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The Combined Contributions of the Cue-Familiarity and Accessibility Heuristics to Feelings of Knowing

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A model for the basis of feeling of knowing (FOK) is proposed, which combines 2 apparently competing accounts, cue familiarity (L. M. Reder, 1987), and accessibility (A. Koriat, 1993). Both cue familiarity and accessibility are assumed to contribute asynchronously to FOK, but whereas the effects of familiarity occur early, those of accessibility occur later and only when cue familiarity is sufficiently high to drive the interrogation of memory for potential answers. General information questions were used to orthogonally manipulate cue familiarity and accessibility. As expected, both familiarity and accessibility enhanced FOK judgments, but the effects of accessibility were found mostly when familiarity was high. This interactive pattern was replicated when FOK judgments were delayed but not when they were immediate. The results support the proposed cascaded model of FOK but also imply a differentiation between 2 variants of the accessibility heuristic.

The feeling-of-knowing (FOK) phenomenon has attracted much attention presumably because of the dissociation it instantiates between objective and subjective indices of knowing: A person who is unable to recall a particular word or name is often quite confident that the solicited item is available in the memory store and will be recalled or recognized in the future. Sometimes the subjective experience is so intense that one feels that the elusive item is "on the tip of the tongue" and is on the verge of emerging into consciousness (see Brown, 1991; Schwartz, 1998; Schwartz & Smith, 1997; Schwartz, Travis, Castro, & Smith, 2000; Smith, 1994). Following Koriat and Lieblich (1977), we use the term *memory pointer* to designate the stimulus that is intended to cue memory and the term *target* to designate the solicited response, usually a particular memory entry.

As noted by Koriat (1993), most FOK studies so far have focused on one question: How valid are FOK judgments in predicting future memory performance? The typical procedure used to evaluate the accuracy of FOK judgments is the recall–judgment–recognition paradigm introduced by Hart (1965): Participants are presented with a memory pointer and asked to recall the corresponding target from memory. When they are unable to retrieve the target, they are asked to make an FOK judgment regarding the likelihood of identifying the correct target among several distractors in a subsequently presented recognition test. In general, FOK judgments have been found to be moderately accurate in predicting subsequent recognition performance (Hart, 1967; Koriat, 1993; Reder, 1987; Ryan, Petty, & Wenzlaff, 1982; Schwartz, 1994; Schwartz & Metcalfe, 1992), although in some conditions a marked dissociation has been observed between FOK judgments and memory performance (Koriat, 1995).

In recent years, however, there has been a greater concern with a second question about FOK: What is the basis of FOK judgments? In retrospect, it seems that research on this question has been hindered by the implicit assumption that FOK is based on direct access to memory traces. This so-called trace-access account of FOK was put forward explicitly by Hart (1965). Hart proposed that FOK judgments are the output of a specialized monitoring mechanism that can detect the availability in memory of information that is not immediately accessible. Nelson, Gerler, and Narens (1984; see also Krinsky & Nelson, 1985), who listed 12 possible mechanisms that may underlie FOK, proposed to classify them into two classes: trace-access mechanisms and inferential mechanisms. Trace-access mechanisms share the characteristic that the person is presumed to have direct access to the nonrecalled item during FOK. In inferential mechanisms, in contrast, other information in memory is examined, such as domain knowledge and pertinent episodic information, and this information is used to infer the likelihood of remembering the solicited target in the future.

In recent discussions of metacognition, however, there has been a growing tendency to abandon the possibility of direct trace monitoring in favor of the idea that all metacognitive judgments are inferential in nature. Whereas some such judgments are information-based (i.e., mediated by deliberate, analytic inferences that rely on beliefs and retrieved memories), others are experience-based, entailing the implicit application of global heuristics (see Koriat, 2000; Koriat & Levy-Sadot, 1999; see also Strack, 1992). These heuristics may operate below full consciousness to influence

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and shape subjective experience. Therefore, they can explain the kind of unmediated FOK for which the trace-access account has seemed to provide the most suitable explanation.

Several heuristics have been considered as possible determinants of different types of metacognitive judgments. For example, it has been proposed that judgments of learning elicited after the study of new items are based on the ease of processing these items (Begg, Duft, Lalonde, Melnick, & Sanvito, 1989; Koriat, 1997) or rest on the fluency with which information is perceived or retrieved (Benjamin & Bjork, 1996). Subjective confidence in retrieved information has also been claimed to rest on the ease with which information comes to mind (Kelley & Lindsay, 1993; Nelson & Narens, 1990; Zakay & Tuvia, 1998).

With regard to FOK judgments, two heuristic-based accounts have won some support in recent years, the cue-familiarity and accessibility accounts. According to the cue-familiarity hypothesis, FOK is based on the familiarity of the pointer in question (Metcalfe, Schwartz, & Joaquim, 1993; Reder, 1987). According to the accessibility view (Koriat, 1993, 1995), in contrast, FOK is based on the overall accessibility of partial information activated during the search for the target. In this article, we attempt to evaluate the relationship between these accounts and to specify the possible dynamic interplay between the two postulated mechanisms in determining the FOK. We first consider each of these two mechanisms in turn and then examine how they might be integrated within a single conceptual scheme.

The Cue-Familiarity Account of FOK

In the cue-familiarity account, which was first proposed by Reder (1987; see also Metcalfe, 1993), FOK judgments are said to rest on the overall familiarity of the pointer that serves to cue the target, not on the retrievability of the target itself. According to this account, a rapid preliminary FOK is routinely and automatically elicited by a pointer, and this FOK governs question-answering strategy.

Consistent support for the cue-familiarity hypothesis has been marshaled in several studies that used a priming procedure to manipulate the familiarity of the pointer. In this procedure, elements of the pointer are presented prior to the recall task. Assuming that such prior exposure increases the familiarity of the pointer (Jacoby, 1991; Jacoby & Kelley, 1987; Jacoby, Woloshyn, & Kelley, 1989), it should be expected to enhance FOK judgments associated with that pointer.

Indeed, such was found to be the case in Reder's (1987, 1988) studies. Participants made frequency judgments on words, some of which appeared later in general information questions. This procedure enhanced preliminary FOK judgments without correspondingly raising the probability of recall or recognition of the answer. This result was replicated by Schwartz and Metcalfe (1992), who focused on FOK judgments elicited after recall failure. Whereas cue priming enhanced FOK judgments regarding the unrecalled target, the priming of the target itself generally failed to affect FOK. Metcalfe et al. (1993) used a proactive interference paradigm with two lists of paired associates presented one after the other. For the second list, FOK judgments elicited after recall failure were higher when the same cue words were repeated across the two lists than when different cue words were used. Repetition of response terms across the two lists, in contrast, did not enhance FOK judgments.

Remarkable support for the cue-familiarity account of FOK comes also from studies of Reder and her associates using arithmetic problems. Reder and Ritter (1992) had participants make fast FOK judgments by indicating whether they knew the answer to an arithmetic problem and could retrieve it directly or whether they had to compute it. "Know" judgments were found to increase with increasing frequency of previous exposures to the same parts of the problem, not with availability of the answer. Thus, previous exposure to the problem $25 + 39$ increased FOK judgments to such problems as $25 + 46$ or 25×39 even though these problems had not been presented earlier. Furthermore, in a more recent study (Schunn, Reder, Nhouyvanisvong, Richards, & Stroffolino, 1997), FOK judgments increased with increasing frequency of previous exposures to problems even when participants did not have enough time to find their answers (see also Nhouyvanisvong & Reder, 1998; Reder & Schunn, 1996).

Additional support for the cue-familiarity account comes from studies of the feeling of not knowing. Results reported by Glucksberg and McCloskey (1981) and by Klin, Guzman, and Levine (1997) suggest that lack of familiarity can serve as a basis for determining that something is not known. Increasing the familiarity of questions for which participants did not know the answer increased the latency of "don't know" responses as well as the tendency to erroneously make a "know" response.

The Accessibility Account of FOK

A second nonanalytic heuristic that has been proposed to underlie FOK is the accessibility of pertinent information regarding the target. According to the accessibility account (Koriat, 1993, 1994, 1995), when participants fail to recall an answer, their FOK judgments are based on the amount and intensity of the partial information accessed in the course of the search for the target. The assumption is that even when the retrieval attempt is unsuccessful, it may generate a variety of partial clues and activations, such as fragments of the target, semantic and episodic attributes, and so on. These partial clues may induce the subjective feeling that the target is stored in memory and that it will be recalled or recognized in the future.

An important postulate of the accessibility account is that participants have no direct access to the accuracy of the partial clues that come to mind, and therefore both correct and incorrect partial clues should contribute to FOK. Thus, when a person attempts to recall a name from memory, the more letters he or she can retrieve, the stronger his or her FOK, regardless of the accuracy of these letters (Koriat, 1994).

Some evidence in support of the accessibility account was obtained in a study that examined the nature of memory pointers (word definitions) that consistently induce a tip-of-the-tongue (TOT) state across participants (Koriat & Lieblich, 1977). The results suggested that the critical factor is the overall amount of partial information they tend to precipitate regardless of whether that information is correct or not. For example, word definitions that contain redundant information tend to produce inflated FOKs, presumably because redundancy increases the amount of activations without correspondingly enhancing recall of the target. Also, FOK is inflated when the correct target has many "close neighbors" (i.e., words that roughly fit the definition). Activations emanating from such words can enhance FOK even when participants eventually succeed in recalling the correct target.

Consistent with the accessibility account is also the observation that FOK judgments are remarkably higher after commission errors (reporting an incorrect answer) than after omission errors (a failure to retrieve any response; Koriat, 1993; Krinsky & Nelson, 1985; Nelson & Narens, 1990). This pattern suggests that the mere accessibility of an answer serves as a strong cue that one knows the correct answer (Koriat, 1993).

The contribution of partial information to FOK was examined in detail by Koriat (1993). In one experiment, after studying a nonsense string, participants attempted to recall the entire string or as many of the letters as they could remember, and then they provided FOK judgments regarding the probability of recognizing the correct string among lures. FOK was found to increase with both the number of correct letters and the number of incorrect letters retrieved, suggesting that it was based on the mere amount of information that came to mind. Furthermore, when the number of letters accessed was held constant, FOK judgments also increased with the ease with which information came to mind, as indexed by the latency to initiate recall.

Although FOK judgments were generally insensitive to the accuracy of the partial information retrieved, they were nevertheless relatively accurate in predicting subsequent recall. According to the accessibility model, this is due to the relatively high output-bound accuracy of memory (see Koriat & Goldsmith, 1994, 1996): Information that comes to mind is more likely to be correct than incorrect. Hence, the total amount of partial information accessed is a good predictor of the accessibility or availability of the correct target. Indeed, the number of letters recalled (regardless of their accuracy) was found to be as predictive of correct recognition as was the participant's FOK. For example, in Experiment 1 the mean within-subject gamma correlation between FOK and recognition averaged .55, whereas that between number of letters and recognition was .58.

Koriat (1995) classified general information questions as high accessibility or low accessibility on the basis of the percentage of participants who provided an answer to that question (regardless of whether the answer was right or wrong). Among participants who failed to retrieve an answer, high-accessibility questions produced higher FOK judgments than low-accessibility questions, presumably because the former questions precipitated more partial clues than the latter. In turn, the accuracy of FOK judgments in predicting recognition performance appeared to depend critically on the accuracy of the partial clues retrieved. The results suggest that FOK judgments are valid as long as these clues are more likely to be correct than incorrect, which is true of most memory questions. However, deceptive questions (Fischhoff, Slovic, & Lichtenstein, 1977), which tend to bring to mind more incorrect than correct information, produce a strong illusion of knowing after recall failure (i.e., unduly high FOK judgments). These questions, in fact, demonstrate a dissociation between knowing and FOK to the extent that FOK judgments are negatively correlated with recognition memory performance.

Partial support for the accessibility account was also obtained by Schwartz and Smith (1997) with regard to TOT states. They had participants study different amounts of information about imaginary animals and then recall the animals' names. The likelihood of reporting TOT was found to increase with the amount of information presented about the animal at study. This, however, was true for one kind of information (pictorial information) but not for others (the animal's diet and size).

