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7 Getting Into and Out of Mental Ruts: A Theory of Fixation, Incubation, and Insight

Steven M. Smith

SPINNING YOUR WHEELS

When my partner, Stan, saw Roger's truck slip into the mud on the construction site where we were working, he laughed, slapped his knee, and guffawed, "Now, *that* is what you call spinning your wheels!" Roger alternately spun his wheels forward and backward, digging his truck quickly into a rut up to the axle. Stan didn't let up on Roger the whole time we were towing him out of the rut, but he stopped laughing a few minutes later when it was our truck that slipped into the mud. I mentioned something about Roger getting his revenge, but Stan just shook his head and told me to get a 50-pound sack of quicklime from the back of our truck. We spread the lime on the mud in front of and behind the tires. "Time for a break," Stan announced, and although I didn't understand why at the time, I wasn't about to argue about taking a break. After the break, Stan started up the truck and put it slowly in gear. I expected him to sink quickly up to the axle but, to my surprise, the quicklime had made a new crust on top of the mud, providing just enough traction for the tires to grip, and he drove straight out.

In this case, getting out of a trap was not accomplished by trying harder and sticking to the job; spinning his wheels faster only got Roger deeper into the rut. What was needed was time to allow conditions to become more favorable for getting out of the trap. Analogously, in our thinking, we sometimes start spinning our mental wheels; that is, we work harder and harder at a frustrating problem, but succeed only in getting deeper into a mental rut. In these cases, allowing time for mental conditions to become more favorable for getting out of a mental trap can facilitate discovery of insight into a problem's solution. In this chapter, I will explain what insight has to do with mental ruts, and I will suggest some ways for climbing back out of such ruts.

Although there are many ideas about how insight can be achieved, most approaches are *constructive*, describing, for example, how an insight can be incrementally assembled from parts, how prior knowledge can be transferred or mapped from another domain, or how unconscious sensitivity to a problem helps us notice relevant ideas when they occur. My approach, however, focuses not so much on how insight is constructed but rather on what prevents insight experiences from occurring. Probabilistically speaking, ideas are more likely to pop unexpectedly into mind once we stop ourselves from blocking those thoughts. Although there may be many causes of insight, it is my contention that incubation improves the chances that insight experiences will occur by facilitating escape from the mental ruts that block insight. Furthermore, I propose that patterns of fixation, incubation, and insight in problem solving resemble certain memory phenomena and can be explained, in part, in terms of a theory of memory interference and recovery.

INCREMENTAL PROGRESS VERSUS RESTRUCTURING IN INSIGHT

Experimental psychological research on insight was conducted by Gestalt psychologists, including Köhler (1925), Maier (1931), and Duncker (1945). They characterized insight as a sudden shift in the problem's *gestalt*, or a spontaneous restructuring of the problem's mental representation. This sudden restructuring was supposedly similar to the perceptual restructuring that can occur, for example, when shifting back and forth between alternate interpretations of certain optical illusions.

In the early 1980s, Robert Weisberg and his colleagues revived the subject of insight in order to debunk what Weisberg (1986) referred to as the "myth of insight." Weisberg's characterization of the Gestalt position stated that (1) subjects can fixate (or get stuck) on unwarranted assumptions about a problem because of past experience; (2) this fixation prevents insight; (3) if the source of fixation is removed, insight will occur quickly; and (4) remembering one's past experience is not a central factor in solving insight problems.

Weisberg (1986) proposed that past experience *is* very important for solving problems, although one's retrieved knowledge can be used and combined in novel ways. He also stated that removing mental blocks does not result in a rapid restructuring that leads to successful problem solving (e.g., Weisberg & Alba, 1981), showing that certain so-called insight problems could not be rapidly solved merely because subjects were informed explicitly about blocks that had been traditionally assumed to prevent solutions. He has concluded that insight problems are solved via an incremental accumulation of knowledge relevant to the solution.

In the late 1980s, however, Janet Metcalfe offered important new evidence in support of the restructuring position. Metcalfe (1986a,b; Metcalfe & Wiebe, 1987) examined metacognitions (awareness of one's thinking) as a way of assessing insight and noninsight processes. In her studies, she found that subjects were unable to predict their eventual success on insight problems, whereas they could predict success on memory tasks and noninsight problems. Metcalfe concluded that subjects' lack of partial knowledge of solutions showed that solutions to insight problems do not involve a gradual accrual of remembered knowledge relevant to the problem. If information were remembered gradually during work on insight problems, then subjects should be aware of that partial knowledge, just as they are during work on noninsight problems. The alternative explanation involves a radical transformation in the problem's gestalt (i.e., the conceptualization or mental representation of the problem).

