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Cue Familiarity but not Target Retrievability Enhances Feeling-of-Knowing Judgments

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Two hypotheses concerning people's ability to predict later memory performance for unrecalled items were investigated. The *target retrievability hypothesis* states that feeling-of-knowing judgments (FKJs) are based on partial target information; and the *cue familiarity hypothesis* asserts that they are based on recognition of the cues. In Experiments 1 and 2, subjects either generated or read the targets of paired associates. Half of the cues had been primed in a pleasantness-rating task. The generation manipulation increased recall but had no effect on FKJs. Cue priming had no effect on recall but increased FKJs. In Experiment 3, using general information questions, primed after the initial recall attempt, both cue and target priming increased FKJs. Experiment 4, which remedied difficulties in Experiment 3, showed no effect of target priming whereas cue priming increased FKJs. The results favor the cue familiarity hypothesis.

In feeling-of-knowing experiments, subjects report the likelihood that they will remember later an item that they cannot remember now. First, they attempt to recall an item from memory, and if they are unable to do so, they make a feeling-of-knowing judgment. Later, they perform another memory test such as recognition. Subjects' feeling-of-knowing judgments frequently predict performance for both simple paired associates (Blake, 1973; Hart, 1967; Leonesio & Nelson, 1990; Nelson, Leonesio, Shimamura, Landwehr, & Narens, 1982; Schacter, 1983) and for general information questions (Hart, 1965; Metcalfe, 1986; Nelson, Gerler, & Narens, 1984). Furthermore, subjects' feeling-of-knowing judgments predict performance for different tests of memory, such as first-letter cued recall (Gruneberg & Monks, 1974), attribute identification (Schacter & Worling, 1985), relearning and perceptual identification (Nelson et al., 1984), stem completion (Lupker, Harbluk, & Patrick, 1991), and lexical decision (Yaniv & Meyer, 1987).

Two theories, proposed to account for feeling-of-knowing judgments, are investigated here (see Metcalfe, in press, Nelson et al., 1984, and Reder & Ritter, 1992, for reviews). The *target retrievability hypothesis* is based on the intuitive feeling that an item may be on the "tip of the tongue." The hypothesis states that a monitor (the metacognitive system) bases the response on partial retrieval of information about the unrecalled target when the target's memory trace is too weak to allow recall (see Hart, 1967, Koriat, 1991, and Nelson & Narens, 1990, for such explanations). Alternatively, the *cue familiarity hypothesis* states that feeling-of-knowing judgments are made without explicit access to the unrecalled information itself. Instead, the monitor assesses the familiarity or recognizability of the cue. A more familiar cue results in higher feeling-of-knowing judgments. Cue familiarity has been offered as an explanation of feeling-of-knowing judgments by Metcalfe (in press), Reder (1987), and Reder and Ritter (1992). Although the two hypotheses are not mutually exclusive, they can lead to different predictions.

Several experiments have presented evidence that favors the cue familiarity hypothesis. For instance, Reder (1987, 1988) was able to induce spurious feelings of knowing for general information questions by priming cue words. Subjects made frequency judgments on words, some of which appeared later as cues (questions). More of these primed items were judged as answerable by the subject than unprimed items. Reder and Ritter (1992) found that familiarity with arithmetic problem operands, and not the answers, predicted feeling-of-knowing judgments. Koriat and Lieblich (1977) observed that more elaborate questions led to higher feeling of knowing for an unrecalled item. Moreover, Schacter (1981) noted that cue recognition and feeling-of-knowing judgments were positively correlated. Costermans, Lories, and Ansay (1992) found that beliefs about what should be known predicted feeling-of-knowing judgments. Finally, research has indicated that familiarity with domains (areas of expertise) increased metacognitive judgments of memory (Reder, 1987) and comprehension (Glenberg, Sanocki, Epstein, & Morris, 1987).

Other experiments have produced data that are more consistent with the target retrievability hypothesis. Blake (1973) demonstrated that partial recall of three-letter trigrams was related to higher reported feeling of knowing. Schacter and Worling (1985) found that subjects could recall better the affective valence of unrecalled items given higher feeling-of-knowing judgments than those given lower judgments. Yaniv and Meyer (1987) discovered that lexical decisions were faster for unrecalled targets given high feeling-of-knowing judg-

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ments than unrecalled targets given low feeling-of-knowing judgments.

The results of two other studies may support either the target retrievability hypothesis or the cue familiarity hypothesis. In these studies, recall and feeling-of-knowing judgments are affected by a variable in a similar way, but cue familiarity may be confounded with memorability. Nelson et al. (1982) examined the influence of study time on feeling of knowing. They tested items, studied to a criterion level of recall, 4 weeks later. Unrecalled items in the retest, which had been previously studied to a higher criterion level of recall, were given higher feeling-of-knowing ratings. However, because the cues were presented more often in the conditions in which recall was higher, it is not clear whether target memorability or cue familiarity increased the feeling-of-knowing judgments. Lupker et al. (1991) found that deep encoding in a levels-of-processing manipulation led to both higher recall and higher feeling-of-knowing judgments for the unrecalled items. However, here too, the increased attention in the deep-processing condition may have influenced both cue familiarity and target retrievability.

