CHAPTER TWENTY-ONE

Metamemory: The feeling of knowing and its vagaries

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The study of the "feeling of knowing" (FOK) provides insights regarding some of the fundamental issues concerning the subjective monitoring of one's own knowledge. How accurate are FOKs? What are the processes underlying their accuracy? Recent work suggests that metacognitive judgments do not reflect direct access to the underlying memory traces, but are mediated by inferential heuristics, which generally work. Sometimes, however, these heuristics result in serious dissociations between knowing and the FOK. These dissociations may have troubling consequences, because people generally trust their subjective feelings, and use them to control their behaviors.

L'étude du "sentiment de savoir" (SdS) éclaire quelques-unes des questions fondamentales portant sur le contrôle continu qu'un individu exerce sur ses connaissances. Dans quelle mesure le SdS est-il exact? Quels sont les processus responsables de cette exactitude? Des travaux récents suggèrent que les jugements métacognitifs ne reflètent pas un accès direct aux traces mnémoniques sous-jacentes; leur servent plutôt d'intermédiaires des heuristiques inférentielles qui fonctionnent habituellement bien. Il arrive parfois que ces heuristiques entraînent cependant de sérieuses dissociations entre le fait de savoir et le SdS. Ces dissociations peuvent avoir des conséquences problématiques parce que les gens ont en général confiance en leurs sentiments et les utilisent pour contrôler leurs comportements.

At any point in time we can retrieve from memory only a small portion of what is stored there. Often we fail to retrieve a piece of information although we may be able to recall it at some later time or recognize it among distractors. Such episodes of recall failures are sometimes accompanied by a strong conviction that the needed information is available in memory. This is what happens, for example, in the of tip-of-the-tongue (TOT) state, when we struggle to retrieve an elusive name or word from memory. The TOT state has attracted attention

because it combines two seemingly inconsistent features: On the one hand, the person is unable to retrieve the sought for target. On the other hand, he or she experiences a strong feeling of knowing, and can sometimes monitor the emergence of the elusive target into consciousness.

The discrepancy between subjective and objective indices of knowledge that occurs in the TOT state raises the question of how do I know that I know a name or a word in the face of being unable to produce it? Experimental work on the feeling of knowing (FOK) has addressed this question, and more generally, has attempted to unravel the mechanisms responsible for the FOK and its accuracy. The importance of this work is that it would seem to contribute to our understanding of the interface between subjective and objective knowledge. In particular, it may shed some light on the role of consciousness in information processing, and on the distinction between explicit and implicit memory. After all, the major feature distinguishing between explicit and implicit memory is that in the case of explicit memory not only do I possess some information about the past but I also subjectively know that I know it, whereas in implicit memory I may possess information without knowing that I know it. Perhaps, then, the study of the relationship between knowledge and metaknowledge can provide clues to some of the basic issues about consciousness and subjective experience.

THE TWO FACES OF METACOGNITION

What, then, is the status of metacognition *vis-à-vis* the distinction between explicit and implicit modes of knowing? Several quotes from recent work of leading experts, all taken from Reder (1996), reveal a basic confusion. Thus, Kelley and Jacoby (1996b, p. 287), discussing the relationship between implicit memory and metacognition noted:

> How does [the work on implicit memory] relate to questions about metacognition? After agreeing to write this chapter, we went through a long period thinking the answer was "it doesn't". As the deadline for the chapter drew near, we became more creative (desperate?) in our analysis, and have now arrived at the position that metacognition and implicit memory are so similar as to not be separate topics.

Funnell, Metcalfe, and Tsapkini (1996, p. 172), on the other hand, concluded:

> We understand the feeling-of-knowing judgment to be an explicit task and to rely on *explicit* knowledge. Indeed the judgment of what and how much you know about what you know or will know is a classic, almost definitional, explicit task . . . Because feeling-of-knowing judgments are explicit, it is unlikely that subliminal activation could affect these judgments.

A different opinion, still, was expressed by Reder and Schunn (1996, p. 50):

> Given that feeling of knowing, like strategy selection, tends to be thought of as the essence of a metacognitive strategy, it is important to defend our claim that this rapid feeling of knowing is actually an *implicit process* rather than an *explicit process* . . . The decision-making process involves rapid and automatic flow of activation rather than slow and controlled decision making about discrete features in the environment.

These quotations imply a fundamental ambivalence about the status of metacognitive judgments. In the conceptual scheme that I would like to propose here, I argue that this ambivalence actually discloses the two faces of metacognition: Metacognitive judgments, such as judgments of learning (Benjamin & Bjork, 1996; Koriat, in press b; Nelson & Dunlosky, 1991), feeling of knowing (Metcalfe, 1996; Schwartz, 1994), subjective confidence (Baranski & Petrusic, in press; Gigerenzer, Hoffrage, & Kleinbölting, 1991), and the variety of subjective monitoring processes that accompany thought and action, occupy a unique position in the distinction between implicit and explicit processes. Generally speaking, we may distinguish between two modes of operation, an explicit mode and an implicit mode. The explicit mode of operation underlies much of our conscious-controlled activities: When we have a clear goal, we evaluate the options, choose the most appropriate course of action, and guide our behavior accordingly.

In the implicit mode of operation, in contrast, various factors registered below full consciousness may influence our behavior directly. Bargh and Gollwitzer (1994, p. 72) stated:

> We argue that goal-directed action can be triggered directly by environmental stimuli, without the need of conscious involvement. Given a specific set of situational features, an individual may behave in ways he or she did not consciously choose or intend or may not be aware of the reasons for that behavior at the time.

Recent work in social psychology supports this statement: For example, in a study by Bornstein, Leone, and Galley (1987) subjects were subliminally presented with a photograph of one of two confederates with whom they later interacted. They were found then to express greater agreement with the primed than with the unprimed confederate. Similarly, in a recent study by Bargh, Chen, and Burrows (1996), the activation of the elderly stereotype through advance priming caused subjects to walk more slowly across the hall when the experiment was over, compared to a control group. These and other findings reviewed by Bargh (1997) indicate that a variety of processes can affect behavior *directly* and *automatically* without the mediation of consciousness.