Metcalfe also tested metacognitions of impending solutions during problem solving, asking subjects at 10-second intervals for subjective warmth ratings whereby *warmer* meant "closer to a solution." This on-line metacognitive monitoring technique shows that warmth ratings increase in a gradual, incremental pattern prior to solution of noninsight problems. With insight problems, however, subjective warmth ratings sharply increased only seconds prior to solving a problem. Furthermore, when subjects worked on insight problems, it was found that gradually increasing patterns of warmth ratings were more likely to herald an impending failure rather than an impending solution.

Do solutions of insight problems occur as a rapid restructuring of the problem's gestalt, with ideas breaking suddenly and unexpectedly into awareness? I believe that understanding the role of mental blocks can bring us closer to answering this question.

A PROPOSED VIEW OF INSIGHT

Definitions

To begin, I propose that a distinction be drawn among the terms *insight*, *insight experience*, and *insight problem*. *Insight* I define as "an understanding." Insight can refer, for example, to understanding a mechanism, an analogy, an inductive principle, or a reconceptualization. By this definition, insight can be acquired in a variety of ways, including an incremental acquisition of knowledge or via a sudden realization of an idea. The mode of acquiring insight may be independent of its subsequent use: An insightful discovery that dawned suddenly and unexpectedly in the mind of a creative genius can usually be explained to others in increments, as evidenced by the teaching of the brilliant insights of Darwin, Pasteur, or Einstein to college students.

The *insight experience* is the sudden emergence of an idea into conscious awareness, the "Aha!" experience. This is the phenomenon that seems to have been the focus of Gestalt psychologists and studies that have emphasized metacognition (Metcalfe, 1986a, 1986b; Metcalfe & Wiebe, 1987). Metcalfe and Wiebe (1987) defined insight in terms of the metacognitions immediately preceding the moment when a solution is reached. According to this view, abrupt increases in warmth ratings define insight, whereas incremental increases in warmth indicate noninsight problem solving.

It is important to note that insight experiences need not result in profound earth-shattering ideas, such as the theory of evolution, or the idea of special relativity in physics. According to this definition, the essential elements of insight experiences are that ideas are sudden and unexpected, not that they are profound or important.

An *insight problem*, in contrast to a noninsight problem, is one for which the solution is more likely to be reached via an insight

experience. The solution to a noninsight problem is less often realized in a flash but is usually constructed incrementally. Because it is expressed relatively and probabilistically, this definition leaves room for the variability in problem solving caused by individual differences and situational factors. Not every solution to an insight problem need be generated by an insight experience, and noninsight problems might be solved via an insight experience. The definition states that the population of solutions for insight problems is more likely than that of solutions for noninsight problems to result from insight experiences.

There are at least two important reasons for identifying insight problems. One is that experimental studies of insight experiences must have a means of eliciting the phenomenon of interest. A second is that examination of insight problems may reveal something important about the nature of insight experiences.

The abruptness and unexpectedness of insight experiences resembles other "mind-popping" phenomena in which a memory or idea emerges suddenly into awareness (Mandler, 1992). Mandler's examples of mind-popping include reminiscence in recall (i.e., remembering something one had not recalled on a previous attempt), incubation in problem solving, and recall of dreams. These are all situations in which conscious constructions arise independently of conscious intentions. Another example is the "pop-up" memory—that is, a retrieval block that is resolved without deliberately searching memory (Reason & Lucas, 1984). Although insight experiences have historically been described as resembling perception, it is apparent that insight experiences also resemble certain types of remembering, particularly those memories that burst suddenly and unexpectedly into consciousness.

Insight experiences often entail an abrupt and unanticipated resolution or transcendence of blocks. Whether resolution of blocks is definitional to insight experiences is open to debate and empirical testing. What I propose is that block resolution is a common feature of insight experiences.

Restructuring is "structuring again," an alteration of a cognitive representation. In contrast, forming an original cognitive structure to represent a problem does not necessarily involve destruction or alteration of another. Ideas on restructuring typically focus on the new cognitive structure, the one on which a final solution is ultimately based, not the original cognitive structures that resulted in failed attempts. The cognitive structures representing initial solution attempts have in common the fact that they do not produce satisfactory problem solutions; if they did lead to solutions, restructuring would not be necessary to achieve insight.

A structure for solving a problem can be thought of as a plan, one that uses a set of operations, and it envisions the type of solution that will be produced by the plan. Plans may vary in their specificity, but even vague plans can be used to attain an expected type of goal. I propose that the cognitive structure revealed in an insight experience is one that did not fit an earlier plan. Noninsight problem solving, in contrast, proceeds within a plan.

If initial plans lead to a solution, or serve as the basis for a solution, then they require no restructuring. Inappropriate plans, however, may hinder discovery of a solution, inadvertently causing a block. Therefore, restructuring involves transcendence of blocks, or revision of plans. It is not necessary actually to have instituted and rejected plans for them to constitute blocks; blocks can be said to occur as long as the inappropriate plans compete or interfere with the cognitive structure that represents a satisfactory solution.

