mean 600 per million). The number of strokes ranged from 10 to 15. Four lists of paired associates were constructed to counterbalance the frequency and the number of strokes of cue and target characters. Detail information about the frequency, the stroke, and the structure of Chinese words can be found in the article by Shu, Chen, Anderson, Wu, and Xuan (2003).

Procedure
Participants were tested in five phases: an initial cue familiarization phase to increase familiarity with some of the cue words, a target word familiarization phase to increase the retrievability of some of the target words, a paired-associate learning phase, a feeling-of-knowing judgement phase, and a recognition phase.

Cue familiarization phase. A total of 30 cue characters were presented on the centre of the screen one at a time for participants to make two speeded judgements by pressing two “Ctrl” buttons. For each word, participants first responded whether it had a right−left structure. If they thought that the character on the screen had a right−left structure, they had to respond quickly by pressing the right “Ctrl” button; if they did not think so, the other side of “Ctrl” button had to be pressed. Then participants made a speeded response about whether the word had more than 12 strokes, and they responded with “Ctrl” buttons just as before. The next word was presented 500 ms after participants’ responses, or if 1 minute had passed since the presentation of the previous character, whichever came earlier.

Target familiarization phase. A total of 30 target words were presented on the computer twice in random order. Each word was presented for 1 s, with an intertrial interval of 1 s. Participants were told to remember the words.

Paired-associate learning. Participants were told to remember a list of paired words; they were told that their memory would later be tested in that they would be presented with the left character for retrieving the right word. Each of the 60 pairs of words was presented on the screen for 3 s with a 1-s intertrial interval. A total of 8 filler pairs were also included: 4 at the beginning of the learning trials and 4 at the very end; they served to reduce primacy and recency effects. The 60 pairs of words were composed of four types of combination of familiarity and retrievability: (a) 15 high-familiarity/high-retrievability pairs with old cues and old targets presented in the familiarization phases; (b) 15 high-familiarity/low-retrievability pairs with old cues and new targets; (c) 15 low-familiarity/high-retrievability pairs with new cues and old targets; and (d) 15 low-familiarity/low-retrievability pairs different from those used in the previous phases.

Feeling-of-knowing judgements. We adopted Koriat and Levy-Sadot (2001)'s paradigm to test feeling-of-knowing in two steps. In Step 1, participants were shown the cue word and were asked whether they could correctly identify the target (without providing the actual target). For participants in the immediate-judgement condition (i.e., preliminary feeling-of-knowing), they were told to respond as soon as the cue word was shown, with a warning for immediate response at 2 s and a final time-out limit of 3 s. Responses longer than 3 s (a total of 10 trials across all participants) were discarded. For participants in the delayed-judgement condition (i.e., postretrieval feeling-of-knowing), they were told to try retrieving the target word upon seeing the cue, and their metamemorial judgement was tested only after 10 s. For both groups, the judgement consisted of a simple yes or no answer to whether they thought they could come up with the target word. In Step 2, participants were asked to indicate the probability that they could recognize the correct target word from six alternatives. The response consisted of a rating from 1 to 10, with 1 being minimal confidence to recognize it successfully and 10 being maximum confidence for correct recognition, and participants were told to make the ratings consistent with their initial yes (rating of 6–10) or no (rating of 1–5) response. Inconsistent responses between the Step 1 yes–no judgement and Step 2 rating were rare (a total of two trials for all participants) and were discarded from data analysis.

Recognition. Participants were presented with 60 trials of a six-alternative forced-choice recognition test. The six alternatives were five fillers plus one target word, for each cue word. The distractor words had not appeared previously. The six words were presented horizontally in a row, with the target location randomly selected. Participants were told to respond without giving too much rumination.

Results

Overall feeling-of-knowing judgements

Table 1 shows the percentage of "Yes" responses and the latency of "Yes" and "No" responses in Step 1 of feeling-of-knowing judgement phase, and positive and negative feeling-of-knowing ratings in Step 2 of feeling-of-knowing judgement phase.