Where do metacognitive judgments lie in this simplistic scheme? I propose that metacognitive judgments, particularly those that are based on a sheer gut feeling, occupy a unique position in mediating between implicit and explicit modes of

operation: They are generally implicit as far as their antecedents are concerned, but explicit as far as their consequences are concerned. Thus, metacognitive judgments like subjective confidence and the feeling of knowing may be influenced and shaped by implicit factors that operate below full consciousness. Once formed, however, these judgments can serve as the basis for controlled, conscious action. It is this crossover function of metacognitive judgments that is responsible for the confusion that I noted about the status of metacognition, and it is also what makes metacognitive judgments interesting and important.

Let me first illustrate the implicit segment of the crossover mode. As I have indicated, unconscious activations may influence behavior directly and automatically. In addition, however, such activations may also shape subjective experience and inform metacognitive judgments. For example, in several studies (e.g. Reder, 1987; Schwartz & Metcalfe, 1992) people were asked to answer general-information questions. FOK judgments about the answer were found to increase when some of the words of the question had been primed in the context of an allegedly unrelated task. Similarly, in a study by Kelley and Lindsay (1993) people expressed stronger confidence in the correctness of their answer if that answer had been primed previously in the context of an unrelated task. This occurred both when the primed answer was correct and when it was wrong.

Let me turn now to the explicit segment of the crossover mode. Metacognitive processes are clearly explicit in terms of the two components of metacognition—monitoring and control (see Nelson & Narens, 1990). Monitoring refers to the subjective feelings that accompanies learning and remembering, whereas control refers to operational decisions that follow from such feelings. As far as monitoring is concerned, the phenomenal quality of metacognitive judgments clearly makes them part of the explicit mode. Thus, although I may not know the reason for my strong feeling of knowing about an elusive name, the feeling itself is part and parcel of conscious, subjective experience.

As far as the control aspect is concerned, a common assumption among students of metacognition is that metacognitive judgments play a causal role in determining and guiding behavior, and constitute an important basis for controled processes (see Nelson, 1996). For example, when studying a list of paired-associates under self-paced conditions, subjects allocate study time to different items in accordance with the judgments of learning associated with each item (e.g. Mazzoni & Cornoldi, 1993; Nelson & Leonesio, 1988). Also, in answering general-information questions, people spend more time searching when they have a strong FOK than when they have a weak FOK (e.g. Costermans, Lories, & Ansay, 1992; Gruneberg & Monks, 1974; Nelson, Gerler, & Narens, 1984).

Some recent findings from our laboratory can help illustrate the causal role played by metacognitive judgments (Koriat & Goldsmith, 1996). We speculated that a person on a witness stand, who is sworn to tell the whole truth and nothing but the truth, must deliberate whether to volunteer a piece of information that comes to mind or not. How does he do that? Possibly on the basis of his feelings about the correctness of the information. To simulate this process, we asked

students to answer general-information questions under the instructions that they will win one Israeli Shekel for each correct answer, but will lose one Shekel for each wrong answer they produce. In one condition they were forced to answer all questions, whereas in another they had the option to skip answers. As expected, those who had the option to choose which questions to answer were more accurate, and therefore made more money. How did they do that? Apparently they monitored the correctness of each candidate answer and withheld those answers that were likely to be wrong. Indeed, the within-subject gamma correlation between the confidence associated with an answer, measured in one phase of the experiment, and the tendency to report that answer in a second phase of the experiment was .93 for recognition, and .97 for recall! Thus, people rely heavily on their confidence judgments in deciding which answers to volunteer. This is obviously a good policy because people's confidence judgments are generally accurate. In this manner, metacognitive accuracy can help people enhance the accuracy of what they report.

There are conditions, however, in which people's confidence judgments have little validity in distinguishing between correct and incorrect answers (see e.g. Fischhoff, Slovic, & Lichtenstein, 1977). What happens then? We found that even then subjects rely very heavily on their confidence judgments, volunteering answers that they believe are right and withholding those that they believe are wrong. Of course, now our subjects ended up losing a great deal of money (or at least they would have if we had made them pay their losses). Thus, people are blind followers of their metacognitive judgments and intuitions, and these judgments may have profound effects on behavior. Therefore, the importance of metacognitive judgments for researchers is that they provide an excellent predictor of one's behavior regardless of whether they are right or wrong.

In sum, I propose that metacognitive judgments lie at the interface between implicit and explicit modes of knowing. They sometimes play the role of a go-between, allowing a transition from automatic influences to controlled, reasoned behavior.

THE EXPERIMENTAL INVESTIGATION OF THE FEELING OF KNOWING

In view of the fact that metacognitive judgments play a causal role in controlling information processing and behavior, it is important to examine the accuracy or validity of these judgments. The systematic investigation of the effectiveness of subjective monitoring following recall failure began with the classic studies of Brown and McNeill (1966) on the TOT state, and Hart's studies (1965) on the feeling of knowing. An important contribution of these studies is that they introduced experimental paradigms for examining the relationship between subjective and objective indices of knowing. In both paradigms subjects are presented with a memory pointer (see Koriat & Lieblich, 1977), that is, a cue intended to point to a particular memory entry that the subject must attempt to retrieve. In TOT

studies, the focus is on the accuracy of the partial information retrieved when recall of the complete target fails. Thus, in Brown and McNeill's study the pointer consisted of a word definition, and the solicited target was the corresponding word. When subjects signaled that the elusive word was on the tip of their tongue, they were able to retrieve some partial structural information about the word, such as its initial letter, the number of syllables it contained, and so on. Koriat and Lieblich (1974) later established that the partial information provided was more likely to be correct when people signalled a TOT state than when they signalled a "don't know" state. The TOT procedure has been extended to the study of experimentally presented information (Smith, 1994). Also, it was demonstrated that people can access other attributes of a momentarily inaccessible target besides its phonological characteristics, such as whether the solicited word has a positive or negative connotation (see e.g. Lovelace, 1987; Schacter & Worling, 1985; Yarmey, 1973).

In the Recall-Judgment-Recognition paradigm introduced by Hart (1965), in contrast, the focus is on the accuracy of FOK judgments in predicting the subsequent recognition of a nonrecalled target. Subjects are first presented with a memory pointer (e.g. "What Biblical character allegedly lived 969 years?"). When they fail to find the answer, they are asked to judge whether or not they "know" the answer to the extent of being able to recognize it among distractors. Finally, they are tested on that question using a forced-choice recognition memory test. Many studies that used this paradigm have found that FOK judgments following recall failure are predictive of recognition success. The correlations are generally not very high, but they are nevertheless sizable and significant (see Schwartz, 1994; Schwartz & Metcalfe, 1994).