The approach to insight that I have described here is consistent with Metcalfe's results that relate metacognitive warmth ratings to success and failure on insight and noninsight problems (1986a, 1986b; Metcalfe & Wiebe, 1987). If an appropriate gestalt of a problem is initially blocked, then one cannot know how near an appropriate solution is. If the appropriate gestalt is blocked because one is engaged in an inappropriate approach, then incremental feelings of increasing warmth would be based on work completed toward an incorrect solution, which is demonstrated by Metcalfe's (1986b) finding that high warmth ratings tend to indicate impending failures on an insight problem. The variety of blocks that can impede insight I refer to as cases of *fixation*, which I define as "a counterproductive use or undesirable effect of prior knowledge."

Fixation

The primary thesis of this chapter is that fixation blocks insight experiences from occurring. Traditionally, the term *fixation* has been used to refer to an inappropriate adherence to an approach to solving a problem, but I have expanded the definition somewhat to encompass other situations, including remembering and generating creative ideas in more open-ended tasks. Classic demonstrations of fixation in problem solving include Maier's (1931) two-string problem and Luchins and Luchins's (1959) water-jar problem, both of which have been described in detail elsewhere (see chapter 1). Rather than reiterate these cases, I will present more recent examples of blocks in memory and problem solving from my own research.

Fixation in Memory

In terms of research in human memory, the basic concept of interference, or response competition, is most typically used to explain how one piece of learning can negatively affect the use of another learned response. As simplified in figure 7.1, given the stimulus, the probability (p) of retrieving the target response is perfect ($p = 1.00$) when the target is the only associated response (figure 7.1A). The probability of retrieving the target response decreases if there is another competing response associated with the stimulus, because there is some chance that the competing response

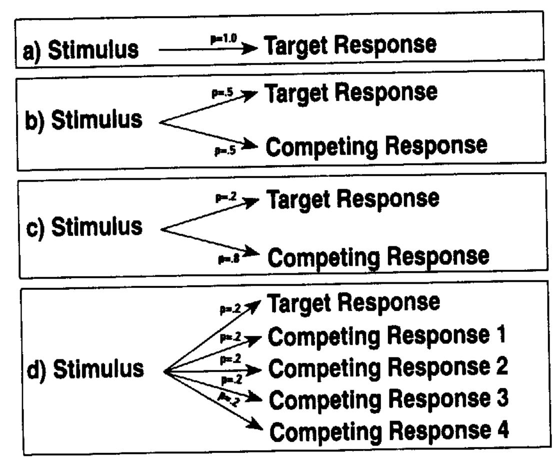

Figure 7.1
Interference as response competition. The probability of retrieving the target response decreases as the number and strength of competing associations increases.

will be retrieved instead of the target (figure 7.1B). This is how response competition operates in this simplified model of interference. Furthermore, the stronger the association between the stimulus and a competitor (figure 7.1C), and the more competing responses there are (figure 7.1D), the less chance there is that the target will be retrieved when the stimulus is used to cue memory.

For example, if the only chemical company you knew was Dow Chemical, then it would be fairly easy to retrieve the name of the company when asked who it is that manufactures napalm. If, however, you also knew other chemical companies, such as DuPont and Monsanto, the chance of retrieving Dow would be decreased, because there would be some possibility of retrieving DuPont or Monsanto instead.

Interference effects can be momentarily increased if you retrieve the interfering competitors. Extending the previous example, once the names Dow, DuPont, and Monsanto are primed, it becomes more difficult to think of the name of the chemical company responsible for the toxic gas leak that killed thousands in Bhopal, India, in 1985. (*Hint*: It was *not* Dow, DuPont, or Monsanto.) Similarly, priming the words *compass*, *astrolabe*, and *protractor* may make it more difficult to remember the correct word for the navigational instrument used for measuring the angle from the horizon to a heavenly object. Such momentary memory blocks are referred to as *tip-of-the-tongue* (TOT) states when the blocks are accompanied by subjective feelings that retrieval of targets seems imminent. This subjective sense of *imminence* goes beyond the more commonly studied feeling that one knows the answer to a question; imminence refers to feeling that after only brief moments the answer will burst into consciousness.

In fact, successful recall is *not* necessarily imminent, even though it may seem to be at the time when one experiences a TOT state. My experimental studies (Smith, 1991) show that few TOTs are resolved (i.e., few correct targets are finally retrieved) if subjects work continuously on retrieving targets, particularly when competitors (e.g., Dow, DuPont, Monsanto) are shown to the subjects in TOT states. I am repeatedly reminded of this fact whenever I experience a TOT state while I am speaking before a crowd of people. If I interrupt my talk to concentrate on remembering a momentarily blocked word or name, I am inevitably frustrated in my attempts to recall the target. This is particularly problematic when a competing word or name keeps intruding. (*Note*: If you are suffering from a TOT experience, the correct chemical company name in the Bhopal, India, case will be given later in this chapter.)