Support for the proposition that FOK judgments monitor the accessibility of partial information has also been observed in several earlier experiments (Blake, 1973; Eysenck, 1979; Schacter & Worling, 1985). However, as noted by Koriat (1993), in all of these experiments accessibility was defined as the amount of correct partial information retrieved about the elusive target.

On the whole, the results reviewed earlier are consistent with the accessibility account's claims that (a) FOK judgments increase with the amount and ease of access of partial clues regardless of whether these clues are correct or incorrect and (b) FOK is valid in predicting memory performance only as long as the partial clues that come to mind are correct by and large.

Comparing the Cue-Familiarity and Accessibility Accounts of FOK

The cue-familiarity and accessibility accounts share the assumption that FOK judgments do not have privileged access to the trace of the sought-for target but are based instead on the application of a global heuristic. However, they differ in critical respects, particularly in the hypothesized stage at which FOK judgments are assumed to occur. According to the cue-familiarity account, FOK is driven by a mechanism that operates at a preretrieval stage and helps to guide the choice of question-answering strategy (Miner & Reder, 1994; Reder, 1987). Therefore, it must be based on properties of the pointer, such as its familiarity or novelty, rather than on characteristics of the retrieved information (Metcalfe, 1993; Miner & Reder, 1994; Reder, 1987, 1988; Reder & Ritter, 1992). In the accessibility account, in contrast, FOK judgments are assumed to depend on the by-products of the retrieval attempt: The assumption is that only by trying to retrieve a target from memory can a person appreciate the amount and ease of the clues that come to mind.

What is the relation between cue familiarity and accessibility as potential accounts of FOK? One possibility is that they represent competing, alternative accounts of FOK. Indeed, this is how the two accounts have been treated in some of the experiments that compared the effects of cue priming with those of target priming (e.g., Schwartz & Metcalfe, 1992). The results of these experiments were taken to suggest that FOK monitors the familiarity of the pointer, not the accessibility of the target.

As noted by Koriat (1993), however, these results may have some bearing on the target retrievability hypothesis but are less directly pertinent to the accessibility hypothesis. The target retrievability hypothesis (or the "partial recall mechanism"; see Nelson et al., 1984) claims that FOK monitors the retrievability of the target proper. This implies that FOK is specifically tuned to the partial recall of the actual correct target (see Blake, 1973; Eysenck, 1979; Schacter & Worling, 1985). In the accessibility account, in contrast, FOK is seen to rely on the sheer amount of information accessible, regardless of its accuracy.

A second possibility is that cue familiarity and accessibility are intimately related and constitute different facets of the same mechanism (see Koriat, 1993). On the one hand, perhaps it is the ease with which information comes to mind that serves as the cue for the subjective experience of familiarity (e.g., Jacoby & Dallas, 1981; Jacoby & Kelley, 1987; Kelley & Jacoby, 1996; Lindsay & Kelley, 1996). On the other hand, familiarity also implies accessibility: A familiar memory pointer is one that brings some associations to mind, whereas an unfamiliar pointer leaves the person "blank."

In fact, it is not always clear whether some of the reported effects on FOK are derived from enhanced familiarity or from enhanced accessibility. For example, in a study by Brown and Bradley (1985), FOK judgments about the recognition of a U.S. state capital were enhanced by advance exposure to other cities from the same state. This effect could be mediated either by increased familiarity of the state or by the enhanced accessibility of potential candidates. Similarly, in a study by Metcalfe et al. (1993), cue priming, which was found to enhance FOK, also increased the proportion of both correct and incorrect responses (Experiment 4). Thus, the effects of priming on FOK may be mediated by increased cue familiarity, increased accessibility of pertinent information, or both (see also Schwartz & Smith, 1997).

Finally, a third possibility is that cue familiarity and accessibility constitute separate mechanisms, with each making a unique contribution to FOK (see Koriat, 1993). Benjamin and Bjork (1996), for example, distinguished between perceptual fluency and retrieval fluency as two possible bases for metacognitive judgments. This distinction roughly parallels that between cue familiarity and accessibility. Perceptual fluency (i.e., the ease with which information is perceived) has been assumed to underlie experienced familiarity (Jacoby & Whitehouse, 1989; Johnston, Dark, & Jacoby, 1985; Whittlesea, Jacoby, & Girard, 1990), whereas retrieval fluency corresponds to accessibility, referring to the ease with which information comes to mind.

The Interactive Hypothesis: The Interplay Between Cue Familiarity and Accessibility

In this study, we examined the view that cue familiarity and accessibility do indeed constitute two separate mechanisms, with each making an autonomous contribution to the FOK. In line with Miner and Reder (1994) and Nhouyvanisvong and Reder (1998), we distinguished between a familiarity-based preliminary FOK, on the one hand, and a postretrieval FOK influenced by the results of the retrieval attempt, on the other hand. We assumed that cue familiarity enhances FOK very early to the extent of motivating search and retrieval (Reder, 1987), but thereafter the amount of accessible information also affects FOK judgments (see Koriat, 1998b; Nhouyvanisvong & Reder, 1998). Furthermore, we proposed that an interactive interplay takes place between the two mechanisms: It is primarily when familiarity is strong enough to drive memory search that the amount of accessible information comes to play a role in affecting FOK. According to the interactive hypothesis advanced here, when cue familiarity is low, little attempt will be made to initiate a deliberate search for the target (Reder, 1987), and hence accessibility of potential clues is likely to exert little effect on FOK judgments. Some degree of familiarity of the pointer, then, is necessary for the effects of accessibility to manifest themselves.

This hypothesis was motivated by an analysis of the nature of memory pointers that precipitate a strong, unwarranted FOK (see Koriat, 1995, 1998a). Consider, for example, the following question: "In which U.S. state is Yale University located?" When this question was presented to Israeli participants, none of them produced the correct answer, and fully 42%[1] of them provided an incorrect answer. These answers included no fewer than nine different U.S. states! This question also precipitated an unduly strong FOK among participants who failed to produce any answer (predicted and actual probabilities of recognition were .45 and .08, respectively). In contrast, the question "In which U.S. state is the College of William and Mary located?" yielded no answers at all among another group of participants and appropriately evoked a feeling of not knowing. Although the number of potential answers (names of U.S. states) is apparently the same for both questions, it would seem that only in the case of Yale University are some of the possible candidate answers considered, whereas in the case of the College of William and Mary, no candidate answers are entertained, leading to low FOK.

These observations suggest that for a pointer to yield a particularly strong FOK, it must evoke a sense of familiarity that drives the interrogation of memory for a possible answer. With questions such as those just considered, what seems to matter most is the familiarity of the question's referent (Yale University vs. College of William and Mary), because when the referent is unfamiliar, FOK is low even when the domain within which the search for the answer must be conducted (U.S. states) may be quite familiar. When memory interrogation begins, it may lead to the accumulation of partial information, and the amount of such information can then contribute further to the enhancement of FOK. Thus, in addition to contributing to initial FOK, the familiarity of the question may be seen to operate as a gating mechanism: It allows information to be released from long-term to short-term memory. It is the activated information in short-term memory that then affects eventual FOK. The implication is that the amount of potentially accessible information (e.g., possible U.S. states) will have an effect on FOK only or mostly when the familiarity of the referent is relatively high.

We tested the proposed interactive model for the basis of FOK by using tetrads of questions representing all combinations of high and low familiarity and high and low accessibility. To achieve as clear a separation as possible between the two mechanisms, we used general knowledge questions that conformed to a particular format (see Table 1). The questions included either a large or a small category term (e.g., composers or choreographers, respectively) and either a familiar or an unfamiliar referent (e.g., the ballet "Swan Lake" or the ballet "The Legend of Joseph," respectively). Thus, potential accessibility was manipulated through category size because category size determines the number of potential candidates that may come to mind during the controlled search for the answer, and familiarity was manipulated through the familiarity of the referent.

[1] In Koriat (1995), this figure was erroneously reported as 11.1% rather than 41.7%.

Table 1
An Example of a Tetrad of Questions Representing Different Levels of Referent Familiarity and Potential Accessibility

	Potential accessibility	
Referent familiarity	Low	High
High	Who was the choreographer of the ballet "Swan Lake"?	Who composed the music for the ballet "Swan Lake"?
Low	Who was the choreographer of the ballet "The Legend of Joseph"?	Who composed the music for the ballet "The Legend of Joseph"?

Note that the operational definitions of cue familiarity and accessibility that we used in this study were somewhat more circumscribed than those underlying previous research. First, cue familiarity was defined in terms of the familiarity of the question's referent (rather than the familiarity of any pair of terms in the question; e.g., Reder, 1987) because, as noted earlier, it is the familiarity of the referent that is assumed to control the initiation of a deliberate search for the answer. Also, cue familiarity was defined in terms of the mere experienced familiarity induced by the referent term and not as the self-assessed familiarity or expertise in a domain (e.g., Reder, 1988) because the latter implicates amount of knowledge about a domain and therefore confounds cue familiarity and accessibility. Second, accessibility was operationally defined in terms of the number of potential members of the category term rather than in terms of the total amount of partial information precipitated by the cue (Koriat, 1993). Possibly, automatically activated partial clues emanating from the question as a whole also contribute to the FOK (see later discussion). However, it is specifically the accessibility of targets within the domain of candidate answers that becomes critical when a deliberate search for the answer is conducted.

Note that the definition of accessibility in terms of the number of potential answers sharpens the counterintuitive nature of the predictions derived from the accessibility model. Given that the referent term in a question is familiar enough, it might have been expected, then, that FOK judgments should decrease with category size because the larger the number of candidates from which the answer must be chosen, the lower should be the likelihood of recalling or choosing the right answer. Indeed, this is the very prediction that follows from the competition view of FOK (Maki, 1999; Schreiber, 1998; Schreiber & Nelson, 1998), according to which the stronger the competition between the concepts that are associated with a certain cue, the weaker the FOK. Results consistent with this view have been obtained using list learning: In a cued-recall task, extralist cues associated with more targets tended to yield lower FOKs (Schreiber & Nelson, 1998). The predictions of the accessibility model, however, follow from the postulated nonanalytic nature of the accessibility heuristic (see Jacoby & Brooks, 1984). This heuristic is assumed to respond to the total amount of information that comes to mind during retrieval, regardless of the correctness of that information or the consistency between different pieces of information that come to mind (see Koriat, 1993, 1995).

Norming Study

The norming study was designed to allow the selection of tetrads of questions to be used in Experiments 1 and 2, representing all combinations of high and low referent familiarity and high and low potential accessibility, with difficulty level controlled across the 4 questions of a tetrad. For each of 99 questions, norms were collected regarding three variables: (a) potential accessibility (or set size) for the category term, as indexed by the number of instances that it brought to mind within 40 s; (b) ratings of the subjective familiarity of the referent of the question; and (c) the difficulty level of the question, as indexed by the percentage of participants who correctly recalled the answer.

We should note that the approach we adopted for the manipulation of cue familiarity in this study differs from that of previous studies of the cue-familiarity hypothesis. In previous studies, cue familiarity was manipulated through priming, under the assumption that advance priming of the cue would enhance its subjective familiarity (e.g., Metcalfe et al., 1993; Reder, 1987; Reder & Ritter, 1992; Schwartz & Metcalfe, 1992). In the present study, in contrast, we defined cue familiarity in terms of subjective ratings of the familiarity of the question's referents. This approach is similar to that used in several other studies that attempted to specify possible phenomenological determinants of metacognitive judgments (e.g., ease of imagery, ease of understanding, vividness, cognitive effort, ease of visualization, and feeling of difficulty; see, e.g., Begg et al., 1989; Efklides, in press; Robinson, Johnson, & Herndon, 1997). Thus, familiarity was manipulated here through the selection of different referents.

Furthermore, recent studies have suggested that the extent of experienced familiarity induced by a term depends on the context in which that term appears. For example, Whittlesea and Williams (2000) showed that nonwords that are experienced as familiar when presented in isolation are experienced as novel when presented in certain contexts, apparently because in these contexts (e.g., a rhyme word) their fluent processing was expected. If so, the familiarity of a referent in isolation may not be fully indicative of its familiarity in the question. This problem may of course weaken the effects of our manipulation of familiarity.