We measured the percentage of positive responses in the feeling-of-knowing task, which served as an index of the magnitude of overall feeling-of-knowing (Koriat & Levy-Sadot, 2001). A three-way analysis of variance (ANOVA) revealed that participants were more likely to give a positive feeling-of-knowing to cues presented in the familiarization phase with higher familiarity, $F(1, 54) = 55.49$, $MSE = 15{,}172.11$, $p < .001$, and to targets that were initially seen in a learning session with higher retrievability, $F(1, 54) = 16.96$, $MSE = 3{,}202.41$, $p < .001$. Although the main effect of feeling-of-knowing immediacy was not significant, $F(1, 54) = 1.02$, interaction between feeling-of-knowing immediacy and cue familiarity was significant, $F(1, 54) = 5.03$, $MSE = 1{,}374.84$, $p < .05$, and so was the interaction between feeling-of-knowing immediacy and target retrievability, $F(1, 54) = 4.26$, $MSE = 804.35$, $p < .05$.

To understand how feeling-of-knowing immediacy affected percentage of positive feeling-of-knowing judgements, we conducted follow-up ANOVA separately for the immediate feeling-of-knowing and delayed feeling-of-knowing

Table 1. *Percentage of yes response, yes response latency, no response latency, positive feeling-of-knowing magnitude, and negative feeling-of-knowing magnitude as functions of cue familiarity and target retrievability for immediate and delayed responses*

			Metamemory									
			Yes response[a]		*pFOK*		*nFOK*		*YRL*		*NRL*	
Response	*Cue*	*Target*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Immediate	High	High	63.40	20.58	7.49	0.86	2.72	0.84	1,168	274	1,299	252
		Low	59.48	23.79	7.21	0.77	2.90	0.75	1,147	272	1,330	335
	Low	High	41.84	19.50	7.31	0.88	2.51	0.80	1,222	264	1,196	232
		Low	38.21	17.70	7.41	0.89	2.49	0.79	1,231	340	1,166	205
Delayed	High	High	64.76	17.58	7.55	0.75	3.68	0.83				
		Low	57.38	20.64	7.33	0.77	3.50	0.83				
	Low	High	57.23	20.46	7.54	0.55	2.97	0.89				
		Low	41.91	25.33	7.62	0.97	3.06	0.75				

Note: YRL = yes response latency (in ms). NRL = no response latency (in ms). pFOK = positive feeling-of-knowing magnitude. nFOK = negative feeling-of-knowing magnitude. Cue = cue familiarity. Target = target retrievability.
[a]In percentages.

groups. The immediate feeling-of-knowing group produced more positive feeling-of-knowing to high-familiar cues than to low-familiar cues, $F(1, 27) = 45.08$, $MSE = 12{,}840.67$, $p < .001$, but they were not affected by target retrievability, $F(1, 27) = 2.34$, $MSE = 398.43$. There was no significant interaction effect observed, $F(1, 27) = 0.005$, $MSE = 0.63$. In contrast, the delayed feeling-of-knowing group produced more positive feeling-of-knowing both when the cue was more familiar, $F(1, 27) = 14.15$, $MSE = 3{,}706.29$, $p < .005$, and when the target was more retrievable, $F(1, 27) = 17.44$, $MSE = 3{,}608.33$, $p < .001$.

In addition to the percentage of positive feeling-of-knowing, we also analysed response latency for participants who made an immediate feeling-of-knowing judgement. When a positive feeling-of-knowing was given, participants responded significantly faster for high-familiarity cues than for low-familiarity cues, $F(1, 27) = 6.92$, $MSE = 132{,}591.79$, $p < .05$. However, the latency of positive feeling-of-knowing was not affected by target retrievability, $F(1, 27) = 0.075$, $MSE = 968.10$. On the contrary, when a negative feeling-of-knowing was given, participants responded significantly slower for high-familiarity cues than for low-familiarity cues, $F(1, 27) = 12.52$, $MSE = 532{,}430.90$, $p < .005$. However, the latency of negative feeling-of-knowing was also unaffected by target retrievability, $F(1, 27) = 0.01$, $MSE = 317.17$.

