Chapter 1

Intimations of Memory and Thought

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Poe dismissed the methods of both Bacon and Aristotle as the paths to certain knowledge. He argued for a third method to knowledge which he called imagination; we now call it intuition. . . . [Intuition] lets the classification start so that the successive iterations, back and forth between the empirical and the rational, hone the product until it eventually conforms to nature. . . . Simply start, and like Poe, trust in the imagination.

—Allan Sandage and John Bedke
Cambridge Atlas of Galaxies, 1994

In *The Art of Thought,* Wallas (1926) decomposed human problem solving into a series of discrete stages, depicted in Fig. 1.1. In the *preparation* stage, the thinker accumulates declarative and procedural knowledge within the domain of the problem. Preparation requires awareness that there is a problem to be solved; it entails the adoption of a problem-solving attitude, and the deliberate analysis of the problem itself. Sometimes, the thinker solves the problem at this point. This is especially the case, Wallas thought, with what we would now call routine problems, in which the systematic application of a well-known algorithm will eventually produce the correct solution. If so, the thinker moves immediately from preparation to the *verification* stage, in which the provisional solution is confirmed and refined or discovered to be incorrect after all.[1]

At other times, however, the deliberate cognitive effort deployed during the preparation stage fails, and the thinker falls short of solving the problem.

[1]For a review of Wallas' analysis in light of modern research on thinking and problem solving, see Seifert, Meyer, Davidson, Patalano, and Yaniv (1995).

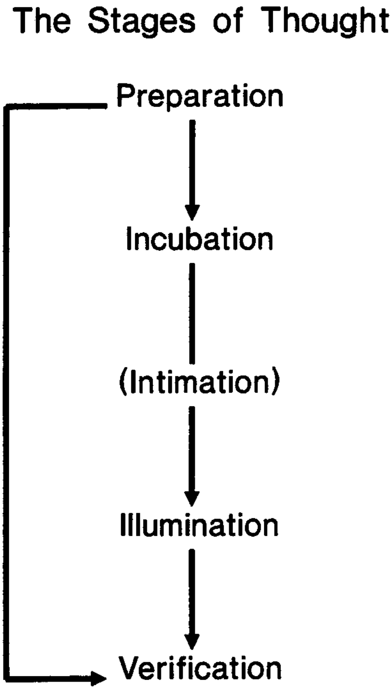

FIG. 1.1. The stages of thought. Adapted from Wallas (1926).

Under these circumstances, Wallas (1926) argued that thinkers often switch to an *incubation* stage, in which deliberate, conscious problem-solving activity is suspended. The thinker may shift his or her attention to some other problem, or take a break and not think of any problem at all. In either case, Wallas believed, problem-solving activity continued at or beyond the fringes of consciousness. That this was the case was demonstrated (at least to Wallas's satisfaction) by the fact that the incubation period often ends in a "flash" of insight in which the solution to the problem suddenly appears in the consciousness of the thinker. This newfound insight is then subject to verification, just as before. As Wallas described it:

> The Incubation stage covers two different things, of which the first is the negative fact that during Incubation we do not voluntarily or consciously think on a particular problem, and the second is the positive fact that a series of unconscious and involuntary (or foreconscious and forevoluntary) mental events may take place during that period. (p. 86)
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> * * *
>
> [T]he final "flash," or "click" . . . is the culmination of a successful train of association, which may have lasted for an appreciable time, and which has probably been preceded by a series of tentative and unsuccessful trains. (pp. 93–94)
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> * * *

> [T]he evidence seems to show that both the unsuccessful trains of association, which might have led to the "flash" of success, and the final and successful train are normally either unconscious, or take place (with "risings" and "fallings" of consciousness as success seems to approach or retire), in that periphery or "fringe" of consciousness which surrounds the disk of full luminosity. (p. 94)

The risings of consciousness as success seems to approach: Wallas was quite clear that, during the incubation stage at least (and, for that matter, perhaps during the preparation stage as well), there comes a time when the thinker knows that the solution is forthcoming, even though he or she does not know what that solution is. He used the term *intimation* to refer to: "that moment in the Illumination stage when our fringe-consciousness of an association-train is in the state of rising consciousness which indicates that the fully conscious flash of success is coming" (p. 97). In other words, Wallas's intimations are *intuitions* (Bowers, 1984, 1994; Bowers, Farvolden, & Mermigis, 1995).

Intuitions, in turn, are a special form of *metacognition* (Flavell, 1979; Nelson & Narens, 1994; for reviews, see Metcalfe & Shimamura, 1994; Nelson, 1992). Metacognitions reflect people's knowledge or beliefs about their cognitive states and processes. In the context of problem solving, they are exemplified by feelings of warmth (FOWs; Newell, Simon, & Shaw, 1962/1979), where thinkers believe they are close to a solution, even though they are not aware of what that solution is. In the context of remembering, they are exemplified by feelings of knowing (FOKs; Hart, 1965), where rememberers believe that they know something, even though they are not aware of what they know.