The bulk of the experimental work on the TOT and FOK states has focused on evaluating the accuracy of FOK judgments. FOK was found to predict later performance in a variety of memory tasks such as general information questions, episodic memory of words, paired associates, and memory for nonsense syllables (Blake, 1973; Hart, 1967; Leonesio & Nelson, 1990; Reder, 1987; Ryan, Petty, & Wenzlaff, 1982; Schacter, 1983). Also, it was found to be relatively accurate in predicting several criterion tests, including recognition memory, later recall, cued recall, attribute identification, relearning, and perceptual identification (e.g. Gruneberg & Monks, 1974; Nelson et al., 1984; Shimizu & Kawaguchi, 1993). Work on FOK accuracy has indicated, for example, that the accuracy of the FOK varies with the number of test alternatives in the recognition test (Leonesio & Nelson, 1990; Schwartz & Metcalfe, 1994), and that it is rather low among certain brain-damaged populations. Korsakoff patients, for example, were found to be considerably lower than normals not only in their memory performance but also in their FOK accuracy (Shimamura & Squire, 1986). Janowsky, Shimamura, and Squire (1989) found deficits in FOK accuracy to be associated with frontal lobe damage. On the other hand, FOK accuracy in anomic patients and in elderly people seems to be relatively normal (Bäckman & Karlsson, 1985; Funnell et al., 1996).

In recent years, however, there has been a greater concern with uncovering the mechanisms underlying the feeling of knowing and its accuracy. Several mechanisms have been proposed. These will be classified here into three general categories: (1) trace access, (2) global heuristics, and (3) explicit inferences. I would like to take up explicit inferences first, because they represent the most obvious basis for metacognitive judgments.

FOK judgments based on explicit-analytic inferences

Undoubtedly, FOK judgments are often based on explicit inferences. Thus, I may judge that I should know the name of the leading actress in the movie *Room at the Top* because I can see her face, and can recollect that she has been married to Yves Montand, or else I can judge that there is no chance that I will be able to recognize the name of the winner of the Pulitzer Prize for photography in 1970 because I know nothing about photography or the Pulitzer Prize. Indeed, Nelson et al. (1984) listed six inferential mechanisms that can contribute to the FOK, such as retrieval of specific episodic information, or expertise in the area of the question. Clearly, these inferential mechanisms are not very different from those underlying, for example, the prediction whether I am likely to find a parking place near the office today, or which soccer team is likely to win. Inferential mechanisms often give rise to what might be termed "judgments of knowing" (see Costermans et al., 1992). Possibly metacognitive judgments would not have attracted special attention if they were based entirely on analytic inferences.

Consider, however, the type of intuitive feeling discussed in connection with the creative process: A scientist may experience a strong intuition that he is on the right track, and can sense that the solution to a problem is about to emerge into consciousness (Polanyi, 1962; Policastro, 1995). The phenomenal quality of such intuitive feelings or "hunches" is more like that of direct perception than of analytic reasoning. On a smaller scale, when I am in the TOT state I sometimes feel that I can *directly* detect the presence of an elusive target, and can monitor its emergence into consciousness (see James, 1893). These feelings suggest the operation of a different type of mechanism than that underlying analytic, reasoned inferences.

The trace-access account of the feeling of knowing

The trace-access account of the FOK was first proposed by Hart (1965) and has been implicitly endorsed by many researchers since. Basically the idea is that there must exist some specialized monitoring mechanism that allows one to know that one knows. Thus, when I search for a certain name, there must be some way by which I can recognize that name when I retrieve it from memory, otherwise the search process may continue indefinitely. Perhaps, then, this mechanism can also monitor the presence of the name in my memory even before

I retrieve it. This mechanism was termed memory-monitoring by Hart (1967). According to Hart, the memory-monitoring module has privileged access to memory traces, and can detect the availability of the target in memory when recall fails. Thus, whenever a person is required to recall a target from memory, the monitoring module is first activated to ensure that the target is available in the store before attempting to retrieve it. Consistent with this assumption is the finding that subjects spend more time searching for a target when the initial FOK is high than when it is low (Gruneberg & Monks, 1974). Hart stressed the functional utility of a monitoring module given the fallibility of the memory system.

The trace-access model is appealing for two reasons. First, it is consistent with the phenomenology of FOK and TOT states, namely, the feeling that one directly monitors the presence of the elusive target. Second, it explains why the FOK is accurate: Clearly, if the FOK monitors directly the availability of the target in memory, then it should be predictive of the subsequent recall or recognition of the target. An additional appeal of the idea of a specialized monitoring mechanism is that it can handle observations suggesting selective impairment of the subjective monitoring of knowledge among certain patient populations. For example, it has been proposed that frontal lobe damage may cause selective breakdown of the metacognitive function (see Metcalfe, 1996).

Heuristic-based accounts of the feeling of knowing

An alternative account of the FOK is that it is based on the implicit application of heuristics that rely on global, internal mnemonic cues (Jacoby & Brooks, 1984; Jacoby & Kelley, 1987; Kelley & Jacoby, 1996a; Koriat, 1994). Indeed, recent discussions of metacognition have stressed the role of internal, subjective cues as a source for metacognitive judgments such as FOK, judgment of learning, and retrospective confidence (see Koriat, in press b). Several mnemonic cues have been considered, including the accessibility of pertinent information (Dunlosky & Nelson, 1992; Koriat, 1993; Morris, 1990), the ease with which information comes to mind (Kelley & Lindsay, 1993; Mazzoni & Nelson, 1995), cue familiarity (Metcalfe, 1993; Metcalfe, Schwartz, & Joaquim, 1993; Reder, 1987; Reder & Ritter, 1992), and the ease or fluency of processing of a presented item (Begg, Duft, Lalonde, Melnick, & Sanvito, 1989; Benjamin & Bjork, 1996). Each of these internal cues can support a heuristic for monitoring one's own knowledge. Although such heuristics are also inferential in nature, they differ from analytic inferences in that they are used implicitly or unconsciously, and their effects are relatively automatic (see Jacoby & Brooks, 1984; Kelley & Jacoby, 1996a). This is why their effects are experienced as intuitive feelings rather than as logical deductions. Thus, explanations of metacognitive judgments in terms of nonanalytic heuristics have the advantage that they may be

able to account for the direct, unmediated quality of metacognitive judgments without postulating trace access.

