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Group Creativity

Innovation Through Collaboration

■ *Edited by Paul B. Paulus and Bernard A. Nijstad*

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■ Steven M. Smith

The Constraining Effects of Initial Ideas

■

What is the best source of creative ideas? The wisdom of proverbs advises us that if we are to see farther than others, we must “stand on the shoulders of giants.” This means that we should use the prior knowledge that has been provided by our predecessors, because in solving problems there is no need to “re-invent the wheel.” On the other hand, a different proverb advises us not to get “stuck in a rut,” meaning that using prior knowledge to solve problems can lead us to the same old tired ideas and blocked thinking that stymied progress on those problems in the past. How are we to choose between these apparently contradictory sources of wisdom? One way to address this question is through empirical studies of creative thinking and problem solving, a method called the creative cognition approach (Smith, Ward, & Finke, 1995). In the present chapter, I review a number of such empirical studies that examine the potentially constraining effects of prior knowledge, studies motivated by the creative cognition approach.

Creative thinking can be classified in many ways; one such classification is paradigmatic versus revolutionary thinking. Paradigmatic creative thinking generates new ideas in small, incremental steps; revolutionary creative thinking opens bold new vistas and perspectives. Whereas most creative thinking is paradigmatic in nature, there are occasional flashes of insight that constitute revolutionary advances in creative thinking. While acknowledging the importance of incremental paradigmatic creativity, the present chapter focuses on the rarer form of creative cognition, that which leads to revolutionary ideas. The

case is made, with supporting empirical evidence, that prior experience can sometimes block or impede cognitive operations in memory, problem solving, and creative thinking and that similar cognitive processes are involved in all three domains. Such constraints can have profound effects on the creative ideas generated not only in individuals but in groups of people as well.

Fixation: Blocks to Cognitive Operations

The term *fixation*, in the present context, refers to something that blocks or impedes the successful completion of various types of cognitive operations, such as those involved in remembering, solving problems, and generating creative ideas (e.g., Dodds & Smith, 1999; Smith, 1994b, 1995b; Smith & Blankenship, 1989, 1991; Smith & Vela, 1991). For example, fixation can obstruct memory retrieval of well-learned names or words, such as the names of famous celebrities or politicians. The same fixating forces can likewise block solutions to puzzles or math problems, such as Luchins and Luchins's (1972) famous water jar problems or common anagrams. The ways that fixation can cause such blocks can also limit the directions taken in creative idea generation in such tasks as divergent thinking and brainstorming.

Although fixation can take many forms, there are a few general patterns in which it can occur: typical thinking, implicit assumptions, and recent experience. Typical thinking refers to taking the same approach to a problem that is usually taken for that class of problems and is essentially the same as paradigmatic thinking. Whereas typical thinking is usually effective for a class of problems, there are some problems for which typical approaches are inappropriate and can lead to dead ends in the problem-solving process (Smith, 1995a). Implicit assumptions are those that one automatically makes in the problem-solving process, without any awareness that such assumptions have been made. When implicit assumptions are incorrect or unfounded, they impede cognitive operations, and, even more insidiously, they do so invisibly, making them difficult to ferret out and reject. Recent experience often prepares us for events by teaching us to adopt mental sets, specific operations that are repetitiously carried out to solve each problem in a series of similar problems. For example, suppose you were calculating a long series of math problems, with each problem involving the same sequence of operations. It would be to your advantage in such a situation to automatize the sequence of operations so that the calculations would no longer require attentional resources. Whenever one's cognitive operations are reproductions of prior experiences, a mental set can guide one unerringly through the well-practiced operations. Although such mental sets usually work to our advantage because they free up our limited attentional resources, there are times when a problem cannot be solved with a recent approach; then, one can become fixated. The research presented in the present chapter focuses on blocks and constraints that are caused by the recent use of knowledge, but the same patterns and

conclusions can be drawn from cases in which blocks occur due to other causes, such as typical thinking and implicit assumptions. In all three cases, prior knowledge is inappropriately reapplied, resulting in a less-than-optimal outcome.

A classic example of the way recent experience can cause fixation is the extensive work done by Luchins and Luchins (e.g., 1959, 1972), whose demonstrations of *Einstellung*, or mental set, show clearly the way that initial experiences can lead to a mechanization of thought in problem solving. In these demonstrations, subjects are given a series of mathematical puzzles, all of the same format, called water jar problems. The task in these problems is to measure out a specific volume of water using only three jars, each with a specifically defined capacity. Some examples are shown in Table 2.1.