The findings from Step 1 of feeling-of-knowing judgement phase suggested that target retrievability and cue familiarity exerted their influence on overall feeling-of-knowing asynchronously: The effects of familiarity occurred early and continued on, while those of the target retrievability occurred later.

Magnitudes of positive and negative feeling-of-knowing judgements

We calculated positive feeling-of-knowing ratings in Step 2 of feeling-of-knowing judgement phase. An analysis of a three-way ANOVA revealed that only the interaction between cue familiarity and target retrievability was significant, $F(1, 54) = 4.33$, $MSE = 1.63$, $p < .05$. None of main effects and other interactions was significant. To analyse the interaction between cue familiarity and target retrievability in detail, we conducted a simple effect analysis. In both the immediate and the delayed conditions, more retrievable targets received higher positive feeling-of-knowing ratings for high-familiarity cues, $F(1, 27) = 2.90$, *MSE* = 1.08, $p = .1, \eta^2 = .1$; $F(1, 27) = 3.30$, *MSE* = 0.68, $p = .08, \eta^2 = .11$, but positive feeling-of-knowing magnitude was unaffected by cue familiarity.

We also measured negative feeling-of-knowing ratings in Step 2. It should be noted that lower negative feeling-of-knowing ratings meant stronger sense of not knowing because these judgements were reverse-coded. A three-way ANOVA revealed that the sense of not knowing was higher both when the cue was less familiar, $F(1, 50) = 32.91$, *MSE* = 9.60, $p < .001$, and when participants made preliminary feeling-of-knowing judgements, $F(1, 50) = 9.35$, *MSE* = 15.67, $p < .005$. The interaction between cue familiarity and response timing was also significant, $F(1, 50) = 4.44$, *MSE* = 1.29, $p < .05$. No other significant effects were found.

To analyse how feeling-of-knowing immediacy affected negative feeling-of-knowing magnitude, we carried out separate ANOVAs for groups tested in immediate feeling-of-knowing and delayed feeling-of-knowing. This analysis found that both groups reported higher sense of not knowing to low-familiar cues than to high-familiar cues: for preliminary feeling-of-knowing, $F(1, 25) = 4.86$, *MSE* = 1.92, $p < .05$; for post-retrieval feeling-of-knowing, $F(1, 25) = 47.69$, *MSE* = 8.97, $p < .001$, but they were not affected by target retrievability.

From the above results, we found positive feeling-of-knowing was mainly determined by target retrievability, whereas negative feeling-of-knowing was affected by cue familiarity. Moreover, this pattern of data was seen for both preliminary feeling-of-knowing and postretrieval feeling-of-knowing.

Accuracy of positive and negative feeling-of-knowing judgements

We calculated the accuracy of positive feeling-of-knowing and negative feeling-of-knowing separately using a method proposed by Luo et al. (2003). The accuracy of positive feeling-of-knowing meant the proportion of items that were recognized successfully later from all positive feeling-of-knowing judgement items in Step 1, while the accuracy of negative feeling-of-knowing meant the proportion of items that were not recognized properly later from all negative feeling-of-knowing judgement items in Step 1. The results are shown in Table 2.

For trials receiving a positive feeling-of-knowing, the accuracy of such judgements was higher when the target retrievability was high, $F(1, 53) = 42.61$, *MSE* = 14,615.78, $p < .001$.

Table 2. *Accuracy of metamemory and accuracy of recognition as functions of cue familiarity and target retrievability for the immediate and delayed conditions*

			Accuracy of metamemory					
			pFOK[a]		*nFOK*[a]		*Accuracy of recognition*[a]	
Response	*Cue*	*Target*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Immediate	High	High	69.70	18.44	34.19	24.52	65.56	16.80
		Low	52.58	28.65	62.68	21.55	45.92	16.67
	Low	High	74.33	20.71	36.17	24.12	67.28	19.72
		Low	58.80	29.49	54.61	18.68	51.51	17.34
Delayed	High	High	75.56	22.83	34.64	30.12	71.14	23.74
		Low	61.76	19.71	58.72	26.52	55.12	18.29
	Low	High	76.90	23.00	35.67	27.57	75.23	18.56
		Low	58.12	34.17	62.98	23.94	47.89	21.57

Note: pFOK = positive feeling-of-knowing magnitude. nFOK = negative feeling-of-knowing magnitude. Cue = Cue familiarity. Target = Target retrievability.