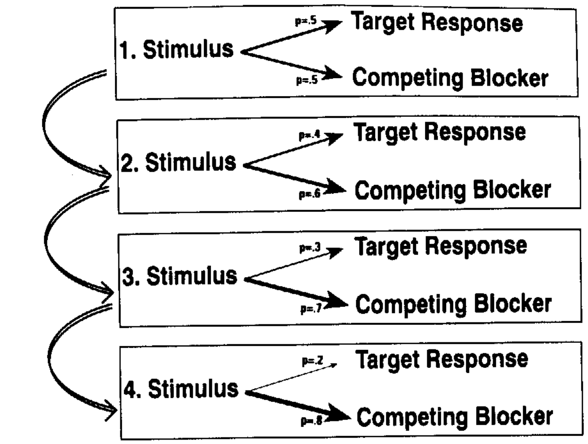

Figure 7.2
The mental rut. Accessing the target becomes increasingly difficult each time the competing blocker is retrieved and incremented in strength.

This pattern, in which a block worsens because attempted memory retrievals strengthen the block, describes a *mental rut.* Each time a retrieval attempt is made, the competing blocker is retrieved instead of the correct target, and the blocker becomes temporarily more strongly associated with the stimulus being used to cue memory. The developing strength of fixation is depicted in figure 7.2. This model of fixation can be generalized to other situations beyond memory retrieval, as will be shown later.

Fixation in Problem Solving

Fixation in problem solving can be demonstrated in the problem depicted in figure 7.3. The problems are rebuses, picture word puzzles that suggest common phrases. The phrase depicted is the solution to a rebus. For example, the solution to the example rebus shown in figure 7.3 is *just between you and me*, a common phrase indicated by the word *just* between the words *you* and

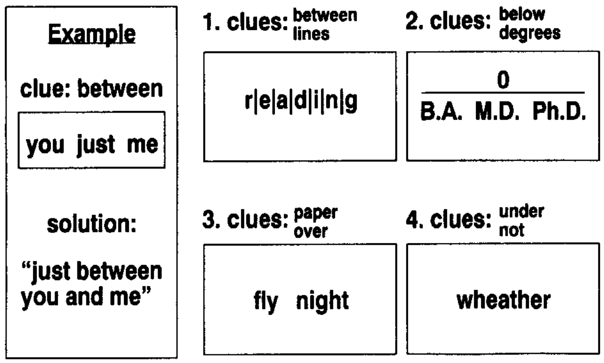

Figure 7.3
Rebus problems. The solution to each problem is a common phrase suggested by the words inside the box. Potential hints are shown above each problem.

me. Now try the other four problems in figure 7.3. Included with each problem is a clue that might give you a hint about the solution. Work the problems from easiest (1) to most difficult (4) for the best effect.

From the first two problems you might learn that the clues are very useful and that the solution often involves the relative positions of the letters and words. The solution to the first is *reading between the lines* and involves the positional element *between.* The solution to the second problem is *three degrees below zero,* this time using the positional element *below.* The third problem might temporarily stump you if you had just completed the first two, because the clues are intentionally misleading, suggesting the phrases *fly paper* and *overnight,* neither of which is the correct solution, *fly by night.* The clues are likewise misleading for the fourth problem and, worse yet, it does not use a positional phrase as in the previous problems. Thus, as illustrated in figure 7.4, work on the earlier problems can cause fixation at different levels. In this case, the search for a solution can be diverted away from the correct target (*ill spell of weather*) at the last step by priming an incorrect piece of information (e.g., the phrases *whether or not* and *under the weather*) or at an earlier step by priming the wrong approach to the problem (e.g., positional solutions). Fixation can conceivably act at any stage of problem solv-

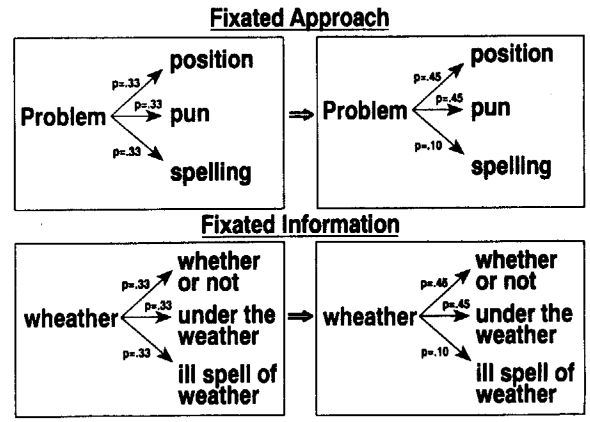

Figure 7.4
Two levels of fixation. Inappropriate approaches to a problem, as well as inappropriate information, can block target approaches and target information if the blocks are temporarily strengthened.

ing, affecting, for example, one's representation of the problem or the knowledge domain in which one analogically searches for ideas.