The present experiments contrast the two hypothetical accounts of feeling of knowing. If cue familiarity accounts for feeling-of-knowing judgments, then memorability and the feeling of knowing may be separate and dissociable (Metcalfe, in press). Consequently, people may be misled into giving higher feeling-of-knowing judgments for items in which the cue has been made more familiar to the subject, as in the work of Reder (1987, 1988) and Reder and Ritter (1992). As such, a variable may influence the feeling-of-knowing judgments but not the memorability measure. Thus, the cue familiarity hypothesis predicts that variables that affect the feeling of knowing may not necessarily affect memorability. On the other hand, target retrievability predicts that variables that affect the memorability of a target will also affect feeling of knowing. Of course, it is also possible that both accounts have some basis in reality and that both factors will affect feeling-of-knowing judgments.

Experiment 1

To compare the target retrievability hypothesis with the cue familiarity hypothesis, we manipulated one variable that affected target memorability and one variable that affected cue familiarity. The memorability manipulation used was Slamecka and Graf's (1978) "generation effect." The rule used to learn paired associates was varied between items. Subjects generated some of the items and read some of them. For the generated items, the subjects followed a rule: They produced as a target a word that rhymed with the cue and that started with an indicated letter. For instance, a subject might see *moon – n* and would provide the target word *noon.* A second subject would see that pair in the read–rhymed condition, as in *moon – noon.* A third subject would see the cue paired with an unrhymed and unrelated word, as in *moon – hand.* The unrhymed (and unrelated) condition provided a base-rate control. Previous research has shown that generated targets are recalled reliably at higher levels than read targets in mixed lists (Slamecka & Graf, 1978; Slamecka & Katsaiti, 1987). Because of the associative relationship between the rhymed items, the read–rhymed items should be recalled at higher levels than the unrhymed controls.

The familiarity manipulation we used followed Reder's (1987, 1988) cue priming technique. Half of the cues were seen prior to the learning task in an unrelated task. Subjects rated a list of words for pleasantness. The familiarity of some of the cues were thus enhanced without providing rehearsal of the cue-target pair.

According to the target retrievability hypothesis, the increase in memorability for the generated words over the read words should be reflected in higher feeling of knowing for the generated words. Furthermore, cue priming should not increase feeling of knowing unless it provides additional target information and consequently improves memorability. On the other hand, the cue familiarity hypothesis predicts higher feeling-of-knowing judgments for primed items regardless of their memorability.

Method

Subjects

We recruited 24 subjects from an introductory psychology course at Dartmouth College. We tested each subject individually in a 1-hr session, and each subject received course credit for participating.

Design

We used a 3 × 2 within-subjects design. The variables were encoding rule (generate, read–rhymed, and unrhymed) and cue priming (primed vs. unprimed). There were three dependent measures: cued recall, feeling-of-knowing judgments, and recognition. We counterbalanced the various conditions across subjects so that each cue word was paired with a target in each of the generate, read–rhymed, and unrhymed conditions (in the unrhymed condition, a new target was used). Most of the words were taken from the items used by Slamecka and Graf (1978), but we constructed several pairs.

Procedure

Priming phase. Subjects rated a list of 180 words on a scale of 1 to 5 in terms of pleasantness. We listed the words on a sheet of paper, and the subjects marked their rating next to the word. Thirty of these words appeared later as cues in paired-associate learning. The remaining words did not appear again in the experiment. The first 12 subjects saw 30 cues as primes, and the remaining 30 cues were unprimed. We switched these cues for the remaining 12 subjects.

Encoding phase. The list of 60 cue words was divided into three sublists of 20 words each. For any given subject, one of the sublists would be the cues for the generate condition, a second sublist would be the cues for the read–rhymed condition, and a third sublist would be the cues for the unrhymed condition. The assignment of sublists was chosen randomly for each subject. The experimenter instructed the subjects that a cued-recall test would follow the presentation of the pairs. The experimenter then showed the subjects the word pairs, which were printed individually on 3 in. × 5 in. (7.62 cm × 12.70 cm) index cards. Subjects viewed 60 word pairs, for approximately 2 s each. We divided the pairs into three conditions depending on which encoding rule was used. In the generate condition, subjects saw the cue word followed by a letter (*moon – n*) and generated a rhyme of the cue starting with the letter provided. In the read–rhymed condition, subjects saw both the cue and the target rhyme (*sail – pail*). In the unrhymed condition, subjects saw the cue accompanied by a randomly chosen word as the target (*dive – finger*). We intermixed the presentation of the three conditions. The subjects repeated the pair aloud in all conditions.

Recall and feeling of knowing. Subjects immediately performed a pencil-and-paper cued-recall test. They had unlimited time to recall an answer. However, we encouraged them not to spend too much time on any particular item. We presented the cues in random order on 3 in. × 5 in. (7.62 cm × 12.70 cm) index cards. If the subjects could not recall the target, then they indicated how confident they were that they would correctly identify the target for that cue in a later recognition test. Subjects made judgments only on omission errors. The scale went from 0 to 100. An answer of 100 indicated maximum confidence in subsequent recognition. They were given no information as to the nature of the ensuing recognition test.

Recognition. The final test was a six-alternative forced-choice recognition test. Each cue was shown again, followed by three rhymes and three nonrhymes (including the correct answer). The five distractor items had not appeared elsewhere in the experiment.

Results

Statistical reliability was measured at $p \leq .05$, as adjusted by Greenhouse-Geisser epsilon, in all of the experiments discussed here. The Greenhouse–Geisser epsilon measures the extent to which the correlation between observations violates the assumption of sphericity, which is required for a univariate repeated-measures hypothesis test (Stevens, 1986, p. 413). Violations of the assumption for univariate tests were minor in all of the analyses reported. We treated the list of words used as primes and the sublists of cue words used in each of the encoding conditions as independent variables. Because neither of these variables affected the outcome of the experiments, all subsequent analyses exclude them.