Equating difficulty level across all questions of a tetrad was important because questions with unfamiliar referents would be expected to yield poorer memory performance than questions with familiar referents. This potential confounding creates the problem that the effects of familiarity on FOK could alternatively be attributed to differences in difficulty. A correlation between FOK and memory performance (difficulty) is compatible with a trace-access account of the FOK (Hart, 1965, 1967; Nelson et al., 1984), which assumes that FOK monitors the strength of the memory trace—the stronger the memory trace, the stronger the FOK and the higher the probability of recall. Thus, it was important to control for item differences in the probability of recall across the four classes of questions (but see Landauer & Meyer, 1972, for a discussion on regression to the mean and its problematic implications when trying to match items on a certain variable).

Method

Participants. Thirty Hebrew-speaking University of Haifa undergraduates (14 men and 16 women) participated in the experiment for course credit.

Stimulus materials. On the basis of our intuitive judgments, 22 tetrads of questions were compiled (in Hebrew), which conformed to the desired structure. The answer to each question was either a term (e.g., *brain*) or a proper name of a person (e.g., *Strauss*) or a place (e.g., *Honshu*). Answers consisted of one or two words. Eleven spare questions were added so that they could be used to replace some of the questions from the original set to achieve tetrads that were more balanced in terms of difficulty level. Each of these questions shared its category term with another question in the original set, but it was paired with a different referent. Altogether there were 44 different category terms (22 expected to yield large sets and 22 expected to yield small sets) and 50 different referents (29 familiar and 21 unfamiliar).

Familiarity form. The familiarity form included 50 names, representing the referents of all the questions (the 44 referents of the 22 tetrads in the original set of questions and 6 referents from the additional 11 questions). Participants were instructed to judge the extent to which each name or term felt familiar and to indicate their judgment on a scale ranging from 1 (*very unfamiliar*) to 10 (*very familiar*). They were told not to consider the amount of information they possessed about a name or a term but simply to judge how familiar the name or the term sounded, even if they knew nothing about it. They were also instructed to try to make use of the full range of ratings.

Accessibility form. The accessibility form included the 44 category terms, each appearing on a separate page. For each category term, participants were instructed to list all the members that they could think of without scrutinizing their responses. Thus, they were told to write down any member that came to mind even if, on second thought, they judged that it actually did not belong to the prespecified category. They were asked to list all the members that came to mind in one column. When 40 s had elapsed, participants were asked to move to the next page. An example involving the names of Israeli fashion models was given before the beginning of the experiment.

Difficulty form. Two versions of the difficulty form were prepared, one with 50 questions and one with the remaining 49 questions. Each version included 2 of the 4 questions in each tetrad, so that each category name and each referent appeared only once in each form (except for a few instances of repetition that resulted from the inclusion of the spare questions). The order of the questions in each version was random except that at least 5 questions intervened between the 2 questions belonging to the same tetrad.

A forced-recall procedure was used. Participants were asked to answer each of the questions, even if they had to guess, but to make an effort to find the best answer they could.

Procedure. One group of 15 participants filled out the familiarity form and then the difficulty form. This took about 30 min. Another group of 15 participants filled out the accessibility form (for about 45 min), and 6 of these participants were also administered the difficulty form immediately afterward. In total, then, 21 participants filled out the difficulty form, with each version of this form administered to either 10 or 11 participants. The experiment was administered in small groups of 1–6 participants.

Results

On the basis of the familiarity, accessibility, and difficulty norms, 18 tetrads were formed. Across these tetrads, the number of words in each question ranged between 5 and 12 (M = 7.7). A brief characterization of these tetrads follows: First, the mean familiarity rating of the familiar referents was always greater than 5, whereas that of the unfamiliar referents was equal to or less than 5. Second, set size for the high potential accessibility categories was at least 3 times larger than that of the low potential accessibility categories, except for 2 tetrads for which the ratio was only 1.2:1. Third, difficulty level, as indexed by percentage of correct answers, was roughly equivalent across the 4 questions of a tetrad.

Table 2 presents the means, calculated across the 18 tetrads, of familiarity ratings, set size, and difficulty (percentage of correct recall) for questions representing all combinations of high and low referent familiarity and high and low potential accessibility. Table 2 shows that across all tetrads, difficulty levels were roughly equal across the two levels of referent familiarity, but high potential accessibility questions yielded somewhat better recall than low potential accessibility questions. This matter has to be taken into account in the interpretation of the results of the following experiments.

Experiment 1

Experiment 1 examined the hypothesis that referent familiarity modulates the effects of target accessibility on FOK judgments, with the effects of accessibility being stronger when the referent is more familiar than when it is not. The 72 questions representing the 18 tetrads from the norming study were used. Participants were presented with each question in turn and were asked to recall the answer and then provide an FOK judgment about the likelihood of selecting the correct answer among four alternatives in a recognition test that was subsequently administered.

Table 2
Means and Standard Errors of Variables for the 18 Selected Tetrads for Questions Representing All Combinations of Low and High Referent Familiarity and Potential Accessibility

	Potential accessibility			
	Low		High	
Referent familiarity and variable	*M*	*SE*	*M*	*SE*
High				
Familiarity rating	8.99	2.12	8.99	2.12
Set size	1.99	2.19	7.15	3.90
% correct recall	5.41	0.23	10.58	0.31
Low				
Familiarity rating	2.75	2.41	2.75	2.41
Set size	1.99	2.19	7.15	3.90
% correct recall	2.63	0.16	10.75	0.31

We expected FOK judgments to increase with both referent familiarity and potential accessibility, but potential accessibility was expected to affect FOK only for high-familiarity questions but not for low-familiarity questions. Referent familiarity, in contrast, was expected to affect FOK regardless of potential accessibility. This pattern of results was predicted to hold for FOK judgments elicited after omission responses as well as for those elicited after commission errors (see Koriat, 1995). Furthermore, as has been proposed (Koriat, 1995), the percentage of answers produced in response to each question (across participants) can serve as a rough index for the amount of information it tends to precipitate (within participant). Therefore, we expected the percentage of commission responses (regardless of their accuracy) to yield a similar pattern of results as that expected for FOK.

Method

Participants. Forty Hebrew-speaking psychology undergraduates (31 women and 9 men) participated in the experiment for course credit. None of them had participated in the norming study.

Stimulus materials. The 72 questions (see the Appendix) were divided into two groups. Each included 2 of the 4 questions in each tetrad so that each category term and each referent appeared only once in each group. Thus, if one group included the high-familiarity/high-accessibility (HFHA) question and the low-familiarity/low-accessibility (LFLA) question of a given tetrad, the other group included the low-familiarity/high-accessibility (LFHA) question and the high-familiarity/low-accessibility (HFLA) question of that tetrad. Two versions of the research forms were prepared, with each including the questions from one group of items. The order of the questions was randomly determined for each version except that at least 2 questions intervened between questions of the same tetrad. The same random order was maintained for both the recall and recognition forms of each version.

Procedure. The experiment was administered in small groups of 1–6 participants and took about 25 min. Each of the two versions of the research forms was administered to half of the participants. In the recall phase, participants were instructed to write down the answer to each question and then to indicate the chance (FOK) that they would be able to identify the correct answer among four alternatives in a subsequent recognition test by writing a number between 25% and 100%. The instructions explained that 25% constituted chance performance. Participants were instructed to make FOK judgments to each of the questions whether they provided an answer or not (Koriat, 1993; see also Krinsky & Nelson, 1985, for a comparison between omission errors and commission errors). When the recall task was completed, participants were handed the recognition booklets and were asked to circle one answer for each of the questions.

Results

On average, participants provided an answer in 12.4% of the cases, and 25.1% of these answers were correct. The reason for this very low recall performance was that the overall level of difficulty that we chose in attempting to equate level of difficulty across the questions of each tetrad was constrained by the difficulty of the low-familiarity questions.

We first present FOK results for all trials combined and then examine the results for omission responses alone. Figure 1A presents mean FOK judgments as a function of referent familiarity and potential accessibility. These means represent the averages of the participants' means across all corresponding tetrads. The results conformed to the hypothesized interactive pattern. A two-way analysis of variance (ANOVA) on these means yielded significant

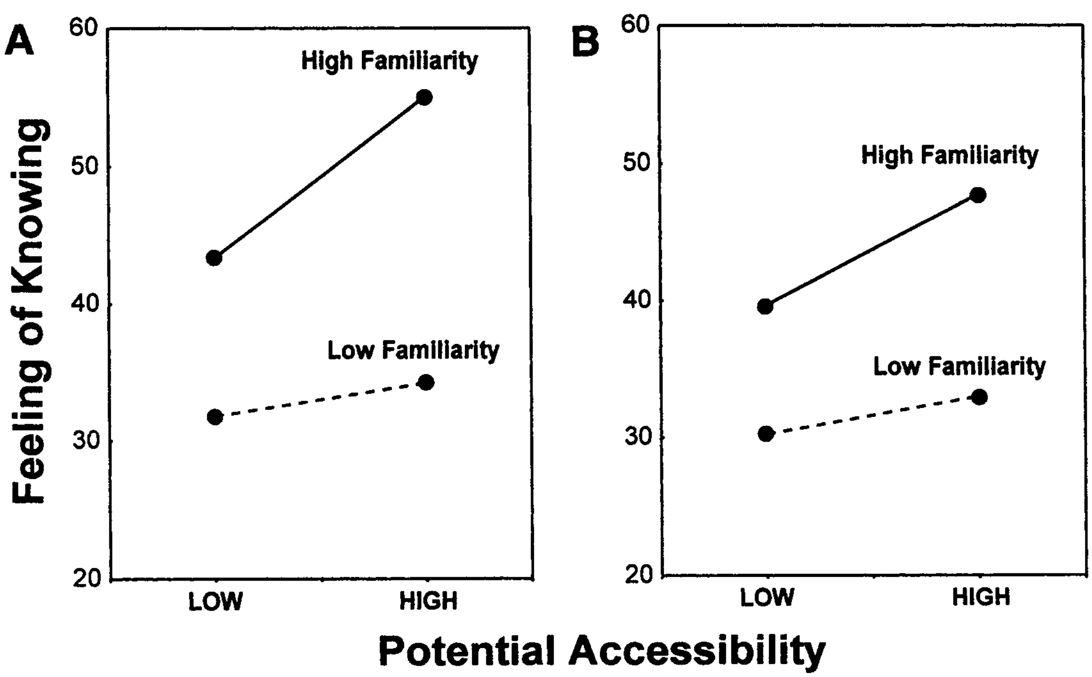

Figure 1. Mean feeling of knowing as a function of referent familiarity and potential accessibility across all recall responses (A) and for omission trials only (B) in Experiment 1.

effects for referent familiarity, $F(1, 39) = 170.53$, $MSE = 61.49$; for potential accessibility, $F(1, 39) = 81.93$, $MSE = 24.30$; and for their interaction, $F(1, 39) = 15.51$, $MSE = 55.33$. Unless otherwise noted, the significance level for all tests reported in this article was set at $p < .05$.

As one can see, FOK judgments were higher for the high-familiarity questions ($M = 49.18$) than for the low-familiarity questions ($M = 32.99$). The effects of familiarity were significant for both the high-accessibility questions, $F(1, 39) = 129.23$, $MSE = 67.10$, and the low-accessibility questions, $F(1, 39) = 53.75$, $MSE = 49.72$. FOK judgments were also higher for the high-accessibility questions ($M = 44.61$) than for the low-accessibility questions (37.55), but this effect was considerably more pronounced when familiarity was high. Separate ANOVAs conducted for each of the familiarity levels indicated a highly significant effect of accessibility for the high-familiarity questions, $F(1, 39) = 56.29$, $MSE = 48.52$, but only a nearly significant effect for the low-familiarity questions, $F(1, 39) = 3.77$, $MSE = 31.10$. Thus, potential accessibility affected FOK only or mainly when familiarity was high.