Subjects typically discover early in the series of problems that the same algorithm, $B - A - 2C$, will produce the desired volume, and they usually reapply the same formula to problem after problem, offering the same solution to all 10 problems. Having recently used the algorithm, subjects mechanistically use the same knowledge throughout the entire sequence. The useful algorithm constrains thinking, however, on problems such as number 9, where a much simpler alternative ($A - C$) is equally effective. The recently used algorithm becomes a downright block on problem 10, in which the algorithm fails altogether, even though a simpler solution ($A - C$) is at hand. Thus, recent experiences can constrain and block successful thinking.

Experimental Evidence of Memory Blocks

Since memory was first experimentally studied, attention has focused on various aspects of phenomena related to forgetting. One aspect of forgetting is memory blocking, that is, the temporary obstruction of knowledge or memories from consciousness. Critically important components of memory blocks include the sought-for material's being encoded in memory, temporarily blocked

Table 2.1. Luchins' Water Jar Demonstration

	Jar A	Jar B	Jar C	Desired Volume	Algorithm
1	8	35	3	21	B - A - 2C
2	7	17	2	6	
3	20	57	8	21	
4	6	18	1	10	
5	5	32	4	19	
6	21	127	4	98	
7	15	90	4	67	
8	20	59	4	31	
9	14	36	8	6	
10	28	76	3	25	

from consciousness, and recoverable in its essentially original form. Although mysterious mechanisms have been imagined, such as repression, that might banish undesirable traumatic memories from consciousness, no such exotic explanations are necessary for the existence of blocks. The only mechanism necessary for blocks to occur is simple response competition: the dominance of unwanted responses over desired ones (see Figure 2.1).

In response competition, a stimulus is associated with multiple responses, including the sought-for response, known as the target response. For the purposes of the present chapter, the stimulus could be a memory prompt (e.g., What is the capital of Australia?), a problem to solve (e.g., What one word can be made with the letters NEW DOOR?), or a prompt for creative idea generation (e.g., What uses can be made of a 2-liter plastic bottle?). In each case, the stimulus has a certain probability of evoking the desired target response, as well as probabilities of evoking any blockers, or competing responses. When target responses are less dominant, the probability of finding correct targets decreases. Examples of factors that decrease the probability of evoking target responses by strengthening competing blockers are increased frequency or recency of occurrence of blockers.

Blocking in Memory Retrieval

A commonly experienced phenomenon in memory failures is the tip-of-the-tongue (TOT) state. The TOT refers to cases in which one is momentarily unable to think of a word or name, yet the target seems to be known and it feels as if the target is going to pop into mind at any moment. Thus, the TOT is defined in terms of both metacognitive components (it feels known and retrieval feels imminent) and memory components (successful retrieval initially fails, yet later it succeeds). Whereas memory is demonstrated by performance on such tasks as recall and recognition, metacognition refers to an awareness of one's own thought processes, such as a feeling that one has adequately learned some material. The present focus is on the memorial aspects of the

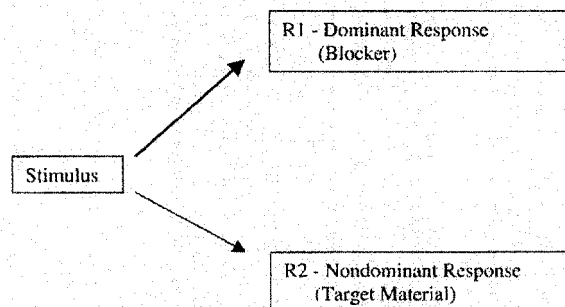


Figure 2.1. *Response Competition*

TOT state, particularly cases in which memory retrieval of a target word or name is blocked by persistent retrieval of competing blockers. For example, if the incorrect response "Sydney" continued coming to mind in the course of trying to remember the name of Australia's capital (Canberra), the competing blocker might be hindering memory retrieval of the target response, thereby evoking a TOT state.

TOT states have been studied experimentally using a variety of laboratory methods (e.g., Schwartz & Smith, 1997; Schwartz, Travis, Castro, & Smith, 2000; Smith, 1994a; Smith, Balfour, & Brown, 1994; Smith, Brown, & Balfour, 1991). Although not all TOT states constitute memory blocks, there is some evidence that competing blockers that are introduced to subjects can increase the incidence of TOT states (Smith, 1994a). For example (Smith, 1994a), when subjects first examined a set of blocker words that were semantically related to memory targets (e.g., *hearth*), they were less able to recall the targets of definitions (e.g., *The facing around and over a fireplace—answer: MANTEL*), and they were more likely to experience TOT states. Although the memory targets were usually well-known to the experimental subjects, the recent experience of seeing semantically related words served to block the already existing memories. Other examples of definitions, targets, and blockers are shown in Table 2.2.