Feeling-of-Knowing Judgments

There was a main effect of cue priming, $F(1, 23) = 13.3$, $MS_e = 115.4$. As is shown in Table 1, primed items were given higher feeling-of-knowing judgments than unprimed items. Neither encoding rule nor the interaction between cue priming and encoding rule affected feeling-of-knowing judgments (Fs < 1).

Cued Recall

There was a main effect of encoding rule, $F(2, 46) = 51.9$, $MS_e = 3.3$. The generation manipulation influenced recall in the expected way: generated items ($M = .44$) were recalled better than read–rhymed items (.30) and read–rhymed items were recalled better than unrhymed items (.06; see Table 1). This was confirmed by Newman-Keuls comparisons (Winer, 1971, p. 528). Neither cue priming nor the interaction term between cue priming and encoding rule produced a significant effect on recall (Fs < 1).

Recognition

There was a trend toward an interaction between cue priming and encoding rule, $F(2, 46) = 2.4$, $p = .11$, $MS_e = .058$, though neither of the main effects were significant on recognition, as measured by percentage correct. Inspection of Table 1 suggests that in the unprimed condition, the generation manipulation was successful, that is, generated items (.60) were better than read–rhymed items (.52), which were better than unrhymed items (.40). There was no difference for the primed items. There are two possible reasons that encoding rule did not result in a larger effect. First, it is possible that there was insufficient power in the experiment to produce significant differences in recognition of unrecalled items. Second, an item selection effect, working in the opposite direction to the encoding rule, may have been at work. If only difficult items remained in the generate condition, but relatively easier items remained in the others, it might appear that encoding rule did not affect recognition. However, it did not appear that this artifact was sufficiently strong as to completely counteract the generation effect. The data presented here indicate that target retrievability was affected by the encoding manipulation in recognition of unrecalled items. These results, though, were only marginally significant and therefore will be investigated further in Experiment 2.

Correlation Between Feeling of Knowing and Recognition

We computed Goodman-Kruskal gamma scores between the rank orderings of the confidence judgments and recognition of unrecalled items for each subject (see Nelson, 1984). In Experiment 1, the mean gamma score across subjects and across conditions was .05, which was not different from zero,

Table 1
Mean Feeling-of-Knowing Judgments (FKJ), Recall, Recognition, and Gamma Correlation as a Function of Encoding Rule and Priming in Experiment 1

	FKJ[a]				Recall				Recognition				Gamma[b]			
Measure	Gen	Read	Unrhy	*M*	Gen	Read	Unrhy	*M*	Gen	Read	Unrhy	*M*	Gen	Read	Unrhy	*M*
Primed	56	57	58	57	.42	.30	.06	.26	.48	.52	.49	.50	−.11	.29	.06	.11
Unprimed	50	53	48	50	.45	.30	.06	.27	.60	.52	.40	.51	.03	.12	−.07	.02
M	53	55	53		.44	.30	.06		.54	.52	.45		−.04	.21	−.01	

Note. Gen = generate condition. Read = read–rhymed condition. Unrhy = unrhymed condition.
[a] Measure of mean prediction of later recognition. [b] Gamma correlation between feeling-of-knowing judgments and recognition.

indicating that subjects were not able to discriminate between items they would recognize and those they would not. Encoding rule, cue priming, and the interaction between encoding rule and cue priming (Fs < 1) did not produce changes in the gamma scores (see Table 1).

Several studies have found above-chance accuracy with newly learned paired associates (Blake, 1973; Schacter, 1983). However, Nelson et al. (1982) found that overlearning was necessary for accurate feeling-of-knowing rankings. Lupker et al. (1991) found that with a 2-s presentation, feeling of knowing did not predict recognition; but with a 7-s presentation, accuracy rose above chance. In the present experiment, the 2-s study time may not have provided sufficient overlearning to allow accurate predictions (also see Lupker et al., 1991, for a discussion). Interestingly, however, subjects in this experiment were well calibrated. Mean feeling-of-knowing judgment in the unprimed condition (.50) corresponded to their mean recognition in the unprimed condition (.51). Priming resulted in a slight overconfidence effect. Mean feeling-of-knowing judgment in the primed condition (.57) was slightly higher than recognition in the primed condition (.50).

Although the priming manipulation affected feeling-of-knowing judgments, it did not affect feeling-of-knowing accuracy. In other words, priming increased all judgments, regardless of whether the targets were subsequently recognized correctly. Because the gamma score is an ordinal statistic, it is not affected by the constant increase in feeling-of-knowing judgments for both correct and incorrect answers. Thus, it is possible to see differences in feeling-of-knowing judgments without corresponding changes in predictive accuracy.

Commission Errors in Recall

There was a main effect of encoding rule, $F(2, 46) = 3.9$, $MS_e = 1.9$. Newman-Keuls post hoc comparisons revealed that more commission errors were made in the unrhymed condition (1.9 per subject) than in the read–rhymed condition (1.4 per subject) or the generate condition (1.1 per subject). Not surprising, most of these errors were words that rhymed with the cue words. Neither cue priming nor the interaction between encoding rule and cue priming (Fs < 1) produced differences in commission errors.