I would like to focus here on two candidate heuristics for the FOK that have received experimental attention in recent years, the accessibility heuristic and the cue-familiarity heuristic.

THE ACCESSIBILITY ACCOUNT OF THE FEELING OF KNOWING

One account of the FOK that does not postulate privileged access to memory traces is provided by the accessibility model. This model emerged from some of our early observations concerning the TOT phenomenon (Koriat & Lieblich, 1977). These observations indicated that there are reliable differences between memory pointers (e.g. word definitions) in the tendency to evoke a strong or weak FOK, and that these differences are independent of the likelihood with which the pointer elicits the correct target. In fact, knowing and the feeling of knowing emerged as two orthogonal factors for characterizing memory pointers. It does not seem, then, that the FOK monitors the availability of the target's trace in memory.

Rather, an analysis of the pointers that tend to produce an overly high FOK 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. This amount seems to depend both on characteristics of the pointer and as on characteristics of the solicited target. I will mention just two examples: As far as the pointer is concerned, word definitions that contain redundancies and repetitions tend to produce inflated FOKs, presumably because they generate a large amount of activation without enhancing the likelihood of recall. As far as the solicited target is concerned, pointers whose target has many "close neighbors" tend to produce inflated initial FOK even when the person ultimately retrieves the correct target. It would seem that the FOK is based on an unfocused scanning of a broad region of memory in which the target is likely to reside, and that activations from neighboring entries enhance the FOK. It is as if entries in the vicinity of the target are mistaken for the target when they are inspected from a distance, although when one gets closer one can easily reject them and home in on the correct target.

These and other observations gave rise to the accessibility model of the FOK (Koriat, 1993), which will now be examined.

The accessibility model assumes that people have *no* knowledge of their own memory over and above what they can retrieve from it. However, when they try to search for a target, often partial information comes to mind, and the FOK is based on the overall accessibility of such information, that is, on the amount of the partial clues and on the ease with which they come to mind. Essentially the FOK monitors the *accessible* information in *short-term* memory rather than

the information available in long-term memory. Therefore, monitoring does not precede retrieval but follows it: It is by attempting to search for the solicited target that one can appreciate whether the target is available in memory.

Some of the clues that come to mind originate from the target and constitute "correct partial information", whereas others stem from many other sources and represent "wrong partial information". It is assumed that people cannot tell these two types of clues apart because they cannot monitor directly the accuracy of what comes to mind. Therefore both correct and wrong partial information contribute equally to the FOK. As a consequence, when memory goes astray as a result of spurious activations, so will the FOK.

The main question, of course, is why FOK judgments are nevertheless accurate in predicting the future recall or recognition of momentarily inaccessible targets. The answer is that the accuracy of metamemory stems directly from the accuracy of memory itself. Memory is by and large accurate in the output-bound sense (see Koriat & Goldsmith, 1994, 1996): Information that comes to mind during retrieval is more likely to be correct than wrong. This is almost part of the definition of memory: If you learn the name of a person, you are more likely to recall that name in the future than to recall another name instead. You may fail to retrieve any name at all, but if some name comes to mind, it is more likely to be right than wrong. Because most of the information that comes to mind is correct, a monitoring mechanism that relies on the accessibility of information, as such, is bound to predict actual recall and recognition performance.

Some support for the model comes from an experiment (Experiment 1, Koriat, 1993) in which subjects memorized a four-letter string (e.g. KBDR) on each trial, and following a filled interval were asked to report the full target or as many letters as they could remember. They then made FOK judgments about the probability of identifying the target among distractors, and their recognition memory for the target was tested. The results indicated the following: Both number of correct letters recalled and number of wrong letters recalled were positively correlated with FOK judgments (the estimated correlations for the grouped data were +.83 and +.76, respectively), suggesting that these judgments were affected by the sheer amount of information accessible regardless of the accuracy of that information. Recognition memory, on the other hand, was positively correlated with the amount of correct partial information (+.61) but negatively correlated with the amount of incorrect partial information (−.52), suggesting that correct partial information contributes to the accuracy of the FOK, whereas incorrect partial information contributes to its inaccuracy.

Nevertheless, despite the conflicting contributions of correct and wrong partial recalls to the validity of FOK judgments, these judgments were quite accurate in predicting recognition performance. The reason is that about 90% of all the letters recalled were correct. Therefore, although subjects did not have access to the accuracy of what they recalled, they could successfully monitor their knowledge on the basis of the sheer amount of information accessible. In fact, the

predictive validity of FOK judgments was about the same as that of the sheer number of letters recalled.

DISSOCIATIONS BETWEEN KNOWING AND THE FEELING OF KNOWING

The implication of these results is that there is nothing mysterious about the FOK. The FOK relies on the implicit use of a simple heuristic that generally works: This heuristic is predicated on the assumption that one is more likely to know the answer to a question if that question brings a large number of partial clues to mind than if it brings to mind few clues. However, it is clear that this is not always true. Some questions activate a great deal of information for a variety of irrelevant reasons, and one may still not recognize the correct target among distractors. These questions should produce an illusion of knowing, that is, a strong unjustified FOK. Thus, we may expect a dissociation between knowing and the FOK in those conditions in which the overall amount of information that comes to mind is not diagnostic. This possibility was examined with general-information questions (Koriat, 1995). The procedure required certain assumptions because of the difficulties in measuring the amount and quality of the partial information that is activated by a general-information question when recall fails. Based on earlier results (Koriat & Lieblich, 1977), it was assumed that memory pointers differ reliably in two parameters: (1) the tendency to produce a high or a low FOK, and (2) the validity of the FOK elicited.

According to the accessibility model, the tendency to produce a high or a low FOK depends on the overall amount of partial information elicited by the pointer, whereas the validity of the FOK in predicting subsequent recall or recognition of the target depends on the output-bound accuracy of that information. To examine these predictions a pool of general-information questions was compiled, which were expected to vary greatly in both the amount of information they tend to precipitate and the quality of that information. These were presented to subjects who were asked to answer each question (Experiment 1). The percentage of subjects who produced an answer, regardless of whether that answer was right or wrong, was used as an index of Accessibility (ACC). If we assume that overt responses are diagnostic of covert responses, that is, that pointers that produce many answers across subjects also activate a large number of partial clues among subjects who fail to retrieve the answer, then we should expect high-ACC pointers to elicit higher FOK judgments than low-ACC pointers.