In problem-solving situations contrived for laboratory research, fixation in a variety of forms has been clearly demonstrated (e.g., Luchins & Luchins, 1959; Maier, 1931; Smith & Blankenship, 1989, 1991). It seems fair to ask whether fixation would have a similar constraining effect on ideas in more realistic tasks, such as the process of creative engineering design. Therefore, with David Jansson, a mechanical engineer, I studied what we referred to as *design fixation,* which we defined as "a counterproductive effect of prior experience on the generation of creative designs aimed at solving a realistic problem" (Jansson & Smith, 1991). Some of the creative design tasks, for example, asked design engineers to generate ideas for a bicycle rack, a measuring cup for the blind, a disposable spillproof coffee cup, and a biomechanical device for taking readings inside of the intestine. In each experiment, all the engineers received the same problem, but half, in addition, were shown an example design. All the experiments showed that the creative designs conformed to the examples when they were given, as compared to the designs of those who

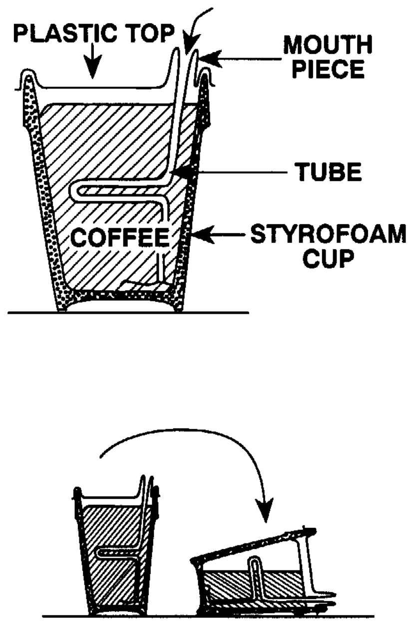

Figure 7.5
Disposable spillproof coffee cup example shown to subjects to induce design fixation. (Reprinted with permission from D.G. Jansson and S.M. Smith [1991], Design fixation. *Design Studies, 12*[1], 3–11.)

had seen no examples. This conformity occurred even for detrimental features of the examples and even when engineers were explicitly told to avoid those negative features. For example, when designers were shown the sketch in figure 7.5 as an example of a disposable spillproof coffee cup, they were instructed not to use straws or mouthpieces in their designs (mouthpieces prevent cooling while sipping the coffee and can cause scalding). Nonetheless, 56 percent of the designs by these subjects did include a straw or mouthpiece, compared to 11 percent of the designs of those who had not seen the example. Clearly, fixation can occur in creative engineering design, a perfectly realistic task in which insights are needed. This mental rut apparently is difficult to prevent by simply telling people to avoid it.

How, then, does one overcome fixation to achieve insight? My current answer to this question is probabilistic rather than deterministic: That is, I contend that incubation, or getting away from

a fixated problem, can increase the chances of avoiding the block and achieving insight.

Incubation

Not much of a traveler, I was curious when I found a retractable cord that would stretch across the tub and latch to the opposite wall in the hotel room where I once was staying. I could have asked anybody what its function was (and I have found out since then that nearly everyone knows), but I took on the problem as a challenge. My best guess at first was that it was a safety device for grabbing onto if one were to slip in the shower. Later I realized that the line was too flimsy for this purpose and would be more a hazard than a safety feature. Then I guessed that it might prevent the shower curtain from attacking me and enveloping my body the moment the shower was on, but I soon found out that the line prevented no such attacks. Daunted and unsatisfied, I put the problem aside. Months later, at another hotel, I saw another of these lines across the tub, but there was no shower nor was there any evidence that there had ever been a shower curtain. Baffled at first at this new twist, it suddenly dawned on me that the line was for hanging out hand-washed clothing to drip dry over the tub and had nothing at all to do with showering.

When initial work on a problem reaches an impasse, we may put the matter momentarily aside. Sometimes, when involved in some unrelated activity during the break or on returning to the problem after the break, a solution will suddenly burst into awareness. This phenomenon, as illustrated by my clothesline realization, is known as *incubation* or, more accurately, an *incubation effect.* Incubation effects are labeled as such only when the time away from the problem leads to *illumination*, another term for an insight experience. The example of my clothesline experience is not a particularly profound or important realization, but it fits my earlier definition of an insight experience because the idea burst suddenly and unexpectedly upon me.