Experiment 2

Before reaching any strong conclusions from Experiment 1, we conducted Experiment 2, which replicates Experiment 1, but with a few methodological changes. First, we wished to demonstrate that our memorability manipulation did affect recognition of unrecalled items. Second, because the experimenter in Experiment 1 was one of the authors, there was a concern about demand characteristics. In Experiment 2, we used a double-blind technique. Both the subject and the experimenter were naive as to the hypotheses being tested. Third, in Experiment 1, we fixed the primed and unprimed words for the first group of 12 subjects and then switched the words for the second group of 12 subjects. Although we found no effect of this variable, nevertheless, in Experiment 2, we selected the words to be included in the primed-words list randomly for each subject. Fourth, during the recall phase, the experimenter recorded when the subject failed to produce the desired word in the generate condition. In fact, subjects generated the desired target 99.2% of the time. Finally, during the recall and feeling-of-knowing task, we asked subjects to make confidence judgments of subsequent recognition on all items.

Method

Subjects

We recruited 25 subjects from an introductory psychology course at Dartmouth College. We tested each individually in a 1-hr session, and each subject received extra credit for participating. None of the subjects had participated in Experiment 1. We removed 1 subject from the analyses because of a learning disability.

Procedure

The procedure was nearly identical to that of Experiment 1. One difference involved items in which the subject made a response in the recall phase of the experiment. In contrast to the Experiment 1 procedure, in Experiment 2 subjects gave feeling-of-knowing judgments for all items, both recalled and unrecalled. The other two differences were that a naive experimenter conducted the experiment and that the lists were randomized.

Results

Feeling-of-Knowing Judgments

There was a main effect of cue priming, $F(1, 22) = 10.2$, $MS_e = 89.6$, on feeling-of-knowing ratings (the data from 1 subject could not be included because of 100% recall in the generate condition). As shown in Table 2, subjects gave primed items higher feeling-of-knowing judgments than unprimed items. Neither the encoding rule nor the interaction between cue priming and encoding rule affected feeling-of-knowing judgments (Fs < 1).

We examined feeling-of-knowing judgments separately for both omission and commission errors in this experiment (see Krinsky & Nelson, 1985). Cue priming affected the omission errors, $F(1, 16) = 16.1$, $MS_e = 188.4$, which is consistent with the combined data. However, cue priming did not affect the feeling-of-knowing judgments given to commission errors. It is unclear whether this null result was because there was insufficient power in the analysis (only 10 subjects had enough commission errors in each condition) or was the result of the different instructions given to subjects pertaining to the judgment of an omission or commission error.

Cued Recall

There was a main effect of encoding rule, $F(2, 46) = 70.1$, $MS_e = 3.4$ (see Table 2). Newman-Keuls post hoc comparisons revealed that generated items (.50) were recalled better than read–rhymed items (.30), and read–rhymed items were recalled better than unrhymed items (.08). This replicated the data from Experiment 1.

Table 2
Mean Feeling-of-Knowing Judgments (FKJ), Recall, Recognition, and Gamma Correlation as a Function of Encoding Rule and Priming in Experiment 2

	FKJ[a]				Recall				Recognition				Gamma[b]			
Measure	Gen	Read	Unrhy	*M*	Gen	Read	Unrhy	*M*	Gen	Read	Unrhy	*M*	Gen	Read	Unrhy	*M*
Primed	42	42	42	42	.44	.34	.08	.29	.54	.54	.45	.51	.16	.16	.01	.11
Unprimed	36	37	37	37	.56	.43	.08	.36	.58	.46	.35	.46	−.27	−.01	−.04	−.11
M	39	40	40		.50	.39	.08		.56	.50	.40		−.06	.08	−.02	

Note. Gen = generate condition. Read = read-rhymed condition. Unrhy = unrhymed condition.
[a] Measure of mean prediction of later recognition. [b] Gamma correlation between feeling-of-knowing judgments and recognition.

We observed two puzzling results in Experiment 2 that did not occur in Experiment 1. First, cue priming affected recall in this experiment: primed words (.29) were recalled more poorly than were unprimed words (.36), $F(1, 23) = 10.1$, $MS_e = 1.6$. This is surprising, because, if anything, we expected cue priming to help recall. If increased familiarity with the cues allows more target information to be retrieved, one would expect the primed items to be recalled better, not worse, as was observed. Second, there was a nonsignificant trend toward an interaction between cue priming and encoding rule, $F(2, 46) = 2.5$, $p = .09$, $MS_e = 1.8$. The interaction may have been due to a floor effect. The unrhymed pairs do not show the cue priming effect. Neither of these effects replicated Experiment 1, which showed no effect of cue priming on recall, nor do we take much stock in them.

Recognition

We examined recognition for both omission and commission errors. For the omission errors, in Experiment 2, there was a main effect of encoding rule, $F(2, 32) = 3.6$, $MS_e = 0.06$. Newman-Keuls post hoc comparisons revealed that generated items (.56) were recognized significantly better than unrhymed items (.40) and read-rhymed items were in the middle (.50; see Table 2). In Experiment 2, then, recognition did show the generation effect, even though we considered only unrecalled items. Neither cue priming ($F = 2.2$) nor the interaction term between cue priming and encoding rule ($F < 1$) produced significant effects. Commission errors were rare, and when added to the analyses, they did not alter the results.