To examine the generality of these conclusions across questions, we repeated these ANOVAs using items as the unit of analysis. The results yielded similar effects to those obtained in the subject-based ANOVA. Significant effects were found for referent familiarity, $F(1, 68) = 53.27$, $MSE = 94.35$; for potential accessibility, $F(1, 68) = 10.55$, $MSE = 94.35$; and for their interaction, $F(1, 68) = 4.15$, $MSE = 94.35$. Familiarity effects were significant for both high-accessibility questions, $F(1, 34) = 37.85$, $MSE = 108.61$, and low-accessibility questions, $F(1, 34) = 16.31$, $MSE = 80.09$. Accessibility effects, in contrast, were significant for high-familiarity questions, $F(1, 34) = 8.57$, $MSE = 153.65$, but not for low-familiarity questions, $F(1, 34) = 1.97$, $MSE = 35.05$.

Previous studies have shown that FOK judgments are higher after commission responses than after omission responses (Koriat, 1993, 1995; Krinsky & Nelson, 1985; Nelson & Narens, 1990). This was true in Experiment 1 as well: Mean FOK judgments were considerably higher after commissions (77.45) than after omissions (36.82), $F(1, 36) = 315.66$, $MSE = 40.61$, consistent with the accessibility view.

Figure 1B depicts the results obtained using omission trials only. The pattern is very similar to that depicted in Figure 1A, although FOK judgments were lower overall. A two-way ANOVA on these results yielded $F(1, 39) = 97.03$, $MSE = 60.29$, for familiarity; $F(1, 39) = 36.91$, $MSE = 32.02$, for accessibility; and $F(1, 39) = 6.98$, $MSE = 40.19$, for their interaction. The effects of familiarity were significant when accessibility was low, $F(1, 39) = 38.23$, $MSE = 46.66$, as well as when accessibility was high, $F(1, 39) = 80.77$, $MSE = 53.81$. The effects of accessibility, in contrast, were strong when familiarity was high, $F(1, 39) = 32.01$, $MSE = 40.83$, but were moderate, although significant, when familiarity was low, $F(1, 39) = 4.95$, $MSE = 31.38$. We conducted a similar analysis using commission trials only. The results yielded a strong effect of familiarity and no other effect. However, rate of commissions was very low, making these results somewhat unreliable.

We proposed that referent familiarity affects the initiation of a memory search: It operates as a gating mechanism that controls the flow of potentially accessible information from long-term to short-term memory. Assuming that the percentage of commission responses roughly reflects the overall amount of partial information that is accessible (Koriat, 1995), then the pattern of results found for FOK should also be observed for the percentage of commission responses. This was indeed the case, as one can see in Figure 2A. A two-way ANOVA on the percentage of answers provided (regardless of their accuracy) yielded $F(1, 39) = 43.53$, $MSE = 0.02$, for familiarity; $F(1, 39) = 26.91$, $MSE = 0.01$, for accessibility; and $F(1, 39) = 17.12$, $MSE = 0.01$, for their interaction. The effects of familiarity were significant for both low-accessibility questions, $F(1, 39) = 9.54$, $MSE = 0.01$, and high-accessibility questions, $F(1, 39) = 48.16$, $MSE = 0.02$. The effects of accessibility, in contrast, were highly significant for the high-familiarity questions, $F(1, 39) = 32.59$, $MSE = 0.01$, but were not significant for the low-familiarity questions, $F(1, 39) = 1.39$, $MSE = 0.007$.

A problem that complicates the interpretation of the results reported thus far is that the percentage of correct answers produced in recall also yielded a similar pattern to that found for FOK and for the percentage of commission responses, as one can see in Figure 2B. Indeed, a two-way ANOVA on these data also yielded significant effects for familiarity, $F(1, 39) = 27.52$, $MSE = 0.003$; accessibility, $F(1, 39) = 11.87$, $MSE = 0.004$; and their interaction, $F(1, 39) = 8.92$, $MSE = 0.004$. Thus, despite our efforts to equate difficulty level across the members of each tetrad, the effects on FOK could alternatively be interpreted in terms of a trace-access account in which FOK is assumed to monitor the presence of the correct target in the memory store. In an attempt to evaluate this interpretation, we focused on the 8 tetrads in which percentage of correct recall was 0% for all participants for each of the 4 questions in the tetrad. Mean FOK judgments for these tetrads, calculated as a function of referent familiarity and potential accessibility, are plotted in Figure 3A.

A two-way ANOVA on these results replicated the pattern reported earlier, yielding $F(1, 39) = 75.98$, $MSE = 45.19$, for familiarity; $F(1, 39) = 57.41$, $MSE = 47.10$, for accessibility; and $F(1, 39) = 16.44$, $MSE = 63.37$, for their interaction. Thus, the interactive effects of familiarity and accessibility on FOK cannot be accounted for in terms of privileged access to the correct target. Although a trace-access account cannot explain the latter findings, we went ahead and repeated this analysis including omission trials only (see Figure 3B). The exact same pattern emerged again. A two-way ANOVA yielded $F(1, 39) = 76.84$, $MSE = 34.95$, for familiarity; $F(1, 39) = 39.46$, $MSE = 66.47$, for accessibility; and $F(1, 39) = 15.37$, $MSE = 76.85$, for their interaction. Note that rate of commissions for the balanced tetrads was very low (7.0%), so there was a great deal of overlap between the data that were entered into the last two analyses.

Mean percentage of correct responses in the recognition test across all trials was close to chance (27.6%), reflecting the high difficulty level of the questions. A two-way ANOVA on these results yielded $F < 1$ for familiarity; a significant effect for accessibility, $F(1, 39) = 4.60$, $MSE = 0.06$; and a significant effect for their interaction, $F(1, 39) = 8.05$, $MSE = 0.24$. The effects of accessibility were significant when familiarity was low, $F(1, 39) = 17.50$, $MSE = 0.02$ (percentage of correct recognition averaged 32.4% for low-accessibility questions and 20.8% for high-accessibility questions), but not when familiarity was high, $F(1, 39) = 1.06$, $MSE = 0.03$ (percentage of correct recognition

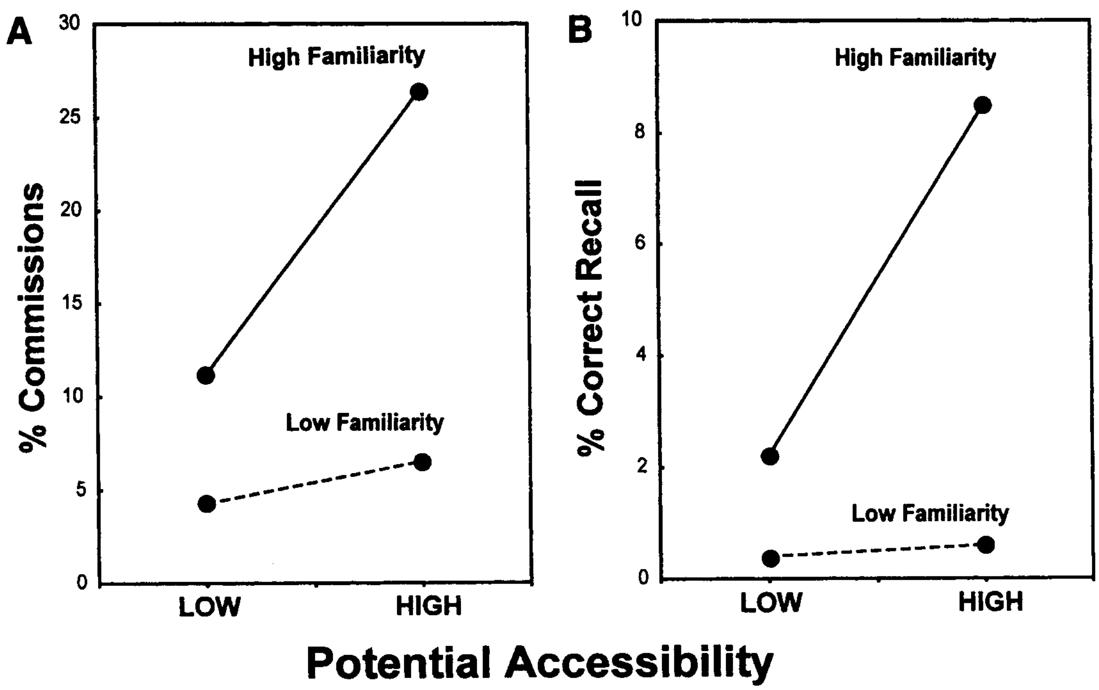

Figure 2. Percentage of commission responses (A) and percentage of correct recall (B) as a function of referent familiarity and potential accessibility in Experiment 1.

averaged 26.7% for low-accessibility questions and 30.5% for high-accessibility questions). A similar two-way ANOVA with items as the unit of analysis yielded no significant effects. The source of some of the unexpected effects is unclear, and in any case, these differences cannot account for the pattern of results found for FOK.

Discussion

Experiment 1 yielded several results that are consistent with our predictions. First, evidence was obtained supporting both the cue-familiarity and accessibility hypotheses. Thus, when cue familiarity and accessibility were manipulated orthogonally, both were found to exert strong effects on FOK. FOK judgments were higher for questions with more familiar referents than for those with less familiar referents, and in parallel, they were higher for questions in which the correct target was drawn from a large category than for those in which it was drawn from a small category. We should note that this latter result is inconsistent with the competition view of FOK (Maki, 1999; Schreiber, 1998; Schreiber & Nelson, 1998).

These results are in line with the proposal that the cue-familiarity and accessibility accounts of FOK do not constitute alternative, competing accounts but represent two mechanisms that may operate in conjunction to affect FOK. The effects of referent familiarity were clear and strong throughout the experiment. Support for the accessibility hypothesis, in turn, comes not only from the effects of category set size on the FOK but also from two ancillary observations. First, as we expected, FOK judgments were higher after commission than after omission responses (see Koriat, 1993, 1995; Krinsky & Nelson, 1985; Nelson & Narens, 1990). Second, the overall pattern of results for percentage of commission responses mimicked that obtained for FOK judgments after recall failure. This finding is consistent with the accessibility account, assuming that the percentage of participants who provide an answer to a question is diagnostic of the amount of partial clues precipitated by that question among participants who fail to yield any answer (see Koriat, 1995).

Second, the effects of referent familiarity and potential accessibility on FOK judgments were found to interact in a manner consistent with predictions. The effects of accessibility were much weaker for the low-familiarity questions than for the high-familiarity questions. However, although we expected the effects of accessibility to be confined to the high-familiarity condition, Figures 1 and 3 show that these effects were detectable even when the familiarity of the referent was low. Although this result may stem from the fact that the low-familiarity referents were not totally unfamiliar, one possibility is that the effects of accessibility under low-familiarity conditions reflect the influence of automatic activations that operate even before a deliberate search for the target is initiated. This possibility is examined in the General Discussion section.