[a]In percentages.

Accuracy was unaffected by cue familiarity or by feeling-of-knowing immediacy or any of the interactions, *Fs* < 1.5. For trials receiving a negative feeling-of-knowing, the accuracy of such judgements was lower when the target retrievability was high, $F(1, 50) = 71.45$, $MSE = 31{,}419.36$, $p < .001$. That is, when participants gave a negative feeling-of-knowing to a highly retrievable target, they later recognized that target at higher percentage than a target with low retrievability. Similarly, accuracy was not affected by cue familiarity, feeling-of-knowing immediacy, and any interaction effects (*F*s < 1.2).

Results on the accuracy of feeling-of-knowing judgements showed that, for both groups, positive feeling-of-knowing ratings were more likely to be correct for high-retrievability items than low-retrievability items, while negative feeling-of-knowing were more likely to be correct for low-retrievability items. Cue familiarity had no influence on their accuracy.

Accuracy of recognition

Recognition performance was better for highly retrievable targets than for low-retrievable targets, $F(1, 54) = 134.71$, $MSE = 21{,}709.80$, $p < .001$. In addition, there was a significant three-way interaction between cue familiarity, target retrievability, and feeling-of-knowing immediacy, $F(1, 54) = 7.20$, $MSE = 808.03$, $p < .05$. No other effects were significant.

Follow-up ANOVAs conducted separately for immediate feeling-of-knowing and delayed feeling-of-knowing groups showed that both groups recognized more highly retrievable targets than low-retrievable targets (*p*s $< .05$). However, only the delayed feeling-of-knowing group showed an interaction between target retrievability and cue familiarity, $F(1, 27) = 73.75$, $MSE = 8{,}773.57$, $p < .001$, in that recognition was much better for pairs involving high-familiar cue and high-retrievable target.

Results of recognition performance were consistent with those of feeling-of-knowing accuracy: High-retrievability target words were more likely to be recognized in the recognition test for both groups.

Discussion

The dissociation of positive feeling-of-knowing and negative feeling-of-knowing

Our findings from quantitative feeling-of-knowing ratings suggest that positive feeling-of-knowing and negative feeling-of-knowing may be dissociable. In both immediate feeling-of-knowing and delayed feeling-of-knowing judgements, target retrievability only affected positive feeling-of-knowing ratings but not negative feeling-of-knowing ratings. Instead, negative feeling-of-knowing ratings were determined entirely by cue familiarity. Such *double dissociation* between positive and negative feeling-of-knowing ratings and cue familiarity and target familiarity strongly suggest that distinct cognitive mechanisms are involved in negative and positive feeling-of-knowing judgements.

Thus, our results were largely consistent with Luo and colleagues' proposal (Luo et al., 2003; Luo et al., 2002; Luo et al., 2004) that positive feeling-of-knowing and negative feeling-of-knowing may be dissociable. This dissociation is more obvious in the postretrieval feeling-of-knowing judgements, in that postretrieval positive feeling-of-knowing ratings were mainly affected by target retrievability, and delayed negative feeling-of-knowing ratings were mainly affected by cue familiarity. However, the dissociation was also evident in the immediate feeling-of-knowing judgements.