Combined Analyses for Experiments 1 and 2

Because of the importance of demonstrating that the memorability manipulation affected the unrecalled items similar to the way in which it affects recalled items, we combined the data for omission errors from Experiments 1 and 2 to achieve more power for the analyses of recognition performance. The combined recognition data for omission errors showed a main effect of encoding rule, $F(2, 78) = 4.7$, $MS_e = 0.07$. Newman-Keuls post hoc comparisons revealed significant differences between the generate (.55) and the unrhymed condition (.43) and between the read-rhymed condition (.51) and the unrhymed condition. Neither cue priming ($F < 1$) nor the interaction between cue priming and encoding rule affected the level of recognition ($F = 2.1$). Thus both recognition and recall showed a similar pattern of target retrievability by experimental condition: Failure of that pattern to show up in the feeling-of-knowing judgments does not appear to be attributable to some inconsistency in the measure of memorability.

Correlation Between Feeling of Knowing and Recognition

The mean gamma across subjects and across conditions was .02, which was not different from zero. Neither encoding rule nor cue priming, nor the interaction between them, showed any effects on the gamma scores (Fs < 1; see Table 2). This result replicated the zero correlation observed in Experiment 1.

Commission Errors

There were more commission errors in the unrhymed (3.4 per subject) than the read-rhymed (2.3) or the generate conditions (1.9), $F(2, 23) = 9.9$, $MS_e = 3.1$. Because we presented more rhyme pairs than nonrhyme pairs, it is not surprising to find a bias to guess rhymes when the subject was not sure of the answer. This bias accounted for the high commission-error rate (consisting primarily of rhymes) in the unrhymed condition. Priming did not significantly affect the commission error rate.

Discussion

Varying memorability by contrasting generated associations with read associations resulted in different levels of recall and recognition. However, subjects' feeling-of-knowing judgments did not differ as a function of this differential target retrievability. This finding fails to provide support for the target-retrievability hypothesis, which predicted that feeling of knowing would track memorability.

On the other hand, priming of the cues influenced feeling-of-knowing judgments. Primed cues yielded higher feeling-of-knowing judgments than did unprimed cues. In Experiment 2, recall was actually better for unprimed items. Whatever caused this result is not known, but the interesting result is that even though recall was better for unprimed items, feeling-of-knowing judgments were higher for the primed items. This dissociation between feeling of knowing and memorability supports the cue familiarity hypothesis and also indicates that the processes involved in feeling-of-knowing judgments are dissociable from memory retrieval.

Experiment 3

Does cue familiarity also predict the feeling-of-knowing judgments for existing preexperimental associations? The cue familiarity and the target retrievability hypotheses were again compared in Experiment 3. Instead of paired associates, we used general information questions. We obtained the materials from the norms of Nelson and Narens (1980), which consisted of questions such as "What was the name of the founder of the American Red Cross?" and "What is the capital of Jamaica?"

In Experiment 3, we primed targets, cues, and lures. If feeling-of-knowing judgments were based on cue familiarity, then priming the cues should enhance these judgments. If feeling-of-knowing judgments were based on target retrievability, then priming the targets may enhance these judgments because redundant information about the target has been presented. Furthermore, if feeling-of-knowing judgments were based on partial or incorrect information, as Koriat (1991) suggested, then priming an incorrect, but plausible, answer (the lure) might also increase feeling of knowing.

There is one study bearing on the issue of target priming. Jameson, Narens, Goldfarb, and Nelson (1990) found that although near-threshold target priming resulted in better recall of general information questions, it did not affect feeling-of-knowing judgments. Their priming technique involved presenting the correct answer to the subject tachistiscopically, very quickly, near the measured threshold of consciousness. Jameson et al. then gave subjects an immediate feeling-of-knowing task. Questions whose answers were primed did not receive higher feeling-of-knowing ranks but did result in higher later recall than questions that had been accompanied by a near-threshold nonsense answer. This suggests that target information does not influence feeling-of-knowing judgments.

In Experiment 3, we primed subjects at both a conscious and nonconscious level. Priming was accomplished by asking the subject to rapidly read a list of words. The color of the words alternated between lines. We instructed subjects to read only the words written in one color and to skip the words in the alternating lines written in a different color. The attended primed condition refers to the items that subjects read, and the unattended primed condition refers to the items that were primed in the nonread lines. (A pilot experiment we conducted showed that subjects were unable to recognize our unattended words as previously seen items.)

The target retrievability hypothesis predicts increased feeling-of-knowing judgments for attended and unattended primed targets, so long as recognition was enhanced in both conditions. The cue familiarity hypothesis predicts differences between the attended cue-priming and unattended cue-priming conditions when compared with the control. Because the unattended cues cannot be recognized as old items, they should not become more familiar to the subject. As a result, the unattended cue primes should not enhance the feeling-of-knowing judgments. However, the attended cues should increase familiarity and, consequently, increase the feeling of knowing.

Method

Subjects

We recruited 32 subjects from an introductory psychology course at Dartmouth College. We tested each subject individually in a 1-hr session, and each subject received extra credit for participating.

Design

A 2 × 3 within-subjects design was used, with each condition compared to the unprimed control condition. The variables were attention (attended primes vs. unattended primes) and level of priming (cue, target, and lure). We included two identical control conditions, and because there were no differences between the two in any of the measures, they were subsequently collapsed for the analyses. The main dependent variables were feeling-of-knowing judgments and recognition. We counterbalanced items in the attended or unattended condition across subjects. Additionally, we used two lists of cues, targets, and lures for two groups of subjects to control for any list effects. Neither of these lists affected the outcome, therefore we did not include them in the described analyses.