Incubation effects also occur commonly when trying to recall a word or a name. In cases in which we cannot recall a name during a conversation, on an examination, or while giving a talk, the solution is not to continue trying to recall the name but rather to put the matter aside momentarily, because the name is likely to pop into mind later. Inconveniently, retrieval of the errant word or name tends to occur once it is already too late to be useful.

The term *incubation* suggests a biological metaphor, implying that the cognitive pattern resembles a process similar to biological maturation. When an egg is laid, the opaque shell prevents us from seeing the development proceeding within, much as the unconscious proceedings of the mind may be invisible to introspection. According to this metaphor, development of an insightful idea occurs via invisible unconscious processes. The fully mature idea then pops rapidly into awareness once the unconscious development is complete.

The term sometimes used for the idea that insights are created unconsciously while the conscious mind is otherwise occupied is the *unconscious work hypothesis*. Like the little elves that would cobble beautiful shoes only while the cobbler was sleeping, unconscious mental forces are imagined to work away at insights only when the conscious mind temporarily retreats. This is a compelling explanation because when incubation results in insight, it seems that work must have been needed for such a wonderful idea but there is no awareness of the work that went into the insight. Because we can do so many complicated things without much apparent conscious attention (e.g., ride a bicycle, use a fork, tie shoelaces), it may make sense that unconscious processes can create insights as well.

If information critical for an insight experience is not accessible during one's initial work on a problem, but it is accessible later, after time away from the problem, then we can try to explain the change in accessibility in terms of a memory model. This pattern of increasing accessibility of critical information over time is illustrated in figure 7.6. The unconscious work hypothesis, as described earlier, suggests that forces of which we are unaware act during incubation intervals to increase the accessibility of information critical to an insight experience. A slow-spreading activation mechanism, as proposed by Yaniv and Meyer (1987), could support such a pattern of increasing accessibility over time. If information critical to an insight is not retrieved during initial work on a problem, but is partially activated by those initial attempts,

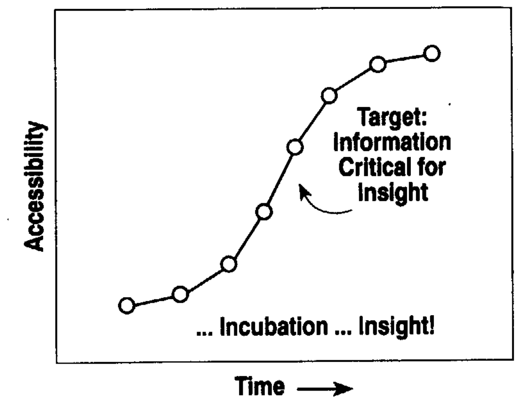

Figure 7.6
Pattern of increasing accessibility of critical target information underlying incubation effects.

then the critical material is "sensitized." Subsequent encounters with stimuli related to the critical information then become more likely to elicit retrieval of that information, thus leading quickly to an insight into the solution of a problem.

Another memory theory, however, provides a different explanation of how incubation can increase the accessibility of critical information. This theory is based on a classic interference pattern of spontaneous recovery (e.g., Barnes & Underwood, 1959; Mensink & Raaijmakers, 1989), and is graphically described in figure 7.7. The pattern of interference begins at the left side of the figure with competition among responses, much the same as described earlier in the discussion of fixation and memory. A well-learned response, labeled *A*, is initially blocked by a more recently learned response, *B*. An interesting finding concerns the time course of this interference effect. Response A recovers spontaneously, or at least without any conscious effort, becoming increasingly accessible over time as response B weakens, in effect losing its power to block response A. This pattern shows an incubation effect for response A; an initially blocked memory is more likely to be accessed due to time away from the block.

The same pattern of shifting accessibility explains why TOT experiences are more easily resolved by taking time away from

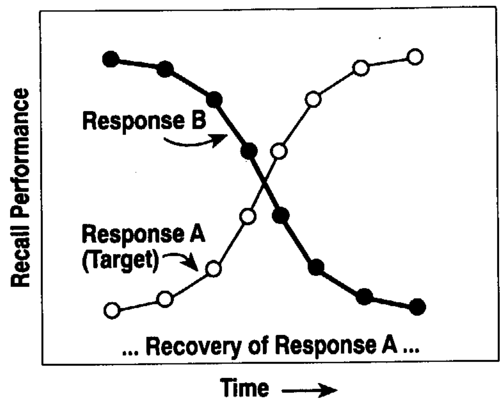

Figure 7.7
Classic pattern of retroactive interference and recovery of original response A. Response A, initially blocked by stronger response B, recovers and increases in accessibility over time as B loses strength.

memory retrieval attempts. Continuing to search for the correct target word or name may serve only to deepen the mental rut, strengthening the retrieval block, as shown at the left of figure 7.7. Taking time away from attempts to retrieve the target allows competing blockers time to lose strength, so that the correct target will be relatively more accessible.