In this chapter, we draw attention to some parallels between FOWs and FOKs on the one hand, and implicit memory on the other. In implicit memory, the person's experience, thought, and action is affected by past events which he or she cannot consciously remember (Graf & Schacter, 1985; for reviews, see Graf & Masson, 1993; Lewandowki, Dunn, & Kirsner, 1989; Roediger & McDermott, 1993; Schacter, 1987, 1995). Similarly, in FOWs and FOKs, the person's experience, thought, and action is affected by the solutions to problems which he or she has not yet consciously solved, or by knowledge which he or she has not yet consciously retrieved. In the remainder of this chapter, we argue that these intimations of memory and thought—FOKs and FOWs—share underlying mechanisms with implicit memory—or, at least, can have their origins in a priming process that is something like implicit memory.[2]

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[2]For other discussions of priming effects in problem solving, see Lockhart and Blackburn (1993) and Mandler (1994).

INTIMATIONS OF THOUGHT

The role played by intuitions in problem solving is admittedly controversial. Newell and Simon (1973), in their work on the General Problem Solver, suggested that intuitions, in the form of FOWs, are produced by a representation in short-term memory of the distance between the problem solver's current state and the ultimate goal state. In a series of studies, however, Metcalfe (1986a, 1986b; Metcalfe & Wiebe, 1987) found that FOWs are not necessarily accurate predictors of problem-solving success. Specifically, Metcalfe has argued that FOWs are accurate when problems are solved by memory retrieval, inasmuch as they reflect the gradual accumulation of problem-relevant information; but they are not accurate, and may even be misleading, when problems are solved by insight, inasmuch as insight requires restructuring the problem itself. Nevertheless, it does not seem that the two categories of problems—those that are solved by memory retrieval and those that are solved by restructuring—are mutually exclusive. In any event, it is clear that problems which can be solved by memory retrieval can still generate the "Aha!" experience that is the phenomenological essence of insight (Simon, 1986/1989).

Consider a particular type of word problem popularized by Mednick (1962; Mednick & Mednick, 1967) in the Remote Associates Test (RAT). The subject is presented with a set of three words, and the problem is to come up with a fourth word that is an associate of all three. A popular example is:

Democrat
Girl
Favor,

to which the solution is *party*. Smith (1995) has proposed a simple algorithm for solving RAT items:

1. select a test word;
2. retrieve an associate to that test word;
3. select a second test word;
4. test whether the associate retrieved in Step 2 is also an associate of the test word selected in Step 3;
   if so, proceed to Step 5;
   if not, return to Step 1;
5. select the third test word;
6. test whether the associate retrieved in Step 2 is also an associate of the test word selected in Step 5;
   if so, that associate is the solution;
   if not, return to Step 1.

A process like this does not have much of the character of an insight problem: It looks more like a matter of pure, brute-force memory retrieval. In fact, however, when people address RAT problems, they often have the "Aha!" experience as they achieve insight into the problem and its solution. If they do not achieve the solution on their own, then they may well have an "Aha!" experience when someone else tells them what the solution is. Both forms of "getting it" have the qualities of insight.

For present purposes, however, it is more important to note that people also have intuitions about these problems, in advance of their solution. Bowers and his colleagues (Bowers et al., 1995; Bowers, Regehr, Balthazard, & Parker, 1990) have developed a variant of the RAT called the Dyads of Triads (DOT) test, in which subjects are presented with two RAT-like items, one of which (the *coherent* item) is soluble, the other (the *incoherent* item) not:

	Playing	Still	
	Credit	Pages	
(Card)	Report	Music	*(none)*

Subjects are asked to inspect the items and generate the answer to the coherent one; if they fail to do so, they are asked to indicate which triad is, in fact, soluble. Bowers et al. (1990) found that subjects are able to distinguish coherent from incoherent triads at better than chance levels, even though they are not able to solve the coherent triad. Figure 1.2 presents the results from five different samples of subjects who went through this procedure. The unsolved DOT items are classified in terms of the subjects' confidence that their choices were correct. In each sample, overall, the choices were correct significantly more often than would be expected by chance. This was especially the case when subjects were at least moderately confident of their choices.

It is of interest to note that Bowers et al. (1990) distinguished between two types of coherent triads. In *semantically convergent* triads, such as:

Goat	
Pass	
Green	(Mountain)

the solution word preserves a single meaning across the three elements. In semantically *divergent* triads, such as:

Strike	
Same	
Tennis	(Match),

the solution word has a different meaning in association with each element. Interestingly, the accuracy with which subjects can identify coherent triads is greater for convergent than for divergent ones.