As we expected, the effects of referent familiarity on FOK were found regardless of the level of potential accessibility. It would seem that the effects of familiarity are not confined to the rapid preliminary FOK judgments that occur before the initiation of search and retrieval, as implied by Reder (1987, 1988; Nhouy-vanisvong & Reder, 1998; Reder & Ritter, 1992). Rather, cue familiarity continues to exert its influence even after attempted retrieval. Indeed, the results of Schwartz and Metcalfe (1992)

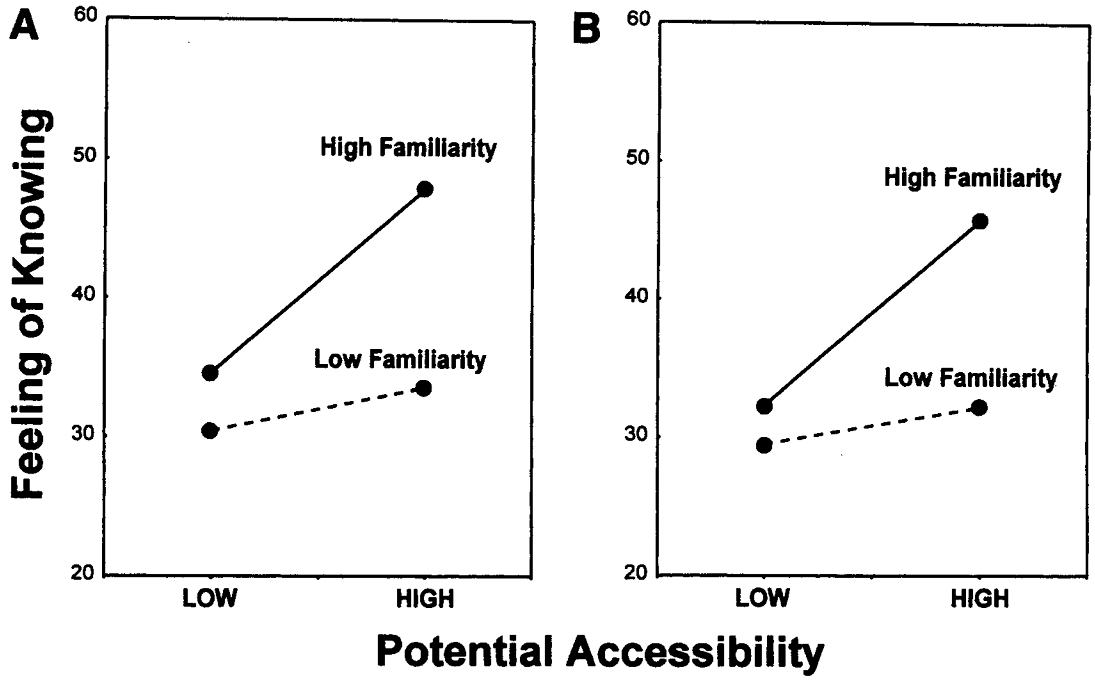

Figure 3. Mean feeling of knowing as a function of referent familiarity and potential accessibility for eight balanced tetrads only across all recall responses (A) and for omission trials only (B) in Experiment 1.

suggest that cue familiarity affects FOK judgments after recall failure.

Experiment 2A

According to the theoretical position advanced in this article, the two heuristic bases of FOK—cue familiarity and accessibility—exert their influence on FOK in a cascaded manner. At a very early stage, FOK judgments are primarily determined by cue familiarity, whereas at a somewhat later stage, accessibility may also come to play a role, contingent on the level of cue familiarity (see Koriat, 1998b; Nhouyvanisvong & Reder, 1998). If so, then the initial rapid FOK that is assumed to be experienced at a preretrieval stage (see, e.g., Nhouyvanisvong & Reder, 1998; Reder, 1987, 1988; Reder & Ritter, 1992) should reflect primarily differences in cue familiarity. Postretrieval FOK (i.e., FOK after attempted retrieval), in contrast, may reveal the contribution of differences in accessibility as well. Thus, the combined effects of familiarity and accessibility should be modulated by the stage (time) at which FOK judgments are elicited.

Reder (1987), in her early experiments, made use of the "game show" paradigm in assessing "rapid" or "preliminary" FOK: Participants were presented with general information questions and were required to decide very quickly whether they would be able to answer each question. Their responses were taken as an index of rapid FOK. We used a variation of this procedure in the first phase of Experiment 2A. Participants were told that in Phase 2 of the experiment they would be required to answer two-alternative general information questions and that they would be rewarded or penalized according to their performance. However, they would have a chance to preview these questions in Phase 1 of the experiment and to decide for each question whether they wanted their answer in Phase 2 to be taken into account in calculating their overall gain. Thus, a *yes* response in Phase 1 would signify that they wanted their answer to count, whereas a *no* response would signify that they wanted their answer to be ignored. These *yes–no* responses were then treated as a measure of FOK.

Response timing for making a *yes–no* response was manipulated between participants. In the immediate condition, participants were required to make the response as soon as they read the question, whereas in the delayed condition, they had to delay their response until 10 s had elapsed. In Phase 2 of the experiment, the same questions were presented again, and participants in both conditions were forced to choose the correct answer from two alternatives. We hypothesized that in the immediate condition, FOK judgments would be affected primarily by cue familiarity, whereas the delayed condition would yield the interactive pattern observed in Experiment 1, with the effects of accessibility being stronger when familiarity was high than when it was low.

Method

Participants. Sixty Hebrew-speaking University of Haifa undergraduates (34 women and 26 men) participated in the experiment. Thirty-two were psychology students who participated for course credit, and 28 were law and economy students who were paid for their effort. None had participated in the previous experiments.

Stimulus materials. The two versions of 36 questions each from Experiment 1 were also used in this experiment, except that 15 filler questions were added to each version. These filler questions were slightly easier than the experimental questions, and their inclusion was intended to increase the tendency to make *yes* responses in Phase 1 of the experiment. Thus, the two versions of the stimulus materials included 51 questions each. In addition, for the recognition phase, only two alternatives (a target and a distractor) were used, the distractor being the most frequently chosen alternative in Experiment 1 (other than the target).

Procedure. An equal number of participants were assigned to the immediate and delayed conditions. In each of these conditions, half of the participants received one version of the questions, and the other half of the participants received the second version of the questions.

The experiment was conducted individually on an IBM-compatible PC. In the instructions to Phase 1, participants were asked to decide for each question whether they would be able to choose the correct answer between two alternatives in a subsequent recognition test and to press one key for *yes* and another key for *no*. It was explained that in Phase 2 of the experiment (i.e., the recognition test), they would gain 1 point for each correct answer but lose 1 point for each incorrect answer. However, only the questions receiving a *yes* response in Phase 1 would count in calculating their bonus. It was also explained that because the forced-choice recognition test included two alternatives, the probability of choosing the correct answer by chance was .50. Therefore, participants were advised to make a *yes* response in Phase 1 if they felt that the probability of choosing the correct answer exceeded .50. Participants were encouraged to make a response in Phase 1 that maximized their net gain in Phase 2.

In Phase 1, participants in the immediate condition were required to respond as soon as they finished reading the question. They were told that if they did not respond within 4 s, a tone would be sounded, in which case they were to respond immediately and to try to avoid getting the tone in subsequent trials. Participants in the delayed condition were told that they should respond only when the question was replaced by the phrase "My decision is ____," which occurred 10 s after presentation of the question. They were instructed to continue thinking about the question as long as it remained on the screen. In the immediate condition, response latency was measured from the presentation of the question until the participant responded.

In both phases of the experiment, the question appeared in the upper part of the screen. In the second phase, each question appeared with two possible answers: the correct answer and a lure. The lure was the most frequently selected wrong answer in Experiment 1. Participants indicated their answer by pressing one of two keys. The order of the questions was random for both phases. Five filler questions were presented at the beginning of each phase for practice.

Results

Overall, there were 12 trials in the immediate condition in which response latency in Phase 1 exceeded 4 s and 1 trial in which response latency was shorter than 250 ms. These trials were eliminated from the analyses. For the remaining trials in the immediate condition, mean response latency in Phase 1 was 2,188 ms.

Yes responses in Phase 1 served as an index of a positive FOK. Figure 4 presents the percentage of these responses as a function of referent familiarity and potential accessibility for the immediate and delayed conditions. As Figure 4 shows, FOK was higher when it was elicited after 10 s than when it was elicited immediately after the question was presented. Both referent familiarity and potential accessibility affected FOK judgments in the delayed condition as well as in the immediate condition. One can see that in the delayed condition accessibility exerted a stronger effect in the high-familiarity questions than in the low-familiarity questions, thus replicating the pattern observed in Experiment 1, whereas in the immediate condition the effects of accessibility and familiarity seemed to be additive.

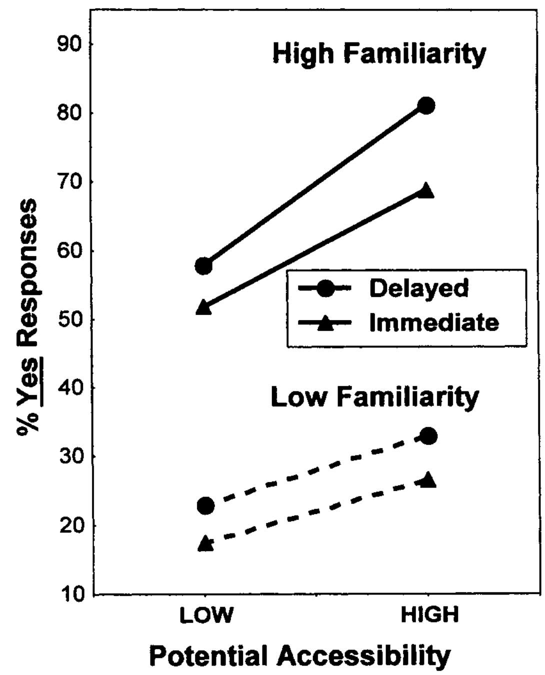

Figure 4. Percentage of *yes* responses as a function of response timing (delayed vs. immediate), referent familiarity, and potential accessibility in Experiment 2A.

A three-way ANOVA, Response Timing × Referent Familiarity × Potential Accessibility, on these data yielded $F(1, 58) = 6.54$, $MSE = 0.05$, for response timing; $F(1, 58) = 495.06$, $MSE = 0.02$, for referent familiarity; $F(1, 58) = 49.42$, $MSE = 0.03$, for potential accessibility; and $F(1, 58) = 8.44$, $MSE = 0.02$, for the interaction between referent familiarity and potential accessibility. None of the interactions involving response timing, however, were significant.

Although the expected triple interaction involving response timing, referent familiarity, and potential accessibility was not significant, we conducted separate Referent Familiarity × Potential Accessibility ANOVAs for the immediate and delayed conditions. In the delayed condition, a significant effect was found for referent familiarity, $F(1, 29) = 302.61$, $MSE = 0.02$. FOK was higher for high-familiarity questions (69.5%) than for low-familiarity questions (27.9%). A significant effect was also found for potential accessibility, $F(1, 29) = 23.33$, $MSE = 0.04$ (FOK averaged 57.0% and 40.4% for high- and low-accessibility questions, respectively), and for the interaction, $F(1, 29) = 6.81$, $MSE = 0.02$. The effects of familiarity were significant for high-accessibility questions, $F(1, 29) = 211.03$, $MSE = 0.02$, as well as for low-accessibility questions, $F(1, 29) = 89.03$, $MSE = 0.02$. Similarly, the effects of accessibility were significant for high-familiarity questions, $F(1, 29) = 25.24$, $MSE = 0.03$, and for low-familiarity questions, $F(1, 29) = 6.38$, $MSE = 0.02$. This pattern is almost identical to that found in Experiment 1.

In the immediate condition, in contrast, significant effects were found for referent familiarity, $F(1, 29) = 204.57$, $MSE = 0.02$, with high-familiarity questions yielding higher FOK (60.3%) than low-familiarity questions (21.9%), and for potential accessibility, $F(1, 29) = 28.83$, $MSE = 0.02$, with high-accessibility questions producing higher FOK (47.6%) than low-familiarity questions (34.6%). Here, however, the two effects did not interact, $F(1, 29) = 2.30$, *ns*.

We also conducted item-based ANOVAs. For the immediate condition, a Referent Familiarity × Potential Accessibility ANOVA yielded similar effects to those obtained in the subject-based ANOVA: $F(1, 68) = 81.69$, $MSE = 0.03$, for referent familiarity; $F(1, 68) = 9.48$, $MSE = 0.03$, for potential accessibility; and $F < 1$ for their interaction. A similar ANOVA for the delayed condition yielded $F(1, 68) = 87.65$, $MSE = 0.04$, for referent familiarity, and $F(1, 68) = 13.37$, $MSE = 0.04$, for potential accessibility, but their interaction failed to reach significance, $F(1, 68) = 1.36$, $MSE = 0.04$.

It is instructive to examine the response latency data for the immediate condition because they can disclose the effects of referent familiarity and potential accessibility. Mean response latencies for *yes* and *no* responses as a function of referent familiarity and potential accessibility are depicted in Figure 5.