Analogously, this pattern of interference and recovery describes fixation, incubation, and insight in problem solving, as shown in figure 7.8. Here fixation is analogous to the initial memory retrieval block shown in figure 7.7, with critical target information blocked by competing approaches, problem representations, or specific pieces of information. This state of fixation can arise, for example, from a mental rut, as described earlier; continuing to use an inappropriate solution or problem-solving approach can strengthen the competing material. Once the problem is put aside, the strengthening of the fixation ceases and the accessibility of the blocking material instead begins to decrease, as shown in figure 7.8. Incubation time—the time away from the problem—therefore allows the target information to increase in relative accessibility, and this increase in accessibility improves the chances that an insightful solution will be realized.

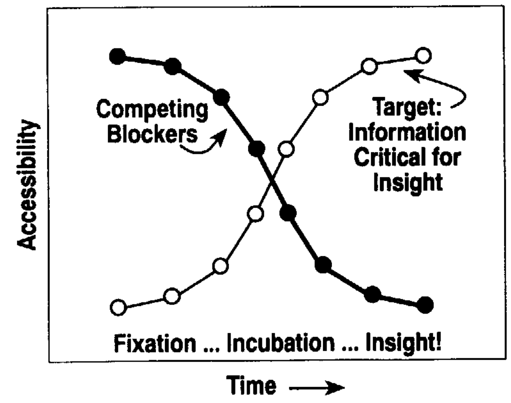

Figure 7.8
Fixation, incubation, and insight as a pattern of changing accessibilities. Initial fixation is caused by competing blockers. After an incubation interval, critical information becomes more accessible, and the chances of an insight experience increase as blockers lose their strength.

Experimental Evidence of Incubation Effects

From a scientific point of view, methods for observing incubation effects and insight experiences in controlled situations are highly desirable if we expect to learn about these phenomena. The usefulness of insight problems, for example, is that they can be used in the laboratory to induce and study insight experiences. Are there also reliable methods for inducing and studying incubation effects?

Incubation effects are common in everyday life, and writers have referred to them at least as early as Wallas (1926), who described incubation as one of the fundamental stages of problem solving. One might think that the experimental psychology research literature would be replete with studies of incubation effects and that by now there would be standard laboratory and classroom methods for producing and observing the phenomenon. However, this is not so. In investigations of incubation, no effects were found by Dominowski and Jenrick (1972), Olton and Johnson (1976), Gall and Mendelsohn (1967), and Gick and Holyoak (1980). Dreistadt (1969) and Fulgosi and Guilford (1968) reported incubation effects, but Olton and Johnson (1976) failed to replicate both findings. Murray and Denny (1969) reported a single effect, restricted to high-ability subjects, yet Patrick's (1986) one finding of an effect occurred only among low-ability subjects. Neither study has been reproduced in a published report. In fact, only a few published articles have ever reported replicated experimental evidence of incubation in the laboratory. The sparseness of experimental evidence has been noted repeatedly in literature on the subject (Kaplan & Simon, 1990; Olton & Johnson, 1976; Smith & Blankenship, 1989, 1991). Is the scarcity of replicable incubation effects attributable to incubation being a rare and enigmatic phenomenon? My observations lead me to believe otherwise.

Consider this: When someone expediently solves a problem, the situation is not relevant to incubation. If someone cannot ever solve a particular problem, incubation will not help. The only situation relevant to incubation is one in which, at the moment, someone has failed to solve a tractable problem. Clearly, incubation can occur only in situations in which problem solving reaches a temporary impasse. Why would people come to an impasse while working on a tractable problem? One possibility is that they are blocked from the knowledge necessary for solving the problem. Thus, I have proposed that incubation effects can be observed if tractable problems are initially blocked, and my experimental studies have supported this hypothesis.

For example, Smith and Blankenship (1989) examined fixation and incubation using rebus problems, such as the four problems shown earlier in figure 7.3. The critical rebus problems in that study were accompanied initially by misleading clues and then were retested either immediately after the initial work on the problem or after a delay. On the retest, subjects first attempted to solve the problem and then tried to recall the misleading clue that had initially been shown with the problem. Figure 7.9 shows both problem-solving performance and recall of the misleading clues as a function of the delay of the retest. In four experiments, retesting produced greater improvement with longer delays, repeated evidence of incubation effects. The improvements in problem solving with longer delays were accompanied by poorer memory of the misleading clues. This pattern of results looks very similar to the theoretical patterns of interference and recov-