Procedure

Question answering. We wrote general information questions selected from the Nelson and Narens (1980) norms on 3 in. × 5 in. (7.62 cm × 12.70 cm) cards. These cards included questions about world and American history, science, sports, literature, and entertainment. Subjects reported their answers aloud and answered questions until they had made seven errors in each condition.

Priming. Immediately after the question–answer phase was completed, we showed subjects a list of 174 words (all possible primed items) on a color computer monitor. The list consisted of alternating lines of words colored in red and green. As quickly as possible, subjects read the words written in one color (the attended-priming condition) and skipped the words written in the other color (the unattended-priming condition). We told the subjects that their reading was being taped for the experimenter to determine how well the subjects avoided the unattended items. We chose the attended color and the color of the words in the top line randomly for each subject. The first two lines were buffers of items unrelated to the questions. The words in the priming list were targets (correct answers to questions), lures (incorrect answers to questions), or cues (a key word selected from the words in each question).

Feeling-of-knowing judgments. After presentation of all the primes, subjects indicated their confidence in being able to recognize the correct answer to each unrecalled general information question. The scale went from 0 to 100. Although we did not encourage subjects to try to recall the answer, if subjects spontaneously recalled the answer during the feeling-of-knowing phase, it was recorded. In those cases, the question was removed from the stack of unrecalled questions.

Recognition. The lures in the eight-alternative forced-choice test included the lure prime that had been presented previously. The correct answer was always present. The distractor items were all from Wilkinson and Nelson (1984).

Results

Feeling-of-Knowing Judgments

There was a main effect of attention, $F(1, 31) = 5.9$, $MS_e = .01$. Attended primed items (45) were given higher feeling-of-knowing judgments than unattended primed items (41; see Table 3). Neither levels of priming ($F < 1$) nor the interaction between attention and levels of priming ($F = 1.6$) produced significant differences. Planned comparisons revealed that both attended cue priming (46), $t(31) = 2.0$, and attended target priming (47), $t(31) = 2.6$, increased feeling-of-knowing judgments in relation to the control condition (40). None of the other conditions, including all the unattended conditions, differed from the control condition. In summary, both cue and target priming had an effect here, so long as subjects attended to those primes.

Recognition

There were no significant effects of either attention, levels of priming, or the interaction between the two on recognition performance of unrecalled items. None of the conditions differed significantly from the control condition. The means of each condition are displayed in Table 3. The data suggest that attended target priming may have helped recognition, but this was not significant. It is possible that the sample was too small to reveal this effect.

Correlation Between Feeling of Knowing and Recognition

We calculated an overall gamma score for each subject across all conditions, $M = .45$, which was above chance, $t(31) = 7.93$. This is consistent with previous studies on general information questions (Metcalfe, 1986; Nelson et al., 1984; Nelson & Narens, 1990), and it is in contrast to the low values in Experiments 1 and 2, which used paired associates.

We also determined gamma scores within conditions (see Table 3). The data from 11 subjects could not be included because the gamma correlation could not be calculated in at least one condition. Attention had no effect ($F < 1$), but levels of priming did affect the gamma scores, $F(2, 40) = 3.6$, $MS_e = .21$. This puzzling effect may be due to the low gamma observed in the target-primed condition (.34) and the high gamma in the cue-primed condition (.62). It is unclear why priming would create this effect. The interaction between attention and levels of priming was not significant.

Spontaneous Recall

Levels of priming produced a significant effect on spontaneously recalled targets, $F(2, 62) = 4.9$, $MS_e = .16$. Neither attention ($F = 2.1$) nor the interaction between attention and levels of priming ($F = 2.0$) was significant. As shown in Table 3, recall in the attended target primed condition was higher than recall in the other conditions. It is plausible, then, particularly in the target primed condition, that subjects may have recognized some answers to specific questions during priming. Although spontaneous recalls represent a very small percentage of total items, a disproportionately large percentage of them did occur in the attended target primed condition.

Discussion

In Experiment 3, priming both the questions (cues) and the answers (targets) produced an increase in the feeling-of-knowing judgments. This suggests that both target retrievability and cue familiarity may affect feeling-of-knowing judgments. However, the target priming effect may be more apparent than real for the following reasons: First, because priming occurred after subjects had been exposed to the question, it is possible that they may have recognized correct answers during the priming phase. Thus, when they were doing the feeling-of-knowing task, they may have given higher judgments for items they already knew. The high number of spontaneous recalls seen in the attended target primed condition supports this hypothesis.

Second, the similarity between the target and the cue may also explain the results. In general information questions, there is a necessary relationship between the cue and the target. They have the same referent. For example, the words *the capital of Jamaica* and *Kingston* refer to the same place. Thus, the target may actually prime the question to which it is related and thus increase the feeling of knowing in the same way that cue priming does. Third, the materials themselves may produce the difference in a manner not anticipated. For instance, with general information questions, the cue consists of a sentence, and the target is a single word. In paired associates, the cue and target are each one word.

Table 3
Mean Feeling-of-Knowing Judgments (FKJ), Recognition, Spontaneous Recall (SR), and Gamma Scores as a Function of Priming Condition in Experiment 3

	FKJ[a]				Recognition[b]				SR[c]				Gamma[d]			
Measure	C	T	L	*M*	C	T	L	*M*	C	T	L	*M*	C	T	L	*M*
Attended	46	47	41	45	.30	.40	.31	.34	.03	.34	.16	.18	.57	.45	.46	.49
Unattended	41	40	42	41	.38	.37	.36	.37	.00	.12	.12	.08	.65	.23	.49	.46
Unprimed	—	—	—	40	—	—	—	.37	—	—	—	.06	—	—	—	.46

Note C = cue priming. T = target priming. L = Lure priming. Dashes indicate not applicable.
[a] Measure of confidence of recognition. [b] Measure of percent of targets recognized correctly. [c] Measure of number of items per subject spontaneously recalled. [d] Measure of the gamma correlation between feeling of knowing and recognition.