The output-bound accuracy of the information precipitated by a pointer was estimated from the Output-Bound Accuracy of the answers provided, that is, the percentage of correct answers out of all answers produced. On the basis of this index, all pointers were divided into two categories, Consensually-Correct, and Consensually-Wrong. Consensually-Correct pointers were those that produced more correct than incorrect answers across subjects. As noted earlier,

most pointers belong to this category. Some of the pointers, however, were Consensually-Wrong or "deceptive" (see Fischhoff et al., 1977): They produced predominantly incorrect answers. It was hypothesized that only for the typical, Consensually-Correct pointers, would FOK judgments be valid in predicting subsequent recognition of the target when recall fails, whereas for Consensually-Wrong pointers FOK accuracy should be very poor.

To examine these hypotheses, the pointers were presented to another group of subjects (Experiment 2) who were asked to give a fast FOK judgment before trying deliberately to search for the answer, but to write down the answer if it came to mind spontaneously. A two-alternative recognition test was used. Subjects did reach an answer in 6% of the trials and these trials were eliminated from the analyses.

The results indicated the following: First, as far as the basis of the FOK is concerned, high-ACC pointers produced significantly higher FOK judgments than low-ACC pointers. This was true for both the Consensually-Correct and the Consensually-Wrong pointers. Thus, FOK judgments following recall failure can be predicted from the mere number of answers elicited by the pointer. These results are consistent with the idea that the FOK monitors the overall accessibility of partial clues regardless of their accuracy.

Second, as far as FOK accuracy is concerned, this was found to vary greatly depending on Output-Bound Accuracy. Thus, the Consensually-Correct and Consensually-Wrong pointers evoked practically identical preliminary FOK judgments, (76.1 and 76.4, respectively), but differed considerably in recognition memory (73.3 and 43.9, respectively). In fact, recognition performance was no better for the Consensually-Wrong pointers than for a set of pointers that had been found to elicit practically no answers across subjects (43.9 and 45.1, respectively), although the former pointers elicited markedly higher FOK judgments (76.4) than the latter pointers (58.7). These results demonstrate a clear double dissociation between knowing and the feeling of knowing.

A similar dissociation was observed in the within-subject correlation between the FOK and recognition performance: The average within-subject correlation was positive and significant (.31) for the Consensually-Correct pointers, indicating that FOK judgments were moderately accurate in predicting recognition memory. For the Consensually-Wrong pointers, in contrast, recognition memory *decreased* significantly as FOK increased, yielding a significantly negative correlation within individuals, −.18! Thus, for these pointers the more one feels that one knows, the less likely that one actually knows.

In sum, these results are consistent with the assumption of the accessibility model that the accuracy of metamemory is a by-product of the accuracy of memory. In general, FOK monitors the overall accessibility of partial clues about the target regardless of whether these clues are correct or not. Because most of the information that comes to mind is correct, FOK judgments tend to be accurate in predicting recognition performance. However, when pointers elicit

predominantly incorrect clues, a dissociation will occur between knowing and the feeling of knowing.

THE CUE-FAMILIARITY ACCOUNT OF THE FEELING OF KNOWING

The assumption underlying the accessibility account is that the FOK is not based on the operation of a monitoring mechanism that has direct access to memory traces, but on the implicit use of an inferential heuristic that relies on internal mnemonic cues. An alternative account of the FOK that also shares this assumption is the cue-familiarity account first proposed by Reder (1987; see also Metcalfe, 1993). It assumes that FOK judgments are based on the overall familiarity of the pointer, not on the retrievability of the target. A rapid FOK is routinely and automatically elicited by the parsing of the question. The purpose of this FOK is to regulate the choice of question-answering strategy, and this operates for all questions, not just for those for which the answer is currently inaccessible.

The cue-familiarity account has gained consistent empirical support in a number of studies. In Reder's (1987, 1988) studies, subjects were presented with general-information questions and were asked to decide quickly whether they could retrieve the answer. Some of the words of the question were primed earlier in the context of a frequency judgment task. Advance priming was found to enhance FOK judgments without correspondingly improving recall or recognition of the answer. Schwartz and Metcalfe (1992) replicated these results with FOK judgments elicited following recall failure. They compared the effects of cue priming and target priming and found that whereas cue priming enhanced FOK judgments, the priming of the target itself generally did not. Metcalfe et al. (1993), using a proactive interference paradigm with two lists of paired associates, found that repetition of the cue word across the two lists enhanced FOK judgments, presumably because of increased stimulus familiarity. In contrast, repetition of the response terms did not affect FOK judgments.

Some impressive results in support of the cue-familiarity account have been obtained by Reder and her associates with arithmetic problems. In a study by Reder and Ritter (1992), subjects were presented with arithmetic problems such as 38 + 54, and were asked to determine rapidly whether they know the answer and can retrieve it or whether they have to compute it. FOK judgments, that is, judgments that the answer can be retrieved, increased with increasing frequency of previous exposures to the same parts of the problem, not with the availability of the answer. FOK judgments also increased when the problem changed, for example, from 38 + 54 to 38 × 54, or when only some of the components of the problem were repeated (e.g. 38 + 29). Hence, familiarity with problem parts and not familiarity with the answer contributes to the FOK.

Furthermore, in recent studies (Schunn, Reder, Nhouyvanisvong, Richards, & Stroffolino, 1997) some of the arithmetic problems were presented under

conditions in which subjects had little chance to actually solve the problem. Nevertheless, FOK judgments increased with increasing frequency of previous exposures to these problems. Thus, once again, there was a dissociation between knowing and the feeling of knowing: When exposure to the problem and exposure to the answer were decoupled, exposure to the problem predicted the feeling of knowing, whereas exposure to the answer predicted actual knowing. These results clearly indicate that the FOK is affected by the familiarity of the pointer, not by access to the target.