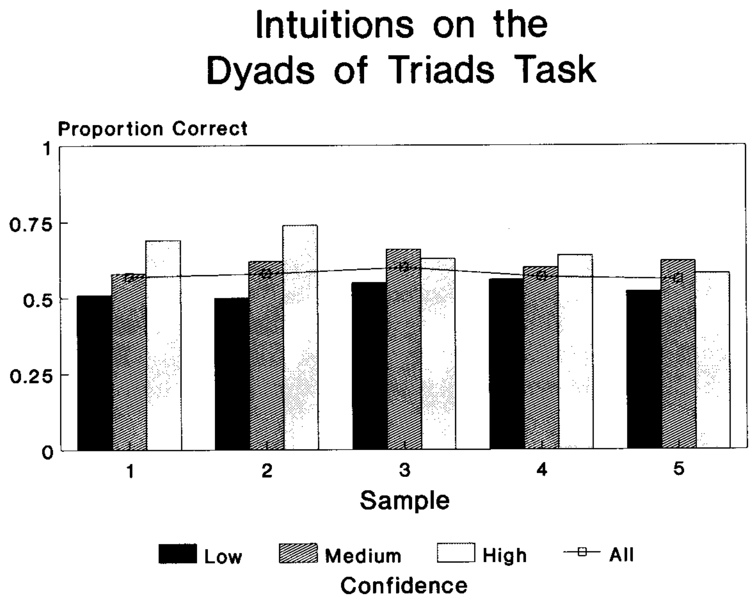

FIG. 1.2. Accuracy of classification of RAT items in the DOT test, by confidence level. Chance performance = .5. Adapted from Bowers et al. (1990).

Bowers et al. (1990; see also Bowers et al., 1995) suggested that these intuitions in problem solving reflect the automatic activation (Anderson, 1983) of knowledge stored in semantic memory—in other words, they suggested that intuitions were based on priming effects similar to those familiar in the study of implicit memory. In this respect, the proposal of Bowers et al. picks up on an earlier suggestion by Yaniv and Meyer (1987) that priming lies at the bottom of another metacognitive phenomenon, FOKs in semantic memory.

Yaniv and Meyer (1987) presented subjects with the definitions of uncommon words, and asked them to generate the word itself:

> LARGE BRIGHT COLORED HANDKERCHIEF; BRIGHTLY COLORED SQUARE OF SILK MATERIAL WITH RED OR YELLOW SPOTS, USUALLY WORN AROUND THE NECK.

If the subjects could produce an answer, they were asked to rate their confidence that they were correct. If they could not do so, they made "tip of the tongue" (TOT) and FOK judgments. In any case, each trial ended with a lexical-decision task, in which the subjects saw six items, among which was the answer to the word-definition problem that had been presented just before. For example:

SPENDING
DASCRIBE
BANDANNA
TRINSFER
ASTEROID
UMBRELLA.

In their first experiment, the lexical-decision task was presented immediately after the rare-word definition. In their second experiment, a period of about 4 minutes intervened between them. Yaniv and Meyer's (1987) general finding was that subjects showed priming on the lexical decision concerning the word targeted by the definition, regardless of whether they were able to produce the answer in the first place. Interestingly, the extent of priming was correlated with the experience of the TOT state and the magnitude of FOK ratings—what they called *latent accessibility*. The priming effect only occurred when the target was in a state of high latent accessibility. Yaniv and Meyer suggested that priming formed the basis of the TOT and FOK judgments to begin with. However, the level of activation involved is subthreshold: large enough to produce palpable priming effects, but less than that required for conscious retrieval of the item from semantic memory. In other words, subjects can be influenced by levels of activation that are lower than those required for conscious awareness.

We are aware of some criticism of Yaniv and Meyer's conclusion. For example, Connor, Balota, and Neely (1992) found that items receiving high TOT and FOK ratings also showed priming when the lexical-decision task preceded the word-generation task by a week—an outcome that is difficult to explain by persistent subthreshold activation. Nevertheless, Shames (1994; see also Shames, Forster, & Kihlstrom, 1995) adapted the Yaniv and Meyer procedure to the RAT task studied by Bowers et al. (1990). The idea is that if Bowers et al. are right, and unsolved (but solvable) RAT items activate semantic memory representations of their solutions, this activation should produce priming on the lexical-decision task.

In his doctoral dissertation, Shames (1994) presented subjects with single RAT items (not the DOTs employed by Bowers et al., 1990). In his basic experiment (Shames, 1994, Experiment 1), the subjects were given 5 seconds to produce the single associate common to all three RAT cues—except that, instead of requiring the subjects to produce the actual remote associates, they were simply asked to indicate whether they knew the answer. In fact, given the difficulty of the items and the short interval for thought, the subjects' responses were negative on most of the trials. Immediately after responding on each trial, six items were presented for lexical decision, following the procedure of Yaniv and Meyer. Comparing response latencies to target and control items, both item and subject analyses revealed a significant priming effect (Fig. 1.3). That is, response latencies were shorter when making lexical decisions about RAT items compared to controls. However, this was only the case for the *unsolved* RAT items: Items that had been successfully solved during the 5-second interval produced smaller, nonsignificant priming effects. When Shames repeated his experiment, using a larger set of RAT items (Experiment 5), he observed priming for both solved and unsolved items. However, in other studies he generally confirmed the original effect, priming for unsolved but not solved items, or at least more priming for solved than for unsolved. For example, in another experiment Shames (Experiment 6) decided not to rely on subjects' verbal reports of success and failure in solving RAT items, and simply compared items classified on the basis of the performance of a normative group. Those items that were very difficult (i.e., those that were unlikely to have been solved in the time allotted) showed priming, whereas those that were somewhat easier (i.e., those that were more likely to have been solved) did not.