Experiment 4

Once the potential problems with Experiment 3 were cleaned up, would we still see both cue and target priming influence feeling-of-knowing judgments? In Experiment 4, we addressed our reservations about the results of Experiment 3. First, in Experiment 3, priming occurred after subjects had seen the questions for which they would later give feeling-of-knowing judgments. In Experiment 4, priming occurred prior to encoding of associations and to recall.

Second, in Experiment 3, we used general information questions. These questions and their answers had the same referents. Because of this relationship we may have inadvertently primed the cue by exposing the target (through associative priming; see Meyer & Schvaneveldt, 1971). As a result, enhanced feeling of knowing for target primed items may have occurred as an artifact of the similarity between the cue and the target. To circumvent this problem, in Experiment 4 we used materials that were unrelated paired associates. If we still found the target priming effect, it would provide strong support for a target retrievability component to feeling-of-knowing judgments. If cue familiarity alone accounts for feeling-of-knowing judgments, however, only the cue priming would be expected to increase the judgments, and target priming should have no effect.

Method

Subjects

We recruited 24 subjects from an introductory psychology course at Dartmouth College. We tested each subject individually in a 1-hr session, and each subject received extra credit for participating. They had not participated in previous experiments.

Design

There were four within-subjects conditions: cue priming, target priming, lure priming, and control (no priming). Each subject saw a unique set of cue, target, and lure words. We chose the words (i.e., cues, targets, and lures) and distractors randomly for each subject from 951 words from the Toronto word pool (Murdock, 1968). Once again, feeling-of-knowing judgments, recall, and recognition were the dependent measures.

Procedure

Priming phase. Subjects rated a list of 60 words on a scale of 1 to 5 for pleasantness. We presented the words individually on a computer monitor, and subjects typed their responses on a computer keyboard. Of these words, 15 appeared later as cues in paired associate learning, 15 appeared later as targets in paired associate learning, 15 appeared later as incorrect distractors in recognition, and 15 did not appear again. We chose cues, targets, and lures randomly for each subject, and we chose all the pairs randomly from the word pool.

Encoding phase. Subjects read instructions informing them they would see pairs of words appearing on a computer screen. They were informed that a cued-recall test would follow presented words on completion of the encoding phase. They viewed 60 word pairs individually for 2 s each on a computer monitor.

Recall. We presented subjects with the cue words on the computer monitor and asked them to type the correct target word. They had unlimited time to recall each answer. However, we encouraged them not to spend too much time on any particular item.

Feeling of knowing. We presented subjects again with the cue words of unrecalled items, in a new order, and asked them to give a feeling-of-knowing judgment. The scale went from 1 to 100. A score of 100 indicated maximum confidence in subsequent recognition. Feeling-of-knowing was again defined as confidence of subsequent recognition. We gave the subjects no information as to the nature of the upcoming recognition test.

Recognition. The final test was an eight-alternative forced-choice recognition test. Each cue was shown again followed by the eight choices. One of the choices was always the target, and if a lure had been primed, the lure was one of the choices as well. The six remaining choices were words drawn from the same word pool. Thus, the only old items were the target and the lure.

Results

As shown in Table 4, cue priming, but not target priming, led to higher feeling-of-knowing judgments, $F(3, 69) = 5.6$, $MS_e = 52.7$. This was confirmed by Newman-Keuls post hoc comparisons. Cue priming (.37) differed from all of the other conditions: target priming (.31), lure priming (.32), and the control (.29), which did not differ from each other.

Overall recall was 18%. This low level of recall was optimal because it left a large set of items on which we obtained feeling-of-knowing judgments. Priming did not influence recall ($F = 1.5$). It is possible that 24 subjects did not allow sufficient power to see an effect of target priming on recall. It is worth noting, though, that recall does follow the same ordinal pattern as the recognition data.

Priming did influence recognition. As shown in Table 4, target priming resulted in higher recognition than did the other types of priming, $F(3, 69) = 11.0$, $MS_e = .02$. Newman-Keuls post hoc comparisons revealed that target priming (.68) differed from each of the other conditions but that cue priming (.55), lure priming (.44), and the control (.49) did not differ from each other. Thus, in Experiment 4, target priming affected at least one measure of memorability. Whereas lure priming did not increase feeling-of-knowing judgments or decrease correct recognition judgments, it did affect incorrect recognition choice. In the lure primed condition, subjects chose the lure 25% of the time when chance alone would equal 12.5%, $t(23) = 4.1$.

The mean gamma across conditions was above chance, at .27, $t(23) = 5.40$. This low but above-chance accuracy is

Table 4
Mean Feeling-of-Knowing Judgments (FKJ), Recall, Recognition, and Gamma Scores as a Function of Item Primed in Experiment 4

Item primed	FKJ[a]	Recall	Recognition	Gamma[b]
Cue	37	.19	.55	.239
Target	31	.20	.68	.267
Lure	32	.15	.44	.222
Unprimed	29	.17	.49	.336

Note. [a] Measure of confidence of recognition. [b] Measure of gamma correlation between feeling-of-knowing judgments and recognition.

consistent with some of the studies that used paired-associate procedures in feeling-of-knowing experiments (Hart, 1967; Lupker et al., 1991; Schacter, 1983). Priming did not produce differences in the gamma scores ($F < 1$).