THE JOINT EFFECTS OF FAMILIARITY AND ACCESSIBILITY

We have, then, two nonanalytic heuristics that can serve to drive the FOK, accessibility and cue-familiarity. In the metacognitive literature these are sometimes seen to represent two alternative, competing accounts of the FOK (e.g. Schwartz & Metcalfe, 1992). They share the basic assumption that the FOK does not monitor the presence of the target in memory, but is based on the implicit application of a nonanalytic heuristic. However, whereas in the cue-familiarity account the FOK occurs at a pre-retrieval stage and depends solely on the characteristics of the pointer, in the accessibility account it is assumed to rely on the output of the retrieval attempt. Some of our recent work, however, suggests that both mechanisms may operate in an interactive manner in influencing the FOK.

That work concerns the illusion of knowing (see Koriat, in press a). The question we asked is what makes a pointer deceptive in the sense of evoking an unduly high FOK? An analysis of the Consensually-Wrong pointers in Koriat (1995) suggested that familiarity of the pointer may play a significant role in mediating the potential effects of accessibility on the FOK. In general, a pointer that has a large set of candidate answers stored in memory will tend to evoke a stronger FOK than one that has only a small set. This seems to occur, however, only when the pointer is familiar enough, because only then does the person tend to explore possible answers, and thus enhance accessibility. It would seem that familiarity serves as a gating mechanism for the effects of accessibility: It allows information to be released from long-term to short-term memory. The activated information in short-term memory, then, is what affects the FOK when recall fails. Indeed, some preliminary data from our laboratory indicate that familiarity and potential accessibility interact so that the amount of potentially accessible information affects the FOK when cue familiarity is relatively high, but not when it is low.

THE CASCADED MECHANISMS OF THE FOK

Let me summarize the view that emerges from the recent work on metacognitive monitoring. This work suggests that the FOK is multiply determined (see Nelson et al., 1984). Thus, even if we eliminate the possibility that FOK is based on a specialized monitoring module that has direct access to memory traces, there

remain at least three types of mechanisms for the FOK: cue familiarity, accessibility, and explicit-analytic inferences. These mechanisms are arranged in the order in which they seem to be activated. Thus, in the very early stages of inspecting a question, FOK may be based on the sheer familiarity of the pointer. This preliminary FOK may encourage or discourage search for the target: when a pointer is unfamiliar, that is, "does not ring a bell", a fast "don't know" judgment is issued. When the pointer evokes some degree of familiarity, this familiarity drives mental exploration, and then the overall accessibility of partial clues also affects the FOK.

Both cue familiarity and accessibility are nonanalytic heuristics that do not involve reasoned, explicit inferences. As far as the cue-familiarity heuristic is concerned, it is clear from the work of Reder and her associates that cue familiarity affects rapid, preliminary FOK through a process that is basically implicit. This is suggested by the findings that the FOK depends on the familiarity of the pointer rather than on the availability of the answer, and by the results suggesting familiarity-mediated effects of advance priming on the FOK. Thus, the nonanalytic use of cue familiarity as the basis for the FOK should be distinguished from the explicit use of familiarity (e.g. familiarity with a topic, or expertise in the area in question, see Nelson et al., 1984) as a basis for an educated probability judgment about the likelihood of recognizing a currently inaccessible target.

Similarly, the accessibility heuristic too is an implicit heuristic that should be distinguished from analytic inferences: It does not entail an explicit deduction that one ought to know the answer to the question because the question precipitates many partial clues, or because these clues are easily accessed. In fact, some of the effects on the FOK would seem to run counter to those following from a logical deduction. For example, FOK judgments, including those elicited following commission responses, seem to increase as the number of candidate answers that come to mind increases (see Brown & Bradley, 1985; Koriat, 1995). If FOK were to depend on a logical deduction, we might have expected the reverse pattern to occur. Rather, the accessibility heuristic, like the cue-familiarity heuristic, is a nonanalytic heuristic that is applied implicitly, and it is its implicit nature that is responsible for the phenomenology of the FOK—the feeling that we directly sense the presence of the elusive target in memory.

The accessibility heuristic operates on the overall amount of information that comes to mind and its ease of access, without regard to the content of that information. Under some conditions, however, particularly in the later stages of the search process, FOK judgments may be based on an explicit consideration of the content of the clues that come to mind (Koriat, 1993). When the content of the retrieved information is consulted, the monitoring process changes its quality from an automatic, nonanalytic process, to a deliberate, inferential process of probability estimation (see Jacoby & Brooks, 1984). The experience then is more like a judgment of knowing than a *feeling* of knowing. Content-based inferences require more time and more effort than nonanalytic, heuristic-driven FOKs (Kelley & Jacoby, 1996b). In many cases, however, the process underlying

the FOK never proceeds beyond a consideration of the mere accessibility of partial clues. This may occur either because the partial clues that come to mind are not articulate enough, and/or because the plausibility of these clues cannot be evaluated. For example, a person in a TOT state is typically unable to determine whether the letters that come to mind are correct or not. Thus, people in the TOT state cannot tell whether these clues originate from the target itself, from related memory entries, or from other sources, and therefore they are often unable to escape the effects of contaminating clues that come to mind by attributing them to their source (see Koriat, 1994). Sometimes only after a TOT state has been resolved does one realize that some of the partial clues initially accessed were actually false.

CONCLUSION

This chapter examined the work on metacognitive judgments in the context of the distinction between implicit and explicit cognitive modes. It was argued that the feeling of knowing (in distinction from the "judgment" of knowing) occupies a unique role in mediating between implicit and explicit processes. As far as its antecedents are concerned, the feeling of knowing (and perhaps other metacognitive feelings) is based on nonanalytic heuristics that operate implicitly. It is the implicit nature of these inferential heuristics that is responsible for the special phenomenal quality of the feeling of knowing, namely, the subjective experience that one actually senses the presence of the elusive target in the memory store, or that one directly monitors its emergence into consciousness. The chapter centered on two main heuristics that have received some experimental support in recent years, cue familiarity and accessibility. However, the feeling of knowing is part and parcel of the explicit mode of operation. This is evident, first, in its "aware" qualities, and second, in the role it plays in the controlled regulation of behavior. The feeling of knowing, then, fulfils an important crossover function in mediating between implicit and explicit modes of operation.