Still, the fact that 5 seconds elapsed between the presentation of the RAT items and the lexical-decision task raises the possibility that correct solutions occur after the 5-second interval, over the course of the lexical-

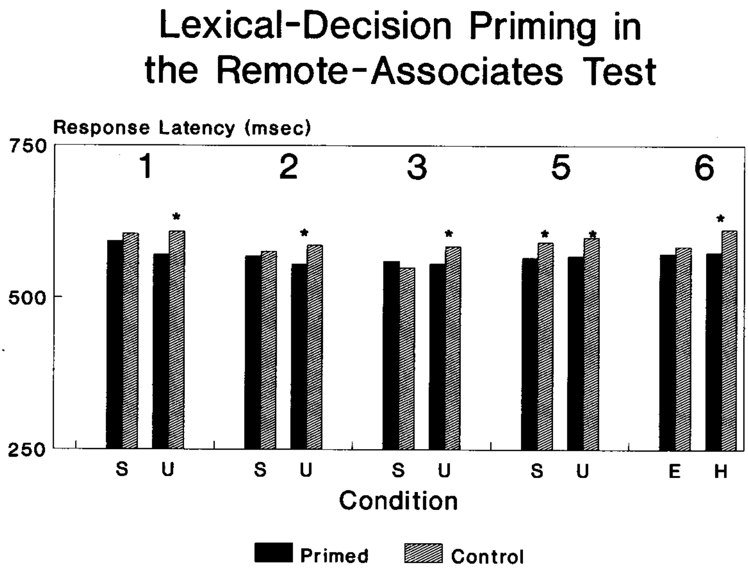

FIG. 1.3. Priming effects on lexical decision of solved and unsolved RAT items in Experiments 1–3 and 5–6 of Shames (1994; see also Shames et al., 1995). S = solved, U = unsolved items; E = easy, H = hard items. An asterisk (*) indicates a significant priming effect. Adapted from Shames (1994).

decision task itself. Thus, for example, the priming effect might reflect the subject's recognition that an item presented for lexical decision is also the solution to the previous RAT item. This does not seem to be the case. When subjects are asked to inspect the six items presented for lexical decision, and decide whether each is the answer to the preceding RAT item, response latencies are about a second longer than when the subjects perform the lexical-decision task (Shames, 1994, Experiment 4). Therefore, the priming effect is emerging before the subjects recognize the target as the solution to an unsolved RAT item.

The difference in priming between solved and unsolved problems is interesting, and has been replicated twice more in experiments discussed here later (Shames, 1994, Experiments 2 and 3; see Fig. 1.3). It may be a form of the Zeigarnik (1927) effect. In the present chapter, however, we want to focus on the priming effects of the unsolved items.

What about the Connor et al. (1992) critique of the Yaniv and Meyer (1987) procedure? Connor et al. suggested that the priming observed by Yaniv and Meyer was due to the general familiarity of information in the cue definitions, rather than any subthreshold activation of the target words, or to a postlexical checking process in which the relation between target and cue facilitated response. We believe that Shames's results are not just item effects, or effects of the RAT cues as opposed to the answers, but rather seem to reflect actual problem-solving activity. Evidence for this comes from another experiment, in which subjects studied RAT items in a recognition-memory paradigm. In other words, they were presented with RAT items to memorize, not to solve. Under these circumstances, there was no priming of the solutions to the RAT task (Shames, 1994, Experiment 2). We find this interesting, because it suggests that activation does not spread automatically from the RAT cues to the corresponding RAT solutions; if it did, the item would prime the solution regardless of the task posed to the subject.

Another piece of evidence against an automatic activation hypothesis is provided by another experiment (Shames, 1994, Experiment 3), in which subjects worked on incoherent RAT items consisting of two related cues, and one unrelated one. In this instance, there was no priming of the common associate to the two related cues. Therefore, the spread of activation toward the item common to the related cues seems to be controlled by the nature of the third cue.

Thus, there are at least two aspects of Shames's data which cast doubt on a cue-familiarity interpretation. First, priming is observed only when subjects perform the RAT task with coherent items, not when they perform a memory task, or when the items are incoherent. Thus, the priming effects cannot be produced by general familiarity with the cues. Second, it takes subjects about a second longer to decide that a target is the solution to an RAT item than to decide that it is a word, so postlexical checking will not help the subjects in this instance. Therefore, Shames (1994) really does seem to have evidence for subthreshold priming by RAT items after all. As Bowers et al. (1990, 1995) have argued, this subthreshold priming of the answers may well form the basis for subjects' intuitions about which RAT items are soluble in the Dyads of Triads task.

INTIMATIONS OF MEMORY

Now let us consider the role of intuitions in memory—by which we mean episodic memory, memory for past events. Most work on intuitions of memory is concerned with FOKs in *semantic* memory tasks, such as answering general-information questions or generating words from their definitions (for early examples, see Brown & McNeil, 1966; Hart, 1965; see also Nelson, Gerler, & Narens, 1984; Reder & Ritter, 1992). Thus, subjects who cannot recall the answer are more or less accurate in predicting whether they will recognize the answer when they see it. In the semantic-memory context, therefore, FOKs are intuitions about what people know. We want to know whether there are similar intuitions about what happened in the past—*feelings of familiarity* (FOFs), perhaps, as opposed to feelings of knowing?