Figure 5 shows that cue familiarity and potential accessibility exerted different effects on response latency. Thus, *yes* responses (Figure 5A) were faster for high-familiarity questions (2,141 ms) than for low-familiarity questions (2,391 ms), $F(1, 26) = 8.88$, $MSE = 94{,}691.18$, whereas potential accessibility tended to influence the latency of *yes* responses in the opposite direction, because *yes* responses were made somewhat faster for low-accessibility questions (2,195 ms) than for high-accessibility questions (2,302 ms), $F(1, 28) = 1.95$, $MSE = 60{,}646.23$ ($p < .20$). There was no interaction between effects of potential accessibility and those of referent familiarity ($F < 1$). For *no* responses (see Figure 5B), potential accessibility affected response latency in the same direction as it did for *yes* responses, with low-accessibility questions yielding faster responses (2,108 ms) than high-accessibility questions (2,302 ms), $F(1, 29) = 18.73$, $MSE = 47{,}129.56$. The effect of referent familiarity was less clear and failed to reach significance, but if anything, the trend was opposite to that observed for *yes* responses, with low-familiarity questions eliciting faster *no* responses (2,174 ms) than high-familiarity questions (2,234 ms), $F(1, 29) = 1.29$, $MSE = 62{,}443.84$. Once again, the interaction between referent familiarity and potential accessibility was marginally significant, $F(1, 27) = 2.84$, $MSE = 70{,}094.32$ ($p < .11$). Thus, it seems that whereas high referent familiarity facilitated *yes* responses and inhibited *no* responses, high potential accessibility delayed both *yes* and *no* responses. Indeed, a three-way ANOVA, Referent Familiarity × Potential Accessibility × Response Type (*yes* vs. *no*), yielded a significant effect for potential accessibility, $F(1, 29) = 18.82$, $MSE = 38{,}376.20$, and an interaction with response type for referent familiarity, $F(1, 29) = 7.14$, $MSE = 75{,}973.55$. The triple interaction was not significant, $F < 1$. This pattern of effects may have interesting implications and is taken up in the General Discussion section.

As in Experiment 1, recognition performance was close to chance (44.9%). A three-way ANOVA, Referent Familiarity ×

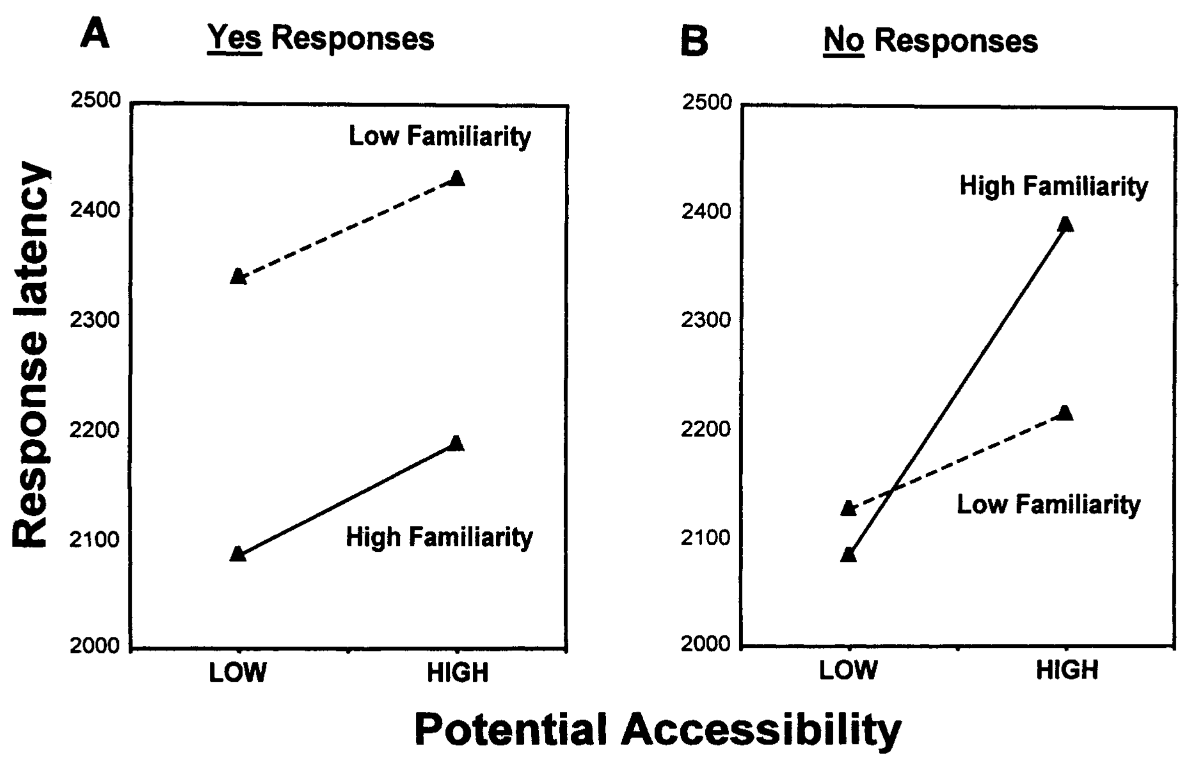

Figure 5. Mean response latency (in milliseconds) as a function of referent familiarity and potential accessibility for *yes* responses (A) and for *no* responses (B) in Experiment 2A.

Potential Accessibility × Response Type (*yes* vs. *no*), conducted with either participants or items as the basic unit of analysis did not reveal any effect on recognition performance. Percentage of correct recognition averaged 49.6% for HFHA questions, 47.3% for HFLA questions, 39.6% for LFHA questions, and 44.2% for LFLA questions in the delayed condition. The respective means in the immediate condition were 46.9%, 44.1%, 43.4%, and 46.4%.

Discussion

The results for the delayed condition closely replicated those obtained in Experiment 1, yielding significant effects for referent familiarity and potential accessibility as well as for their interaction. These results are consistent with our predictions. The results for the immediate condition, in contrast, although substantiating the expected strong effect of familiarity, exhibited a marked effect of accessibility as well, inconsistent with our predictions. Note, however, that the effects of cue familiarity and accessibility were additive, unlike what was found for the delayed condition.

The results for response latency in the immediate condition suggest that a sense of familiarity facilitates *yes* responses and inhibits *no* responses in the very first seconds after the question is presented. Reder (1987) reported similar effects of priming on the time needed to estimate that one will or will not be able to answer the question. High potential accessibility, in contrast, appears to delay both *yes* and *no* responding.

Experiment 2B

The aim of this ancillary experiment was to overcome a potential problem with the design of the immediate condition of Experiment 2A. Participants in that condition were strongly encouraged to respond as soon as they finished reading the question, and indeed, as noted earlier, their response latencies averaged 2.2 s (which included the time for reading the question). However, they were also informed that a warning tone would be sounded only when their response latency exceeded 4 s. This time limit may have permitted them to initiate a memory search on some trials, which could be responsible for the unexpected effect of accessibility on FOK.[2] In an effort to tap the kind of rapid preliminary FOK that has been investigated in Reder's (Reder, 1987; Reder & Ritter, 1992; Schunn et al., 1997) studies, we designed a speeded–immediate condition that closely replicated the conditions that were used by Reder (1987, Experiment 4). If preliminary FOK is determined solely by the degree of familiarity induced by a question, then we should find little effect of accessibility on FOK in this experiment.

Method

Participants. Twenty Hebrew-speaking University of Haifa psychology undergraduates (15 women and 5 men) participated in the experiment for course credit. None had participated in the previous experiments.

Stimulus materials. The stimulus materials were the same as those used in Experiment 2A.

Procedure. The procedure was the same as that used in the immediate condition of Experiment 2A except that the participants' response latency on each trial was displayed on the screen 2 s after the participants had responded, and participants were to try to reduce their response latency further on subsequent trials. No warning tone was used.

Results

There was only one trial across participants, and questions that exceeded 4 s and the data for that trial were eliminated from the analyses. For the remaining trials, response latency averaged 1,700 ms, which is very similar to that obtained by Reder (1987, Experiment 4).

The results (see Figure 6) revealed the exact same pattern as that of the immediate condition of Experiment 2A. A two-way ANOVA, Referent Familiarity × Potential Accessibility on percentage of *yes* responses, revealed a significant effect for referent familiarity, $F(1, 19) = 73.14$, $MSE = 0.03$, with the high- and low-familiarity questions averaging 67.8 and 35.2, respectively. More important, the ANOVA also yielded a significant effect for potential accessibility, $F(1, 19) = 4.46$, $MSE = 0.03$, with high-accessibility questions producing higher FOK ($M = 55.4$) than low-accessibility questions ($M = 47.6$). The interaction was not significant, $F(1, 19) = 2.72$, $MSE = 0.02$. A similar analysis conducted with items as the unit of analysis yielded the same pattern: $F(1, 68) = 57.88$, $MSE = 0.04$, for referent familiarity; $F(1, 68) = 4.40$, $MSE = 0.04$, for potential accessibility; and $F < 1$ for their interaction.

These results are very similar to those of Experiment 2A, substantiating the finding that potential accessibility affects early FOK. It seems that the fast responding of participants in this experiment had little impact on the independent and combined influences exerted by referent familiarity and potential accessibility. Indeed, comparing the results for the immediate condition of Experiment 2A with those of the speeded–immediate condition of Experiment 2B, a three-way ANOVA, Response Timing × Potential Accessibility × Referent Familiarity, yielded little evidence for a three-way interaction ($F < 1$).

The results for the response latency data of Experiment 2B were also consistent with those found in the immediate condition of Experiment 2A. Mean response latencies for *yes* and *no* responses are depicted in Figure 7. As in Experiment 2A, *yes* responses (Figure 7A) were faster for high-familiarity questions (1,617 ms) than for low-familiarity questions (1,806 ms), $F(1, 18) = 4.34$, $MSE = 147{,}679.98$, $p < .06$. As in Experiment 2A, potential accessibility tended to influence latency of *yes* responses in the opposite direction: Responses to low-accessibility questions were slightly faster (1,668 ms) than those to high-accessibility questions (1,746 ms), $F(1, 19) = 1.47$, $MSE = 130{,}622.67$, although here too this effect was not significant. The interaction between potential accessibility and referent familiarity was not significant, $F(1, 16) = 1.22$, $MSE = 146{,}427.77$ (note that 95% confidence intervals for the means in Figure 7A were fairly large—1,419 ms). For *no* responses (see Figure 7B), none of the effects were significant. Low- and high-familiarity questions yielded very similar response latencies (1,786 ms and 1,770 ms, respectively), and low-accessibility questions yielded responses slightly faster (1,731 ms) than high-accessibility questions (1,828 ms). Although less pro-

[2] We thank Lynne Reder for proposing this experiment.

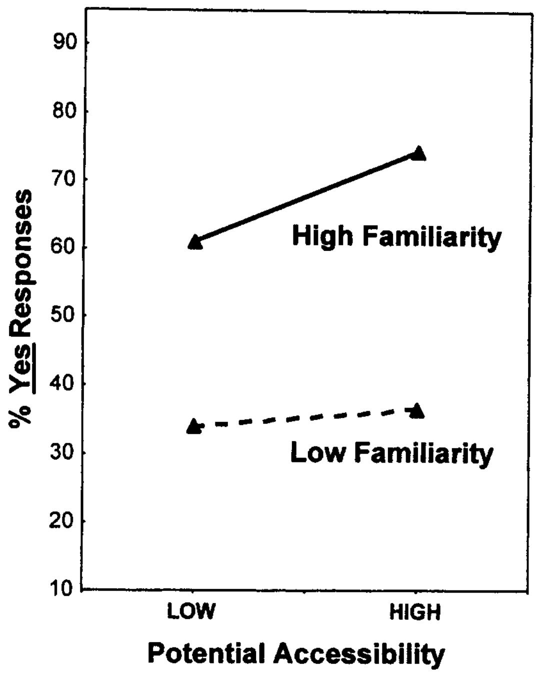

Figure 6. Percentage of *yes* responses as a function of referent familiarity and potential accessibility in Experiment 2B.

nounced than those of Experiment 2A, these results reinforce the pattern described earlier, of high referent familiarity facilitating *yes* responses and inhibiting *no* responses, whereas potential accessibility slowed both types of responses. A three-way ANOVA, Referent Familiarity × Potential Accessibility × Response Type (*yes* vs. *no*), yielded a marginally significant interaction between response type and referent familiarity, $F(1, 18) = 4.18$, $MSE = 64{,}790.94$, $p < .06$.