Moreover, the present findings may be generalized to standard feeling-of-knowing paradigms that instructed participants to recall the target and then make feeling-of-knowing judgement on nonrecalled targets. We actually asked the delayed feeling-of-knowing group to try retrieving the target word upon seeing the cue for 10 seconds before their metamemorial judgement was tested. That is, we provided participants with the opportunity to recall the target before providing a feeling-of-knowing judgement. Moreover, Koriat and Levy-Sadot (2001) used both the standard RJR paradigm and the paradigm similar to ours and found similar results. In addition, the RJR paradigm was used in a previous study conducted by our laboratory (Liu et al., 2005). Reanalysis of data from that study showed that positive feeling-of-knowing ratings were higher for highly retrievable targets than for low-retrievable targets, while negative feeling-of-knowing ratings were affected by cue familiarity as well as target retrievability. Thus, results from the standard RJR paradigm were largely consistent with results from the current JR paradigm, with one main exception—target retrievability also affected the magnitude of negative feeling-of-knowing ratings in our RJR study. The main source of discrepancy originated from the rating procedure itself. In our previous study using the RJR paradigm participants were not constrained to use 1–5 for negative feeling-of-knowing and 6–10 for positive feeling-of-knowing. So ratings below 6 (analysed as negative feeling-of-knowing) could actually reflect low level of positive feeling-of-knowing, so there was some contamination of the negative feeling-of-knowing scores. The current study used a two-step feeling-of-knowing judgement procedure and more cleanly separated positive and negative feelings-of-knowing.

The accuracy of feeling-of-knowing and recognition
Our results also showed that highly retrievable target words (i.e., words that participants initially learned before a paired-associate test) were more likely to be recognized in the final recognition phase. In turn, positive feeling-of-knowing judgements were more likely to be correct for highly retrievable target words than for less-retrievable target words, while negative feeling-of-knowing judgements were more likely to be incorrect for highly retrievable targets.

Converging evidence for the divergence in the accuracy of positive feeling-of-knowing and negative feeling-of-knowing came from the recent study by our laboratory, which showed that the accuracy of positive feeling-of-knowing was enhanced by target retrievability while the accuracy of negative feeling-of-knowing was reduced by target retrievability (Liu et al., 2005).

Thus, a single factor, higher recognition accuracy for highly retrievable words, may account for heightened accuracy in positive feeling-of-knowing and reduced accuracy in negative feeling-of-knowing, while distinct cognitive mechanisms are involved in negative and positive feeling-of-knowing judgements. These results confirmed the distinction made between subjective judgements (feeling-of-knowing) and objective memory performance (recognition) and the distinction between the determinants of metacognitive judgements and the determinants of their accuracy (Koriat, 1993, 1995).

Mechanism of overall feeling-of-knowing
Our findings concerning the magnitude of overall feeling-of-knowing judgements indicate interesting interactions involving response timing. Preliminary judgements of positive feeling-of-knowing were affected by cue familiarity. However, in postretrieval judgements, both cue familiarity and target accessibility enhanced feeling-of-knowing. With regard to preliminary feeling-of-knowing, some studies suggested that cue familiarity resulted in feeling-of-knowing (e.g., Nhouyvanisvong, & Reder, 1998; Reder & Ritter, 1992). Some showed that either target retrievability or cue familiarity was the determinant of postretrieval feeling-of-knowing judgements (e.g., Metcalfe, et al., 1993; Nelson, et al., 1984). Our study suggested that the familiarity of cue had effects on preliminary feeling-of-knowing, and both cue familiarity and target retrievability theories contributed to postretrieval feeling-of-knowing judgements. The present results were largely consistent with results from Koriat and Levy-Sadot (2001), who found that preliminary feeling-of-knowing was affected by cue familiarity, while the accessibility of the cue or target's pertinent information had an impact on postretrieval feeling-of-knowing later. Taken together, it is reasonable to infer that cue familiarity and target retrievability theories may not be mutually exclusive: Each plays its role at different phases during the retrieval process.

CONCLUSIONS

In summary, we found that two kinds of feeling-of-knowing—knowing that you know and knowing that you do not know—may rely on dissociable cognitive mechanisms. Positive feeling-of-knowing ratings were affected primarily by target retrievability while negative feeling-of-knowing ratings were affected primarily by cue familiarity. These results held when feeling-of-knowing judgements about the paired associates were made immediately after the cue presentation and when they were made after a 10-s delay. These findings suggest that the feeling-of-knowing is not a heterogeneous function and that it can be driven by different sources of evidence for a positive feeling-of-knowing and a negative feeling-of-knowing.

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