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REFERENCES

Bäckman, L., & Karlsson, T. (1985). The relation between level of general knowledge and feeling-of-knowing: An adult age study. *Scandinavian Journal of Psychology, 26*, 249–258.

Baranski, J. V., & Petrusic, W. M. (in press). Probing the locus of confidence judgments: Experiments on the time to determine confidence. *Journal of Experimental Psychology: Human Perception and Performance.*

Bargh, J. A. (1997). The automaticity of everyday life. In R. S. Wyer (Ed.), *Advances in social cognition* (vol 10, pp. 1–61). Hillsdale, NJ: Lawrence Erlbaum Associates Inc.

Bargh, J. A., Chen, M., & Burrows, L. (1996). Automaticity of social behavior: Direct effects of trait construct and stereotype activation on action. *Journal of Personality and Social Psychology, 71*, 230–244.

Bargh, J. A., & Gollwitzer, P. M. (1994). Environmental control of goal-directed action: Automatic and strategic contingencies between situations and behavior. *Nebraska Symposium on Motivation, 41*, 71–124.

Begg, I., Duft, S., Lalonde, P., Melnick, R., & Sanvito, J. (1989). Memory predictions are based on ease of processing. *Journal of Memory and Language, 28*, 610–632.

Benjamin, A. S., & Bjork, R. A. (1996). Retrieval fluency as a metacognitive index. In L. M. Reder (Ed.), *Implicit memory and metacognition* (pp. 309–338). Hillsdale, NJ: Lawrence Erlbaum Associates Inc.

Blake, M. (1973). Prediction of recognition when recall fails: Exploring the feeling-of-knowing phenomenon. *Journal of Verbal Learning and Verbal Behavior, 12*, 311–319.

Bornstein, R. F., Leone, D. R., & Galley, D. J. (1987). The generalization of subliminal mere exposure effects: Influence of stimuli perceived without awareness on social behavior. *Journal of Personality and Social Psychology, 53*, 1070–1079.

Brown, A. S., & Bradley, C. K. (1985). Semantic prime inhibition and memory monitoring. *Bulletin of the Psychonomic Society, 23*, 98–100.

Brown, R., & McNeill, D. (1966). The "tip of the tongue" phenomenon. *Journal of Verbal Learning and Verbal Behavior, 5*, 325–337.

Costermans, J., Lories, G., & Ansay, C. (1992). Confidence level and feeling of knowing in question answering: The weight of inferential processes. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 18*, 142–150.

Dunlosky, J., & Nelson, T. O. (1992). Importance of the kind of cue for judgments of learning (JOLs) and the delayed-JOL effect. *Memory and Cognition, 20*, 373–380.

Fischhoff, B., Slovic, P., & Lichtenstein, S. (1977). Knowing with certainty: The appropriateness of extreme confidence. *Journal of Experimental Psychology: Human Perception and Performance, 3*, 552–564.

Funnell, M., Metcalfe, J., & Tsapkini, K. (1996). In the mind but not on the tongue: Feeling of knowing in an anomic patient. In L. M. Reder (Ed.), *Implicit memory and metacognition* (pp. 171–194). Hillsdale, NJ: Lawrence Erlbaum Associates Inc.

Gigerenzer, G., Hoffrage, U., & Kleinbölting, H. (1991). Probabilistic mental models: A Brunswikian theory of confidence. *Psychological Review, 98*, 506–528.

Gruneberg, M. M., & Monks, J. (1974). Feeling of knowing and cued recall. *Acta Psychologica, 38*, 257–265.

Hart, J. T. (1965). Memory and the feeling-of-knowing experience. *Journal of Educational Psychology, 56*, 208–216.

Hart, J. T. (1967). Memory and the memory-monitoring process. *Journal of Verbal Learning and Verbal Behavior, 6*, 685–691.

Jacoby, L. L., & Brooks, L. R. (1984). Nonanalytic cognition: Memory, perception and concept learning. In G. H. Bower (Ed.), *The psychology of learning and motivation: Advances in research and theory* (Vol. 18, pp. 1–47). San Diego, CA: Academic Press.

Jacoby, L. L., & Kelley, C. M. (1987). Unconscious influences of memory for a prior event. *Personality and Social Psychology Bulletin, 13*, 314–336.

James, W. (1893). *The principles of psychology* (Vol. 1). New York: Holt.

Janowsky, J. S., Shimamura, A. P., & Squire, R. L. (1989). Memory and metamemory: Comparisons between frontal lobe lesions and amnesic patients. *Psychology, 17*, 3–11.

Kelley, C. M., & Jacoby, L. L. (1996a). Adult egocentrism: Subjective experience versus analytic bases for judgment. *Journal of Memory and Language, 35*, 157–175.

Kelley, C. M., & Jacoby, L. L. (1996b). Memory attributions: Remembering, knowing, and feeling of knowing. In L. M. Reder (Ed.), *Implicit memory and metacognition* (pp. 287–308). Hillsdale, NJ: Lawrence Erlbaum Associates Inc.

Kelley, C. M., & Lindsay, D. S. (1993). Remembering mistaken for knowing: Ease of retrieval as a basis for confidence in answers to general knowledge question. *Journal of Memory and Language, 32*, 1–24.

Koriat, A. (1993). How do we know that we know? The accessibility model of the feeling of knowing. *Psychological Review, 100*, 609–639.

Koriat, A. (1994). Memory's knowledge of its own knowledge: The accessibility account of the feeling of knowing. In J. Metcalfe & P. Shimamura (Eds.), *Metacognition: Knowing about knowing* (pp. 115–135). Cambridge, MA: MIT Press.

Koriat, A. (1995). Dissociating knowing and the feeling of knowing: Further evidence for the accessibility model. *Journal of Experimental Psychology: General, 124*, 311–333.

Koriat, A. (in press a). Illusions of knowing: A window to the link between knowledge and metaknowledge. In V. Y. Yzerbyt, G. Lories, & B. Dardenne (Eds.), *Metacognition: Cognitive and social dimensions*. London: Sage.

Koriat, A. (in press b). Monitoring one's own knowledge during study: A cue-utilization approach to judgments of learning. *Journal of Experimental Psychology: General.*

Koriat, A., & Goldsmith, M. (1994). Memory in naturalistic and laboratory contexts: Distinguishing the accuracy-oriented and quantity-oriented approaches to memory assessment. *Journal of Experimental Psychology: General, 123*, 297–315.