A variety of experiments on episodic metamemory suggest that there are such feelings (Hart, 1967; Nelson, Leonesio, Shimamura, Landwehr, & Narens, 1982; Schacter, 1983). Consider a prototypical experiment in which subjects are asked to study a list of paired associates, and then to recall the response terms when presented with the stimulus terms as cues. Where they fail to do so, they are asked to predict whether they will be able to identify the response terms when presented with them later. It turns out that such intuitions are relatively accurate. Moreover, FOFs rise and fall as a function of the same sorts of encoding, storage, and retrieval variables that affect recall and recognition. Of course, in the paired-associate case, it could be that FOFs reflect the subject's conscious recollection of the stimulus term, rather than any preconscious intuition about the response term. That is, if you recognize the stimulus term from the study list, it is a reasonable bet that you will recognize the response term as well. However, evidence indicates that FOFs are based on information about the forgotten target, not just about the remembered cue. For example, subjects can often recall partial information about the attributes of the response term, even if they cannot reconstruct it completely.

We have been interested in another aspect of people's intuitions about the past. Our thinking in this domain is grounded in Mandler's (1980) two-process theory of recognition memory (see also Atkinson & Juola, 1973; Jacoby & Dallas, 1981). Mandler began by defining recognition as a *judgment of prior occurrence*. In this way, he reminded us, along with Bartlett (1932), that all remembering is problem-solving activity—a task in which the problem is to reconstruct a mental representation of the past. If so, then it is reasonable to expect that we will have feelings of warmth as we come closer to solving the problem of reconstructing the past. Anyway, Mandler (1980) argued that two quite different mental processes contribute to judgments of recognition. The first of these processes, *retrieval*, entails the actual recovery of an episodic memory trace; it is the conscious recollection of an event, including information about the event itself, the spatio-temporal context in which the event occurred, and the self as the agent or patient, stimulus or experiencer, of the event (Kihlstrom, 1996). The second of these processes, *familiarity*, involves the activation of trace information, but not the recovery of contextual information. Recognition-by-familiarity is exemplified by the common experience when a name, or face, or voice "rings a bell": We have a feeling we have met the person before, but we do not know where or when that encounter happened. We are not even sure it happened at all, but if we had to bet, we would say it did. It is a little like that old Rodgers and Hart song (Hart & Rodgers, 1937/1993):

> Some things that happen for the first time,
> Seem to be happening again.
> And so it seems that we have met before,
> And laughed before, and loved before,
> But who knows where or when!

It seems to Mandler, and it also seems to us, that these two recognition processes are differentially related to explicit and implicit memory. Recognition-by-retrieval is obviously explicit, because it entails the conscious recollection of a past event. By contrast, recognition-by-familiarity has something of the character of implicit memory: a change in the individual's experience, thought, or action that is attributable to a past event, in the absence of conscious recollection of that event. Perhaps the activation of memory representations produces what Jacoby and Dallas (1981) called perceptual *fluency*, and this salience underlies both priming effects and the feeling of familiarity.

If so, then we would have an explanation for a puzzling observation in some forms of amnesia, which is that amnesics can sometimes recognize events that they cannot recall. This observation was first made by Huppert and Piercy (1977), and later confirmed by Hirst and his colleagues (Hirst et al., 1986; Hirst, Johnson, Phelps, & Volpe, 1988). It has long been a puzzle, because recognition should not happen under many theories of amnesia. Thus, it has been proposed that amnesia disrupts episodic but not semantic memory (Schacter & Tulving, 1982); or declarative, but not procedural (or at least nondeclarative), memory (Cohen & Squire, 1980; Squire & Knowlton, 1995); or explicit, but not implicit, memory (Tulving & Schacter, 1990). The problem is that both recall and recognition are explicit, declarative, episodic memory tasks. But are they really? We know by now, particularly from the work of Jacoby and his colleagues (e.g., Jacoby, 1991), that there are no pure tests, and every memory task has both explicit and implicit components. This seems to be especially true for recognition. According to Mandler's analysis, recognition-by-retrieval is definitely related to explicit memory, but recognition-by-familiarity is more closely related to implicit memory. If implicit memory is preserved, amnesics might strategically use priming, or perceptual salience, to make recognition judgments by familiarity.

We now know that implicit memory *is* preserved in amnesia, or at least some forms of priming are. However, until recently it was in doubt that implicit memory could support performance on an explicit memory task. Despite the fact that priming and recognition share many common properties (for a review, see Dorfman, Kihlstrom, Cork, & Misiaszek, 1995), Squire and his colleagues (Squire, Shimamura, & Graf, 1985) have argued that the recognition displayed by amnesics is unrelated to priming. Further, they have implied that when recognition occurs it is because the amnesic patients are not densely enough amnesic to abolish all explicit, declarative, episodic memory. Squire et al. buttressed their argument with a study of depressed patients receiving electroconvulsive therapy (ECT)—a treatment that produces both retrograde and anterograde amnesia (for a review, see Squire, 1984). Their focus was on the anterograde component. In the experiment, patients studied three separate word lists, 45, 65, and 85 minutes following a dose of (bilateral or unilateral) ECT, and received tests of word-stem completion and three-alternative forced-choice recognition 15 minutes after each study trial. The bilateral patients showed a profound recognition impairment compared to the unilateral patients and untreated controls, and their performance improved with time as the effects of the ECT remitted. However, the bilateral patients showed no impairment in stem completion at any time. Squire et al. (1985) claimed that recognition was dissociated from stem completion (the former impaired, the latter spared; the former improved over time, the latter did not). Therefore, priming could not form a basis for recognition.