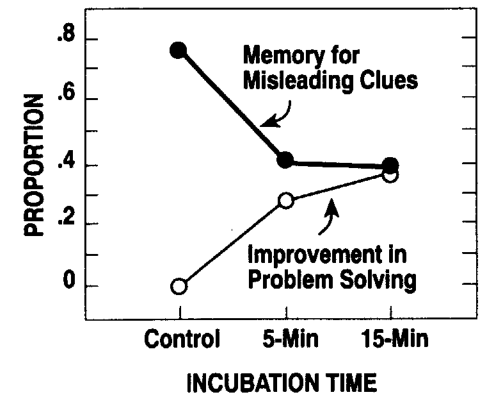

Figure 7.9
Improvement on initially failed problems and memory for misleading clues as a function of incubation time. Longer incubation produced more problem-solving improvement and poorer memory of misleading clues. (Adapted with permission from S.M. Smith and S.E. Blankenship [1989], Incubation effects. *Bulletin of the Psychonomic Society*, *27*, 311–314.)

ery described earlier (see figures 7.7 and 7.8). The misleading cues acted as competing blockers, initially strong and gradually becoming less accessible over time. The information critical for solving the rebus problems, initially blocked, recovered with incubation time, thereby improving the chances of success.

This method of first inducing fixation and then retesting after varying delays has now proven useful for observing incubation effects in several studies of both problem solving and memory. Three experiments demonstrated the same patterns of fixation and incubation using remote associates test (RAT) problems (Smith & Blankenship, 1991). For RAT problems, one must think of a word that in combination with each of three test words makes a two-word phrase or compound word. For example, the solution to the RAT problem *"apple/family/house"* is *tree*, because the solution can make the phrases *apple tree*, *family tree*, and *tree house*. The word *green* is a misleading clue, because it can make a two-word phrase from two of the test words (*green apple* and *greenhouse*), but it does not make a phrase with the third test word, *family*. In those experiments, misleading clues were effective at causing initial fixation and subsequent incubation effects, whether the clues accompanied the initial presentation of the problems or had been studied on a list before subjects were given the problems. This indicates that fixation was caused by memory of the blockers rather than by some type of distraction.

Further evidence linking fixation and incubation to memory phenomena comes from studies of reminiscence and TOT memory blocks. Whereas incubation typically means solving a problem on a retest after failing on a first attempt, *reminiscence* refers to recalling successfully material that one had failed to recall on an earlier attempt. For example, if you were given a second recall test after you had already tried to recall a long list of pictures, you might come up with a few items from the list that you had not recalled on the first test. Smith and Vela (1991) found that such reminiscence effects were greater if an incubation interval was given between the first test and the retest. Similarly, Smith (1991) found that incubation intervals increased the chances of resolving TOT retrieval failures, such as the Union Carbide example given earlier in this chapter. These incubation effects in memory paradigms appear to reflect the same patterns seen in problem-solving studies, that a time interval inserted between an initial failed test and a retest facilitates resolution of the failure.

GETTING OUT OF MENTAL RUTS

If we are to understand how to escape from mental ruts, it is worthwhile to consider briefly a theoretical explanation of the recovery that causes incubation in memory and problem solving. Simply put, theoretical models of recovery emphasize the importance of one's internal cognitive context, which has an effect on what is retrieved from memory during the course of remembering and solving problems. Whereas a problem undertaken in one mental context may lead to a mental rut, another context may lead to an insightful solution. If the initial context in which a problem is attempted leads to fixation, then an incubation interval may allow time for one's mental context to change to one that will yield a solution. Even if it contains no special information that serves as a useful clue to insight, the context can facilitate insight if it is at least not associated with fixated material. If we accept this contextual explanation of incubation, then it would appear that contextual change, rather than time, per se, is needed to escape from mental ruts. Therefore, time away from a fixated problem will encourage insight all the more if you move away from fixated contexts.

Although this contextual explanation of incubation and insight is speculative, there are well-known historical cases of insight occurring in contexts outside the typical workplace. For example, initial efforts at solving important problems resulted in temporary impasses when Archimedes was working on his famous displacement problem, when Kekulé was at work on the structure of the benzene molecule, and when Poincaré worked on what would eventually result in his discovery related to Fuchsian functions in mathematics. The legendary insights in these cases occurred away from the discoverers' regular work contexts—while Archimedes was taking a bath, while Kekulé dozed before the fire, and while Poincaré was stepping onto a bus.

In the beginning of this chapter, we read about a truck that slipped into the mud; the physical rut simply worsened when the truck driver spun his wheels, persisting with a counterproductive strategy that the driver initially believed would get him out of the rut. A more effective strategy was allowing time for conditions to become more favorable for getting out of the mud trap. In the mental domain as well, taking time off and changing contexts can allow mental conditions to become more favorable for escaping a fixated mental rut. Hence, incubation, and perhaps context change, can improve the chances of having insight experiences.

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