Recognition performance was again close to chance (47.1%). Percentage of correct recognition was similar for the different types of questions and averaged 51.4% for HAHF questions, 46.1% for HFLA questions, 42.4% for LFHA questions, and 48.4% for LFLA questions. A three-way ANOVA, Referent Familiarity × Potential Accessibility × Response Type (*yes* vs. *no*), conducted with either participants or items as the basic unit of analysis yielded no significant effects.

General Discussion

What makes people feel that they know the answer to a question when they fail to retrieve it from memory? In this study, we focused on two accounts of FOK: the cue-familiarity account and the accessibility account. These two accounts have, in fact, much in common because according to both accounts FOK is seen to rely on an inferential process rather than on direct access to memory traces. Furthermore, both accounts emphasize the operation of nonanalytic heuristics that are applied implicitly to form an FOK judgment (see Koriat, 1998b; Koriat & Levy-Sadot, 1999; Nhouy-

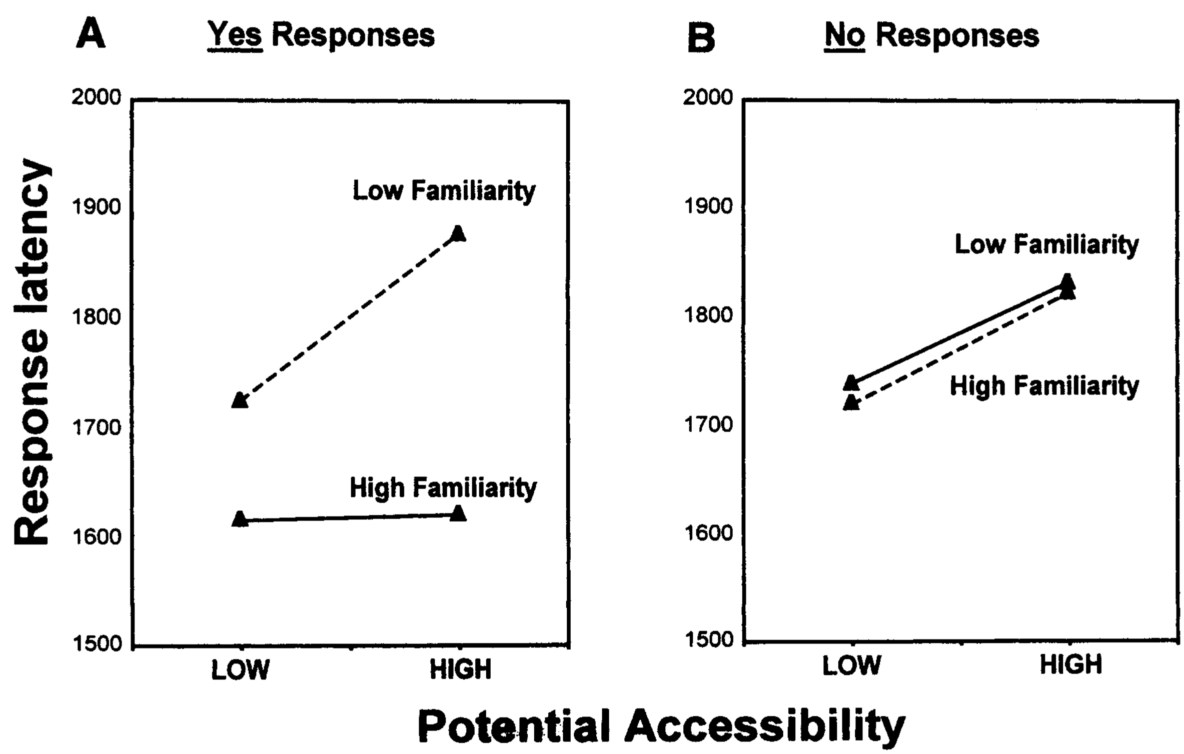

Figure 7. Mean response latency (in milliseconds) as a function of referent familiarity and potential accessibility for *yes* responses (A) and for *no* responses (B) in Experiment 2B.

vanisvong & Reder, 1998). These heuristics contrast with the kind of content-based, deliberate inferences that apparently occur at later stages of FOK judgments, when specific pieces of information are retrieved and consulted to form an educated guess regarding the probability of recalling or recognizing the solicited target in the future (see Costermans, Lories, & Ansay, 1992; Nelson et al., 1984).

One feature that ensues from the nonanalytic nature of the cue-familiarity and accessibility heuristics is that the effective cues in both cases are assumed to influence FOK irrespective of their source or validity. Thus, a critical feature of the accessibility account is that FOK is based on the overall amount of accessed information regardless of its correctness and regardless of its source. Such is also true of the cue-familiarity account: A sense of familiarity associated with a question is assumed to enhance FOK whether familiarity is derived from a previous encounter with the topic of the question (Nelson et al., 1984) or from a temporary spurious activation, such as advance priming of its components (Ayers & Reder, 1998; Reder & Ritter, 1992). This feature of the accessibility and cue-familiarity heuristics has been used to explain illusions of knowing, that is, instances in which FOK is unduly high (Koriat, 1998a, 1998b).

The cue-familiarity and accessibility accounts differ, however, in the nature of the underlying heuristic that is postulated. In the cue-familiarity account, the focus is on characteristics of the question that, in principle, may operate prior to attempted retrieval. The accessibility account, in contrast, focuses on the products of retrieval—the amount of partial clues retrieved and the ease with which they come to mind. The assumption is that only by attempting to retrieve the target from memory can people appreciate the likelihood that it will be recalled or recognized in the future.

Each of these two accounts has marshaled supporting experimental evidence that must be taken into account in any general analysis of the basis of FOK. Yet, the two accounts have been generally treated as alternative, competing hypotheses (e.g., Maki, 1999; Schwartz & Metcalfe, 1992). This study, in contrast, was predicated on the assumption that the two postulated mechanisms are, in fact, complementary, each making a separate and distinct contribution to FOK, and, furthermore, that they may interact in affecting FOK. According to the interactive model proposed, preliminary FOK is determined primarily by cue familiarity. Subsequently, if the question evokes a sufficient degree of familiarity, a deliberate interrogation of memory for the solicited target begins (Reder, 1987; Reder & Ritter, 1992; Schunn et al., 1997), which may result in the accumulation of partial information, thus allowing for the effects of accessibility to manifest themselves. Hence, we expected accessibility and familiarity to interact such that the accessibility of potential answers would affect FOK only or primarily when the familiarity of the question's referent was high.

The experimental paradigm we used to examine these propositions differs from that used in previous research in two respects. First, in previous studies of the cue-familiarity account, familiarity was manipulated by advance priming of the memory pointer or some of its components (Metcalfe et al., 1993; Reder, 1987; Reder & Ritter, 1992; Schwartz & Metcalfe, 1992). In this study, in contrast, we manipulated cue familiarity more directly by using referents that had been rated as generally familiar or unfamiliar. Second, this study is the first to orthogonally manipulate cue familiarity and accessibility so as to allow investigation of their independent as well as interactive effects on FOK. Interestingly, Schwartz and Smith (1997) examined the effects of a similar manipulation on the tip-of-the-tongue phenomenon and also found an interactive pattern, though one different from ours. In their study, accessibility affected the likelihood of a tip-of-the-tongue response only when cue familiarity was low and not when it was high. The reasons for the different results obtained in that study and those found here are unclear.

Our results generally support the proposed model, yielding evidence for the influence of both cue familiarity and accessibility on FOK. First, strong effects of familiarity were found in Experiments 1, 2A, and 2B. Thus, cue-familiarity effects were replicated in this study by using a different operational definition of familiarity from the one commonly used in previous studies. The effects of familiarity were strong and were observed under all conditions. More important, they were found for the immediate conditions of Experiments 2A and 2B, suggesting that cue familiarity affects preliminary preretrieval FOK (see Nhouyvanisvong & Reder, 1998; Reder, 1987, 1988; Reder & Ritter, 1992; Reder & Schunn, 1996; Schunn et al., 1997). But they were also found for omission trials in Experiment 1, indicating that cue familiarity also affects FOK elicited after recall failure (see Schwartz & Metcalfe, 1992).

Second, accessibility also exerted systematic effects on FOK in both Experiments 1 and 2. The interpretation of this effect is based on the assumption that category size is indicative of the number of potential answers accessed during the search for a likely answer. Indeed, in Experiment 1, potential accessibility affected both FOK following recall failure and the likelihood of producing an answer.

The finding that FOK increased with the size of the category from which the answer was drawn contrasts with predictions of the competition approach to FOK (Schreiber, 1998; Schreiber & Nelson, 1998). It is still a puzzle why in studies involving list- and paired-associates learning FOK was found to decrease with the number of associates that were related to the cue. Maki (1999) proposed that perhaps this is because in these studies only one of the responses associated with the cue could be correct (hence producing a competition). In contrast, in Koriat's (1993) experiments, in which accessibility was defined in terms of the number of letters that participants could retrieve from a letter string, more than one letter could be correct. Note, however, that this explanation cannot be applied to the results of the present study in which only one of the potential candidates could serve as the correct answer.

Third, both Experiments 1 and 2 supported the hypothesized interaction between the two mechanisms: The effects of accessibility were generally stronger when cue familiarity was high than when it was low. This pattern is consistent with the idea that a relatively high level of familiarity is necessary to drive memory search (Nhouyvanisvong & Reder, 1998; Reder, 1987) and to allow the effects of potential accessibility to contribute to FOK (but see later discussion).

Finally, Experiments 2A and 2B yielded results suggesting that the predicted interaction between cue familiarity and accessibility is likely to be found only when there is sufficient time for cue familiarity to drive memory search. This interaction was less apparent in conditions that pressed participants to make rapid FOK judgments, presumably before they had a chance to initiate memory search.

Although the results are generally consistent with the proposed model, there are two findings that seem to point to certain limitations of the model. First, in both Experiments 1 and 2A, potential accessibility exerted consistent, albeit weaker, effects on FOK, even when cue familiarity was low. This should not have occurred if the effects of accessibility were strictly conditional on high cue familiarity. Second, the effects of accessibility were not confined to the conditions in which FOK was delayed but were also observed in the immediate conditions of Experiments 2A and 2B. It should be stressed, however, that consistent with the model, unlike what was observed in the delayed conditions, in the two immediate conditions the effects of accessibility did not interact with those of referent familiarity.

We would like to propose that the effects of accessibility observed under low familiarity conditions as well as under conditions requiring fast responding are due to an aspect of accessibility that has not received due attention in our conceptualization. Specifically, the model proposed focused narrowly on the kind of potential accessibility that unfolds as a result of an effortful, deliberate search through the set of potential answers. It is this focus that allowed us to distinguish more clearly between cue familiarity and accessibility.

However, the operational definition of accessibility in terms of the number of category members does not take into account the myriad of partial clues that may be automatically activated by a question prior to the deliberate consideration of specific candidate answers (see Koriat, 1993). Such activations (e.g., partial phonological clues, related episodic and semantic information) may emerge on-line during the reading of the question and may contribute to FOK irrespective of referent familiarity. We have reason to believe that questions involving large and small categories differ not only in the number of candidate answers that are accessed when an effortful search begins but also in the amount of clues that they automatically bring to mind during the initial encoding of the question: Questions with large category terms also tend to evoke more automatic activations than those with small category terms.

We propose, then, that the effects of accessibility observed in the immediate condition and in the low-familiarity questions are due to the automatic component of accessibility, that is, the amount of relatively inarticulate activations aroused by a memory pointer on-line. This component is expected to affect FOK independent of referent familiarity. The effortful component, in contrast, involves the amount of relatively articulate clues that emerge as a result of the deliberate search for the target, primarily potential answers (Koriat & Goldsmith, 1996). The effects of such clues on FOK are manifested only after a familiarity-driven search for the target.