Well, maybe. One problem with the Squire et al. (1985) study is that we do not know what the subjects' criteria for recognition were. If subjects are required to be certain (or think they are), they are most likely to depend on retrieval processes, and to ignore, or discount, feelings of familiarity. However, if subjects are encouraged to guess (or do so anyway), they may capitalize on feelings of familiarity, and their recognition performance might well be related to priming.

It is quite clear that subjects can indeed adopt different criteria for recognition judgments, and that these different criteria yield different outcomes. Subjects can be very conservative, requiring certainty before saying "yes" to a test item; or they can be more liberal, saying "yes" to lots of probes, even when they do not consciously remember them. Of course, we know from the theory of signal detection, if not from common sense, that random guesses will produce lots of false alarms: Hits may go up, but false alarms will go up too, and when we take these into account we may find that recognition does not really improve after all. However, if the feeling of familiarity reflects priming from a previous study episode, false alarms will not go up—or, at least, they will not go up as much. This is because the subjects' guesses are not random, but rather are influenced by experiences of perceptual salience or familiarity; put another way, their guesses are *informed* guesses. They are more like Wallas's (1926) intimations, only in the context of episodic memory, and if subjects rely on these intuitions, their hunches will be right more often than they are wrong.

So, here is the hypothesis:

> if priming produces a feeling of familiarity in response to a cue,

and

> if subjects are allowed, or encouraged, to make strategic use of that feeling,

then

> recognition levels will be genuinely improved over those observed when subjects are discouraged in this respect,

but

> this improvement will occur only if implicit memory is spared in the first place.

It should be clear that in some respects this situation represents the bright side of Jacoby's process-dissociation argument, and its associated method of opposition (Jacoby, 1991; see also Toth, Reingold, & Jacoby, 1994). In his research Jacoby seeks to eliminate conscious influences on test performance, providing an uncontaminated estimate of the extent of unconscious influences. By contrast, asking subjects to shift their criteria for recognition is specifically intended to maximize unconscious influences on task performance.

Let us give you an example from some data on recognition in posthypnotic amnesia. In this phenomenon, subjects cannot remember the events and experiences that transpired while they were hypnotized; in that minority of the population which achieves extremely high scores on the standard hypnotic susceptibility scales (a group known to hypnosis researchers as *hypnotic virtuosos*), this amnesia can be very dense indeed. However, it has long been known (Kihlstrom, 1980) that posthypnotic amnesia spares implicit memory. To illustrate, consider the following results from a study reported by Dorfman and Kihlstrom (1995). Hypnotized subjects memorized a list of words, and then received a suggestion for posthypnotic amnesia worded as follows, after which hypnosis was terminated:

> After you open your eyes, you will not remember the words you have learned, or that you learned any words, until I say to you, *"Now you can remember everything!"* You will not remember anything until then.

A control group memorized the list without being hypnotized, and received no suggestion for amnesia. For the explicit memory test, the subjects were presented with words of which the list items were close associates, as well as an equal number of words associated with nonlist items; for each cue, the subjects were asked to recall a related item from the memorized word list. For the implicit memory test, the subjects were presented with the same sorts of items, and were asked to produce three free associates to each cue (everything was counterbalanced). This procedure revealed a double dissociation between explicit and implicit memory: Hypnotic subjects performed worse than controls on explicit cued recall, but better than controls on implicit free association. Postexperimental interviews, as well as a follow-up study employing Jacoby's method of opposition, strongly suggested that the controls, who remembered the memorized word list perfectly well, consciously suppressed list items that occurred to them as free associates—a suggestion which we are currently pursuing in new research. The important point is that the amnesic subjects showed clear priming on the test of free association. Because implicit memory was preserved in these subjects, we would expect them to show good recognition when encouraged to capitalize on the feeling of familiarity that comes with priming.

We did not have a test of recognition in this study, but we do have relevant data from another series of studies (Kihlstrom, Dorfman, & Tataryn, 1995). In our first study, a group of highly hypnotizable subjects was hypnotized, memorized a list of 16 items, and received a suggestion for amnesia before hypnosis was terminated. Recognition of targets and lures (which were counterbalanced across subjects) was by means of confidence judgments employing a four-point rating scale:

1—You are *certain* that the item was not on the list;
2—You *think* that the item *was not* on the list, but you're not sure;
3—You *think* that the item *was* on the list, but you're not sure; and
4—You are *certain* that the item was on the list.

Such a four-point scale yields three criteria for recognition:

strict—counting only items that receive a rating of "4";
moderate—counting items that receive ratings of "3" as well; and
liberal—counting even those items that receive ratings of "2."