Discussion

The results of Experiment 4 are consistent with the cue familiarity hypothesis. The data also address our reservations about the target priming effect in Experiment 3. Whereas cue priming resulted in increased feeling of knowing in Experiment 4, in Experiment 3, both cue and target priming resulted in increased feeling of knowing. In Experiment 4, we removed the two potential artifacts, which might make the results appear to be based on target retrievability. In Experiment 4, priming occurred before recall so that subjects could not recognize correct answers during priming. Also, the use of unrelated paired associates reduced the possibility of associative priming between the target and the cue. Thus, failure to find any effect of target priming in Experiment 4 suggests that the target priming effect in Experiment 3 was an artifact.

Conclusion

The motivation for these studies was to examine the mechanisms that underlie feeling-of-knowing judgments. The data reported here indicate that cue familiarity is critical in making these judgments. In all four experiments, increasing the familiarity of the cue by priming it resulted in increased feeling of knowing.

The data presented here are consistent with the work of Reder (1987, 1988), who showed that cue familiarity influenced the number of items to which subjects gave positive feeling-of-knowing judgments. By priming words that later appeared as part of general information questions, Reder observed an increased likelihood of obtaining a positive feeling of knowing. She advanced that subjects use feeling of knowing as an indication of what question–answer strategy needs to be used (Reder, 1987). If there is a positive feeling of knowing, subjects attempt to answer rather than simply give up; if not, they can quickly answer that they do not know. This hypothetical function for feeling of knowing requires that these judgments be made rapidly. In fact, Reder (1988) and Reder and Ritter (1992) found faster reaction times for feeling-of-knowing judgments than for actually answering the question. Reder and Ritter manipulated the frequency of presentation of both problem parts (in arithmetical calculations) and the answers. They found that when the exposures to parts and answers were varied separately, it was the frequency of parts that determined whether subjects thought that they knew or had to calculate an answer. Reder and Ritter concluded that an assessment of familiarity allows one to make these fast decisions without explicit retrieval of target information.

Koriat and Lieblich (1977) have also presented data consistent with our results. They presented subjects with word definitions and asked the subjects whether they knew the target. Some definitions were better at inducing high feeling-of-knowing judgments than were others. Those more likely to induce high feeling of knowing tended toward more redundant information. We would argue that this redundant information resulted in higher cue familiarity and thus led to higher feeling-of-knowing judgments. However, Koriat and Lieblich interpreted the results differently. They maintained that redundancy of cue information allows for more partial target information to be retrieved. (We return to this hypothesis shortly.)

The finding that memorability did not affect feeling of knowing vitiates the threshold version of the target retrievability explanation of feeling of knowing (see Hart, 1967, for such a theory). Whereas generating targets led to higher recall and recognition than did reading targets, the manipulation did not affect the feeling of knowing. However, the data presented so far do not necessarily preclude an explanation in terms of inferential mechanisms based on partial target information regardless of whether that information is accurate, such as in Koriat's (1991) accessibility heuristic. Koriat's model states that feeling-of-knowing judgments are based on the retrieval of correct (i.e., refers to the experimenter-designated target) or incorrect (i.e., does not refer to the experimenter-designated target) partial information. One way such a model could account for the present data is by allowing priming of the cues to increase the amount of retrieved information. Then, higher feeling of knowing would be predicted by this model. If this had happened, then more responses (i.e., combined correct and incorrect recall) should have been manifested in the cue-priming conditions in our experiments. However, neither in Experiment 1 nor in Experiment 2 did cue priming increase the commission error rate (or the recall rate). In fact, in Experiment 2, recall was actually higher in the unprimed condition rather than in the primed condition. Thus, despite the elegance and appeal of Koriat's (1991) approach, it cannot account for the data, at least in the present experiments.

Notwithstanding our negative results, there are some data that link partial retrieval to feeling-of-knowing judgments. Blake (1973) found that higher feeling-of-knowing judgments resulted when subjects had partially retrieved an answer (i.e., letters of a three-letter trigram). Schacter and Worling (1985) found that high feeling-of-knowing judgments predicted subsequent attribute identification. However, the experimenters in neither case manipulated the availability of target information. It is possible that under normal circumstances, cue familiarity (and, hence, feeling of knowing) is correlated with the availability of partial information. Indeed, Schacter (1981) reported a correlation between cue recognition and target recognition.

Finally, in a memory model proposed by Metcalfe (in press), feeling-of-knowing judgments are explicitly based on cue familiarity. In the model, a monitor accepts incoming cues and returns a high value if the item is familiar and a low value if it is novel. This computed familiarity can form the basis for feeling-of-knowing judgments. Metcalfe's model also provides a functional explanation of the feeling of knowing. The novelty/familiarity mechanism allows dynamic control of the memory trace by filtering incoming information. At encoding, when an item is entered into the memory trace, the familiarity/novelty filter serves to give more weight to incoming novel information than incoming familiar information. The model predicts that because feeling of knowing is based on a familiarity monitor, any variable that increases familiarity will similarly increase feeling of knowing. Metcalfe's model allows for familiarity to predict feeling-of-knowing judgments without mediators. As the present experiments show, as cue familiarity increases so do feeling-of-knowing judgments.

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