The results of Experiment 2A indicated higher FOK in the delayed condition than in the immediate condition. This finding may be taken to suggest that FOK is updated continuously and agrees with our notion that the effortful accessibility component makes its contribution on top of that of familiarity and automatic accessibility. Note, however, that the mean FOK obtained with the speeded–immediate condition (Experiment 2B) was relatively high, inconsistent with this suggestion.

The foregoing analysis leads to a conception of FOK as being multiply determined (Nelson et al., 1984). Not only should we distinguish between information-based analytic determinants and heuristically driven nonanalytic determinants of FOK (Koriat & Levy-Sadot, 1999), but it is also useful to distinguish between different variants within the latter category. In this study, we distinguished primarily between the familiarity and accessibility heuristics, although, as we explained, the results suggest a further subtle distinction within the latter category (see also Nhouyvanisvong & Reder, 1998).

Although further work is clearly needed to delineate more precisely the differences between the processes proposed here, we briefly outline a tentative view about how these processes might be distinguished. As far as familiarity is concerned, we propose to reserve this term to the meaning it has gained within the widely accepted view elaborated by Jacoby and his associates (see Kelley & Jacoby, 1998). According to this view, familiarity represents the phenomenological outcome of ease of processing (or perceptual fluency; see Benjamin & Bjork, 1996). Prior exposure to a stimulus enhances its subsequent ease of processing, which may then lead to a sense of familiarity (Jacoby & Whitehouse, 1989). The finding that advance priming of a question's components enhances FOK (Reder, 1987; Schwartz & Metcalfe, 1992) agrees with this definition of familiarity as a determinant of FOK.

Whereas familiarity corresponds with Benjamin and Bjork's (1996) notion of perceptual fluency, accessibility is more in line with their notion of retrieval fluency. Accessibility is conceptually distinct from the sheer familiarity of the cue; it refers to the amount of information that the cue brings to mind as well as the ease with which that information is accessed.

In real life, however, cue familiarity and accessibility generally go hand in hand. For example, several variables, such as the frequency and recency of occurrence of a stimulus, enhance familiarity as well as accessibility (see Benjamin & Bjork, 1996; Reder, 1987). Even the priming of a stimulus, usually regarded as a straightforward manipulation of its familiarity (Metcalfe et al., 1993; Reder, 1987), probably also affects the number of associations it invokes (see data by Schwartz & Smith, 1997, Experiment 3, and by Metcalfe et al., 1993, supporting this possibility). Nevertheless, we find it important to distinguish between cue familiarity and both components of accessibility for several reasons. First, cue familiarity and effortful accessibility can be differentially manipulated as was done in this study. Although in our study the accessibility manipulation presumably affected both components of accessibility, we can envisage other manipulations that distinguish specifically between familiarity (or perceptual fluency) and automatic accessibility. Consider, for example, the study by Whittlesea et al. (1990) in which the visual clarity of test words in a recognition memory test was varied. The results indicated that visual clarity affected the tendency to classify the word as old, possibly because it enhanced its fluent processing. It is quite likely that increased visual clarity enhances familiarity without enhancing automatic accessibility. Second, the empirical results obtained in our study support the fruitfulness of the distinction between cue familiarity and effortful accessibility, suggesting that the effects of accessibility are moderated by familiarity level and that the effects of the two heuristics may have a different time course.

In sum, the results of this study are consistent with a general view outlined by Koriat (1998b) in which different mechanisms are assumed to affect FOK in a cascaded manner (see also Nhouyvanisvong & Reder, 1998). Rapid preliminary FOK is affected by cue familiarity and perhaps also by the automatic activations evoked during the encoding of the question. When the question evokes a very low sense of familiarity, a fast "don't know" response may be issued (Glucksberg & McCloskey, 1981; Klin et al., 1997). In contrast, when familiarity is high enough to induce a positive preliminary FOK, memory interrogation is initiated (Reder, 1987). The amount of accessible clues as well as their ease of access can then be used to update the initial FOK. At this point, the clues operate as an "undifferentiated mass" (see Jacoby & Brooks, 1984), affecting FOK regardless of their content or their source, and hence also regardless of the extent to which they agree with one another. At a subsequent stage, the process underlying FOK may become more analytic, influenced by explicit consideration of the content of the clues that come to mind. The process underlying FOK may not proceed any further than yielding a preliminary FOK (e.g., when preliminary FOK is low) or yielding a heuristic-driven positive FOK. Thus, FOK would seem to be multiply determined. It is affected by several processes that differ in their quality as well as in their time course, and these processes may contribute to FOK either independently or interactively.

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(Appendix follows)

Appendix

Questions Used, Their Type, and Percentage of Correct Answers Produced in the Norming Experiment

Question	Type of question	% correct recall
In which U.S. state is Yale University located?	HFHA	0.0 (0.0)
In which U.S. state is Rutgers University located?	LFHA	0.0 (0.0)
Who is the current president of Yale University?	HFLA	0.0 (0.0)
Who is the current president of Rutgers University?	LFLA	0.0 (0.0)
Who is the leading actor in the movie "West-Side Story?"	HFHA	0.0 (0.0)
Who is the leading actor in the movie "Patient David?"	LFHA	0.0 (0.0)
Who is the photographer who filmed "West-Side Story?"	HFLA	0.0 (0.0)
Who is the photographer who filmed "Patient David?"	LFLA	0.0 (0.0)
In which of Israel's holidays is the liturgy of "Yedid Nefesh" read?	HFHA	9.1 (0.3)
In which of Israel's holidays is the liturgy of "Melech Azur Bigvura" read?	LFHA	10.0 (0.3)
Which rabbi is said to have written the liturgy "Yedid Nefesh?"	HFLA	0.0 (0.0)
Which rabbi is said to have written the liturgy "Melech Azur Bigvura?"	LFLA	0.0 (0.0)
In which Israeli settlement did David Ben-Gurion live when he arrived in Israel?	HFHA	0.0 (0.0)
In which Israeli settlement did Moshe Yehuda Helman live when he arrived in Israel?	LFHA	11.1 (0.3)
In which city in Poland was David Ben-Gurion born?	HFLA	0.0 (0.0)
In which city in Poland was Moshe Yehuda Helman born?	LFLA	0.0 (0.0)
Who composed the music for the ballet "Swan Lake?"	HFHA	63.6 (0.5)
Who composed the music for the ballet "The Legend of Joseph?"	LFHA	0.0 (0.0)
Who was the choreographer of the ballet "Swan Lake?"	HFLA	10.0 (0.3)
Who was the choreographer of the ballet "The Legend of Joseph?"	LFLA	0.0 (0.0)
To which of Israel's tribes did Samuel the prophet belong?	HFHA	0.0 (0.0)
To which of Israel's tribes did Yoash Avi Haezri belong?	LFHA	0.0 (0.0)
According to the Bible, in which city of the kingdom of Israel was Samuel the prophet born?	HFLA	0.0 (0.0)
According to the Bible, in which city of the kingdom of Israel was Yoash Avi Haezri born?	LFLA	0.0 (0.0)
Who was the director of the film "The Deer Hunter?"	HFHA	0.0 (0.0)
Who was the director of the film "Broken Arrow?"	LFHA	0.0 (0.0)
Which production company produced the film "The Deer Hunter?"	HFLA	0.0 (0.0)
Which production company produced the film "Broken Arrow?"	LFLA	20.0 (0.4)
Who is the Hebrew poetess who wrote the song "Bo Elay Parpar Nechmad?"	HFHA	0.0 (0.0)
Who is the Hebrew poetess who wrote the song "Al Hapricha?"	LFHA	10.0 (0.3)
What is the prosodic structure of the song "Bo Elay Parpar Nechmad?"	HFLA	0.0 (0.0)
What is the prosodic structure of the song "Al Hapricha?"	LFLA	0.0 (0.0)
In which U.S. city is the center of the computer company IBM located?	HFHA	0.0 (0.0)
In which U.S. city is the center of the computer company Adobe located?	LFHA	0.0 (0.0)
Who is the president of the computer company IBM?	HFLA	0.0 (0.0)
Who is the president of the computer company Adobe?	LFLA	0.0 (0.0)
In which Hebrew month does the holiday of Shavuot occur?	HFHA	36.4 (0.5)
In which Hebrew month does "The Fifth Fast" occur?	LFHA	60.0 (0.5)
What is the Sabbath before the holiday of Shavuot called?	HFLA	0.0 (0.0)
What is the Sabbath after "The Fifth Fast" called?	LFLA	0.0 (0.0)

Appendix (*continued*)

Question	Type of question	% correct recall
In which of Israel's wars did the Phantom aircraft participate for the first time?	HFHA	20.0 (0.4)
In which of Israel's wars did the Durnir 27 aircraft participate for the first time?	LFHA	36.4 (0.5)
What is the Hebrew name for the Phantom aircraft?	HFLA	36.4 (0.5)
What is the Hebrew name for the Durnir 27 aircraft?	LFLA	0.0 (0.0)
Which gate of the old city wall of Jerusalem is the closest to Al Akza mosque?	HFHA	0.0 (0.0)
Which gate of the old city wall of Jerusalem is the closest to the church of Gat Shmanim (Gethsemane)?	LFHA	20.0 (0.4)
Which gate of the Temple Mount in Jerusalem is closest to Al Akza mosque?	HFLA	0.0 (0.0)
Which gate of the Temple Mount in Jerusalem is closest to the church of Gat Shmanim (Gethsemane)?	LFLA	27.3 (0.5)
In which book of the Bible does the term "Ad Efes Makom" appear?	HFHA	0.0 (0.0)
In which book of the Bible does the term "Lemaan Yarutz Kore Bo" appear?	LFHA	0.0 (0.0)
Which of Israel's prophets said "Ad Efes Makom?"	HFLA	36.4 (0.5)
Which of Israel's prophets said "Lemaan Yarutz Kore Bo?"	LFLA	0.0 (0.0)
Which Hebrew writer wrote the book "Hatzanchanit Shelo Shava?"	HFHA	0.0 (0.0)
Which Hebrew writer wrote the book "Hamasa Hamufla Shel Yaldey Shechunat Hapoalim?"	LFHA	0.0 (0.0)
Which prize did the book "Hatzanchanit Shelo Shava" win?	HFLA	0.0 (0.0)
Which prize did the book "Hamasa Hamufla Shel Yaldey Shechunat Hapoalim" win?	LFLA	0.0 (0.0)
What color is the flower "Tzivoni Sasgoni?"	HFHA	0.0 (0.0)
What color is the flower "Zuta Meoreket?"	LFHA	0.0 (0.0)
To which family of flowers does the "Tzivoni Sasgoni" belong?	HFLA	0.0 (0.0)
To which family of flowers does the "Zuta Meoreket" belong?	LFLA	0.0 (0.0)
Which East Asian country is the closest to the Japanese city of Hiroshima?	HFHA	10.0 (0.3)
Which East Asian country is the closest to the Japanese city of Kore?	LFHA	9.0 (0.3)
In which of the Japanese islands is the city of Hiroshima located?	HFLA	9.0 (0.3)
In which of the Japanese islands is the city of Kore located?	LFLA	0.0 (0.0)
Which internal organ of the body produces the growth hormone?	HFHA	40.0 (0.5)
Which internal organ of the body produces the hormone oxytocin?	LFHA	30.0 (0.5)
Which physiologist discovered the growth hormone?	HFLA	0.0 (0.0)
Which physiologist discovered the hormone oxytocin?	LFLA	0.0 (0.0)
In which stream is Hamatmon cave located?	HFHA	10.0 (0.3)
In which stream is Hagdi cave located?	LFHA	90.9 (0.3)
Which archeologist headed the dig in Hamatmon cave?	HFLA	0.0 (0.0)
Which archeologist headed the dig in Hagdi cave?	LFLA	0.0 (0.0)

Note. Standard deviations are in parentheses. HFHA = high familiarity–high accessibility; LFHA = low familiarity–high accessibility; HFLA = high familiarity–low accessibility; LFLA = low familiarity–low accessibility.

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