If we plot hits and false alarms, we see that hits rose appreciably as we loosened the criterion for recognition (Fig. 1.4). False alarms also increased somewhat, but not commensurately, so if we calculate *d′* (from the pooled data), we get increasing values of *d′* for the strict, moderate, and liberal criteria, respectively. We think that this improvement in recognition comes

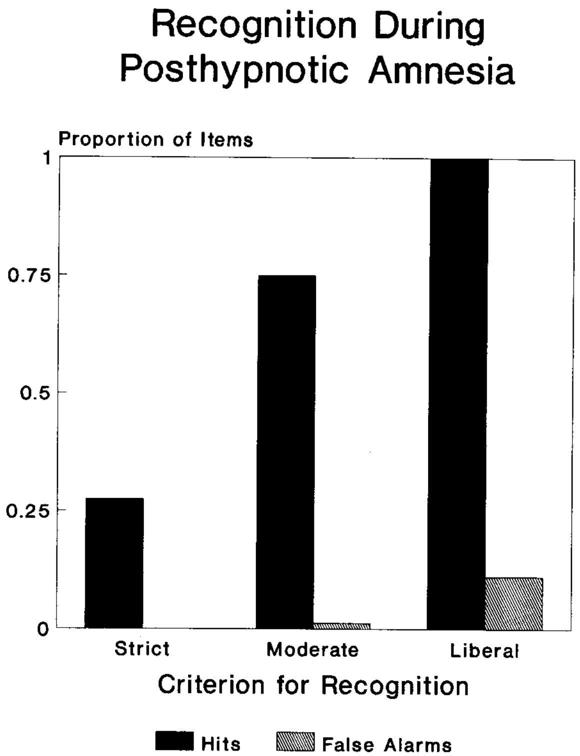

FIG. 1.4. Recognition memory under three criteria during posthypnotic amnesia. Adapted from Kihlstrom, Dorfman, and Tataryn (1995).

from priming, which creates a feeling of familiarity, or an experience of perceptual salience, without the retrieval of contextual information; put another way, priming informs the subject's recognition judgments.

We have other studies of recognition in posthypnotic amnesia that yield substantially the same results, but we wanted to have an experiment in which we could look at priming and recognition in the same subjects; and we also wanted to test our ideas in another form of amnesia. For this purpose, Dorfman et al. (1995) took a leaf from Squire et al. (1985), and reexamined priming and recognition in ECT-induced amnesia. Their experiment was modeled after that of Squire et al., but examined retrograde rather than anterograde amnesia. The patients studied a list of items 10–30 minutes prior to receiving a dose of bilateral ECT, and their memory was tested 50–60 minutes later in the recovery room. The list items were divided into four sets (counterbalanced), each of which was subject to a different form of memory test. Explicit memory for one set of items was tested by stem-cued recall, implicit memory for a second set by stem completion.

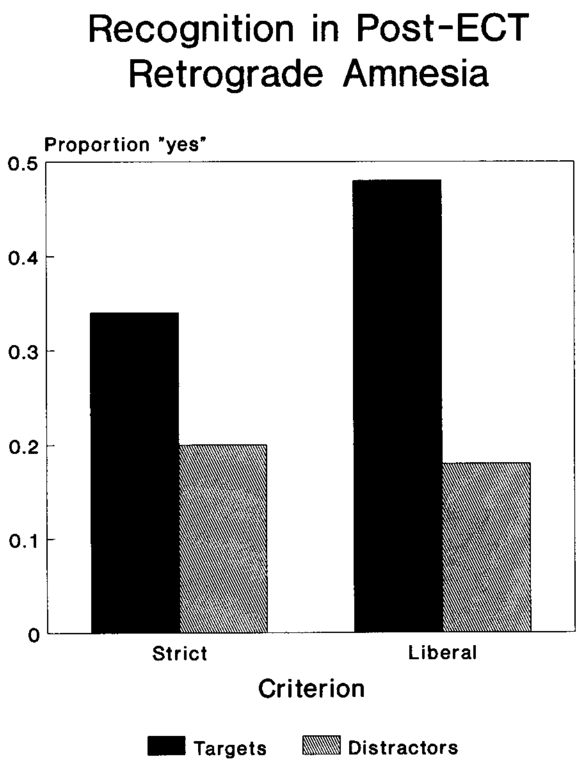

FIG. 1.5. Recognition memory under two criteria during post-ECT retrograde amnesia. Adapted from Dorfman et al. (1995).

The subjects showed very poor stem-cued recall, compared to a control group, but performance on stem completion was unimpaired. Recognition memory for the third and fourth sets of items was tested by a yes/no procedure: For the third group, the subjects were instructed to adopt a strict criterion for recognition, saying "yes" only when they were certain that the item was on the list; for the fourth group, they were instructed to adopt a liberal criterion, saying "yes" if they thought that the item was old, even if they were not sure. Figure 1.5 shows the results. The strict criterion showed the expected impairment; under the liberal criterion, hits went up, but false alarms did not, so that there was actually an increase in d' with the shift in criterion. The important point is that recognition was spared, to at least some degree, when priming was spared—provided that subjects were allowed, or encouraged, to capitalize on the feeling of familiarity that comes with priming.