Koriat, A., & Goldsmith, M. (1996). Monitoring and control processes in the strategic regulation of memory accuracy. *Psychological Review, 103*, 490–517.

Koriat, A. & Lieblich, I. (1974). What does a person in a "TOT" state know that a person in a "don't know" state doesn't know? *Memory and Cognition, 2*, 647–655.

Koriat, A., & Lieblich, I. (1977). A study of memory pointers. *Acta Psychologica, 41*, 151–164.

Leonesio, R. J., & Nelson, T. O. (1990). Do different metamemory judgments tap the same underlying aspects of memory? *Journal of Experimental Psychology: Learning, Memory, and Cognition, 16*, 464–470.

Lovelace, E. A. (1987). Attributes that come to mind in the TOT state. *Bulletin of the Psychonomic Society, 25*, 370–372.

Mazzoni, G., & Cornoldi, C. (1993). Strategies in study time allocation: Why is study time sometimes not effective? *Journal of Experimental Psychology: General, 122*, 47–60.

Mazzoni, G., & Nelson, T. O. (1995). Judgments of learning are affected by the kind of encoding in ways that cannot be attributed to the level of recall. *Journal of Experimental Psychology: Learning, Memory and Cognition, 21*, 1263–1274.

Metcalfe, J. (1993). Novelty monitoring, metacognition and control in a composite holographic associative recall model: Implications for Korsakoff amnesia. *Psychological Review, 100*, 3–22.

Metcalfe, J. (1996). Metacognitive processes. In E. L. Bjork & R. A. Bjork (Eds.), *Handbook of perception and cognition: Memory* (Vol. 10, pp. 381–407). San Diego, CA: Academic Press.

Metcalfe, J., Schwartz, B. L., & Joaquim, S. G. (1993). The cue-familiarity heuristic in metacognition. *Journal of Experimental Psychology: Learning, Memory and Cognition, 19*, 851–861.

Morris, C. C. (1990). Retrieval processes underlying confidence in comprehension judgments. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 16*, 223–232.

Nelson, T. O. (1996). Consciousness and metacognition. *American Psychologist, 51*, 102–116.

Nelson, T. O., & Dunlosky, J. (1991). When people's judgments of learning (JOLs) are extremely accurate at predicting subsequent recall: The "delayed-JOL effect". *Psychological Science, 2*, 267–270.

Nelson, T. O., Gerler, D., & Narens, L. (1984). Accuracy of feeling-of-knowing judgment for predicting perceptual identification and relearning. *Journal of Experimental Psychology: General, 113*, 282–300.

Nelson, T. O., & Leonesio, R. J. (1988). Allocation of self-paced study time and the "Labor-in-vain effect". *Journal of Experimental Psychology: Learning, Memory, and Cognition, 14*, 676–686.

Nelson, T. O., & Narens, L. (1990). Metamemory: A theoretical framework and new findings. In G. H. Bower (Ed.), *The Psychology of learning and motivation: Advances in research and theory* (Vol. 26, pp. 125–173). San Diego, CA: Academic Press.

Polanyi, M. (1962). *Personal Knowledge*. Chicago: University of Chicago Press.

Policastro, E. (1995). Creative intuition: An integrative review. *Creative Research Journal, 8*, 99–113.

Reder, L. M. (1987). Strategy selection in question answering. *Cognitive Psychology, 19*, 90–138.

Reder, L. M. (1988). Strategic control of retrieval strategies. *The Psychology of Learning and Motivation, 22*, 227–259.

Reder, L. M. (Ed.) (1996). *Implicit memory and metacognition*. Hillsdale, NJ: Lawrence Erlbaum Associates Inc.

Reder, L. M., & Ritter, F. E. (1992). What determines initial feeling of knowing? Familiarity with question terms, not with the answer. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 18*, 435–451.

Reder, L. M., & Schunn, C. D. (1996). Metacognition does not imply awareness: Strategy choice is governed by implicit learning and memory. In L. M. Reder (Ed.), *Implicit memory and metacognition* (pp. 45–78). Hillsdale, NJ: Lawrence Erlbaum Associates Inc.

Ryan, M. P., Petty, C. R., & Wenzlaff, R. M. (1982). Motivated remembering efforts during tip-of-the-tongue states. *Acta Psychologica, 51*, 137–147.

Schacter, D. L. (1983). Feeling of knowing in episodic memory. *Journal of Experimental Psychology: Learning, Memory and Cognition, 9*, 39–54.

Schacter, D. L., & Worling, J. R. (1985). Attribute information and the feeling of knowing. *Canadian Journal of Psychology, 39*, 467–475.

Schunn, C. D., Reder, L. M., Nhouyvanisvong, A., Richards, D. R., & Stroffolino, P. J. (1997). To calculate or not to calculate: A source activation confusion (SAC) model of problem-familiarity's role in strategy selection. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 23*, 3–29.

Schwartz, B. L. (1994). Sources of information in metamemory: Judgments of learning and feeling of knowing. *Psychonomic Bulletin and Review, 1*, 357–375.

Schwartz, B. L., & Metcalfe, J. (1992). Cue familiarity but not target retrievability enhances feeling-of-knowing judgments. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 18*, 1074–1083.

Schwartz, B. L., & Metcalfe, J. (1994). Methodological problems and pitfalls in the study of human metacognition. In J. Metcalfe & A. P. Shimamura (Eds.), *Metacognition: Knowing about knowing* (pp. 93–113). Cambridge, MA: MIT Press.

Shimamura, A. P., & Squire, L. R. (1986). Memory and metamemory: A study of the feeling-of-knowing phenomenon in amnesic patients. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 12*, 452–460.

Shimizu, H., & Kawaguchi, J. (1993). The accuracy of feeling-of-knowing judgments for general-information questions using the recall retest method. *Japanese Psychological Research, 35*, 215–220.

Smith, S. M. (1994). Frustrated feelings of imminent recall: On the tip of the tongue. In J. Metcalfe & A. P. Shimamura (Eds.), *Metacognition: Knowing about knowing* (pp. 27–45). Cambridge, MA: MIT Press.

Yarmey, A. D. (1973). I recognize your face but I can't remember your name: Further evidence on the tip-of-the-tongue phenomenon. *Memory and Cognition, 1*, 287–289.

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