To sum up, these experiments reveal something interesting about the relations between metacognition and implicit memory. Metacognition, as reflected in subjects' intuitions about which items *might* have been on the list, was clearly associated with priming, a classical expression of implicit memory. We think this is the same sort of priming that Shames (1994) observed, which in turn lies at the basis of the problem-solving intuitions captured by Bowers and his colleagues (Bowers et al., 1990, 1995)—thus bringing us full circle.

INTIMATIONS, INTUITIONS, AND IMPLICIT THOUGHT

What Wallas called intimations, Bowers (1994) called *intuitions*: They reflect the person's feeling that a decision, judgment, or solution is correct, in the absence of supporting evidence, or even in the face of evidence to the contrary. Intuitions of this sort have not received much attention from cognitive psychologists: Two recent historical surveys of thinking and problem solving (Dominowski & Bourne, 1994; Ericsson & Hastie, 1994) make no reference to the term at all.[3] The term *intuition* does not appear in the index to a comprehensive, and otherwise excellent, textbook on thinking and problem solving (Sternberg, 1994)—although in his contribution to that volume, Hunt (1994) does speak of the transition "From Intuitions to Problem Spaces" (p. 216)—as if the former have been abandoned in favor of the latter. Modern research on thinking and problem solving has a strongly analytic flavor to it, what with its emphasis on mental representation and computation, hypotheses and strategies, and knowledge and

[3]For a systematic analysis of intuitions, written as modern research on thinking was only just beginning, see Westcott (1968).

skill. As Bowers (1994; Bowers et al., 1995) has noted, the very notion of intuitions seems antithetical to the information-processing approach—too right-hemisphere, too warm and fuzzy, too touchy-feely, too—well, too California. By contrast, we wish to argue that intuitions are very *Pittsburgh*—that they can be understood in terms of activation, priming, and other concepts that are part and parcel of modern information-processing theory. Intuitions are not beyond the pale.

Bowers (1994) has noted that "intuition is often tainted by an implication of irrationality, illogicality, or mental laziness" (p. 613). This identification of the intuitive with the irrational underlies Ross's (1977) classic paper on "The Intuitive Psychologist and His Shortcomings," Nisbett and Wilson's (1977) essay "On Telling More Than We Can Know," and many applications of the heuristics approach to judgment and decision making (e.g., Nisbett & Ross, 1980). Just because intuitions are sometimes wrong, however, does not mean that we should not have them, or that we should not use them. In fact, because thinking generally proceeds from partial information to complete information (Newell & Simon, 1973), intuitions must play a central role in thinking, reasoning, and problem solving.

Presentation of a problem, or a retrieval cue, activates and integrates relevant preexisting knowledge structures, and in the course of solving the problem, or remembering the event, the cognitive system builds on these structures, accruing new information and gradually approaching a solution. These activation and elaboration processes are one basis for implicit memory (Dorfman, 1994), so it should not be surprising that they are revealed in phenomena such as priming. In the final analysis, intuitions form part of the motivational backdrop for problem solving, remembering, and thinking in general, because our sense that a problem is soluble, that some fact resides in our mental storehouse of knowledge, or that a past event happened, provides us with reasons for persevering at the task at hand when we might otherwise give up. Andrew Wiles, the mathematician who has apparently proved Fermat's last theorem, would never have devoted 7 years of his life to the task if he had not had the intuition that the path to success was through the Taniyama–Shimura conjecture.

Moreover, as Bowers (1994) has argued, intuitions represent our tendency, as intelligent problem solvers, to go beyond the information given by a problem or a retrieval cue. If that journey sometimes leads us astray, it also sometimes leads us in profitable new directions. Thus, intuitions are an important part of the creative process. As Ferris (1995) has noted in his comments on the passage from Sandage and Bedke (1994) that forms the epigram to this chapter, intuitions are the way out of the closed cognitive loop of induction and deduction.

From the experiments described in this chapter, it appears that the processes underlying intuitions closely resemble those which underlie implicit memory. In recognition, people's intuitions about the past—the feeling of familiarity, in the absence of full recollection—seem to be based on the perceptual fluency that comes with priming. Here, we have a case in which people can strategically capitalize on implicit memory in order to perform an explicit memory task. Priming can also underlie people's intuitions in more traditional problem-solving situations as well. These intuitions are not exactly implicit memories, because they are not representations of past events. Nor are they implicit percepts (Kihlstrom, Barnhardt, & Tataryn, 1993), because they are not representations of current environmental stimuli. We actually think of these mental states as *implicit thoughts* (Kihlstrom, 1987, 1990): instances in which an idea or image influences experience, thought, or action in the absence of conscious awareness of what that idea or image is. Having thoughts, and even knowing that we have thoughts, but yet not knowing what those thoughts are, is a metacognitive puzzle that further research on implicit memory and related phenomena should help us to solve.

For the present, however, it is clear that problem solutions, like memories, are not discontinuous, all-or-none affairs, remaining entirely unconscious until they emerge full-blown into the full light of consciousness. There is a point, as they approach and cross what Wallas (1926), following William James (1890), called the "fringe" of consciousness, when we know they are coming, even when we do not know what they are. This is the point, between preparation and insight, where intuitions occur.

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