The memory-blocking effects reported by Smith (1994a) and other memory blocks, as will be demonstrated, need not be caused by conscious retrieval of blockers from memory. Rather, retrieval of such blockers is unconscious and automatic and based on a type of memory often referred to as implicit memory. Whereas explicit memory refers to remembering that is accompanied by a deliberate attempt and an awareness of remembering, implicit memory is unintentional, swift, and involuntary. Thus, when prompted with the definition "The facing around and over a fireplace," a subject might implicitly retrieve the blocker *hearth*, which could, in turn, block retrieval of the correct target, *mantel*.

Table 2.2. Targets, Blockers, and Definitions for Smith's (1994a) TOT Study

Target	Blocker	Definition
ALLOY	<i>compound</i>	A mixture of metals, one of quality with a poorer one.
BALSA	<i>oak</i>	An extremely light and strong wood used in modeling.
HYPOCHONDRIAC	<i>pretender</i>	One who is healthy but thinks he or she has diseases.
HYPOCRITE	<i>imposter</i>	A person who does not practice what he or she preaches.
INCUBATE	<i>heat</i>	To keep eggs warm until they hatch.
MANTEL	<i>hearth</i>	The facing around and over a fireplace.
OPAQUE	<i>diffraction</i>	Impenetrable by light.
PASTEURIZE	<i>scald</i>	To heat milk below its boiling point to kill bacteria.
PEDIATRICIAN	<i>cardiologist</i>	Expert in children's diseases.
PERJURY	<i>subterfuge</i>	False testimony under oath.

Anatomy of a Memory Block

Although memory blocks can be caused by a number of mechanisms, the present chapter focuses on two such devices: negative priming and retrieval bias. These theoretical mechanisms are implicated not only in memory research, but also in blocks to problem solving and creative idea generation.

Negative priming refers to implicit memory retrieval of blockers that one cannot successfully oppose or reject with conscious cognitive efforts. The term priming has been used a number of ways in the memory and cognition literature; typically, it refers to facilitation in using a word or concept as a result of recent use of the same word or a similar word. For example, priming on a word fragment completion task is found when subjects first see words such as *TEQUILA* and later are asked to complete word fragments such as *TE_UI_A*. Priming is generally considered an implicit memory phenomenon, and it can be found even in brain-damaged patients who are unable to explicitly remember recent events. Negative priming (Smith & Tindell, 1997) can be found in certain cases in which subjects are exposed to words that are orthographically similar to correct responses on an implicit memory task. For example, subjects who are primed with the word *ANALOGY* have great difficulty completing the word fragment *A_L_ _GY* (solution: *ALLERGY*). Other examples from Smith and Tindell are shown in Table 2.3.

Smith and Tindell (1997) showed that subjects who had seen the negative priming blockers were greatly impaired when they tried to complete the orthographically similar word fragments. Furthermore, when subjects were given explicit warnings to avoid thinking about the negative primes, they still could not avoid or overcome this implicit memory-blocking effect. That is, the negative primes were implicitly and involuntarily retrieved when subjects saw the related word fragments, and they were unable to put those blockers out of mind to think of the correct answers. This same pattern of involuntary memory retrieval of inappropriate responses coupled with an inability to banish such re-

Table 2.3. Targets, Negative Priming Materials (Smith & Tindell, 1997)

<i>Target</i>	<i>Negative Prime</i>	<i>Fragment</i>
BAGGAGE	BRIGADE	B_G_A_E
CATALOG	COTTAGE	C_TA__G
COUNTRY	CLUSTER	C_U_TR_
DIGNITY	DENSITY	D__NITY
FAILURE	FIXTURE	F_I_URE
HISTORY	HOLSTER	H_ST_R_
TANGENT	TONIGHT	T_NG__T
TRAGEDY	TRILOGY	TR_G__Y

sponses from conscious consideration is seen in experiments on blocking in problem solving and creative idea generation.

Biased Retrieval Set

A second memory mechanism that is very useful for explaining blocking effects is retrieval bias. If one thinks of memory as a big bag of information, each piece called a memory, then retrieval can be thought of as drawing a sample of these memories from the bag. Of course, retrieval must be conceived as sampling with replacement, because remembering something does not wipe it out of memory. In fact, when a memory is sampled, or retrieved, its retrieval strength increases, at least temporarily. That is, retrieving a memory increases the subsequent likelihood of retrieving that memory again. Increasing the likelihood of retrieving one memory necessarily decreases the chance of retrieving other memories. When memories are sampled, a subset of the memories, those that are initially retrieved, begin to take on such a large portion of the available retrieval strength that additional efforts to retrieve new memories fail. Such a situation is called a biased retrieval set, because one is biased to retrieve only a subset of the available memories, thereby rendering the other available memories at least temporarily inaccessible. The temporarily inaccessible memories can be said to be blocked from consciousness because of the biased retrieval set.

An example of retrieval bias in a memory task can be seen when words from a long list are remembered in a free recall task. What is "free" about free recall is that one may recall the items in any order. As each word on the free recall list is retrieved, it temporarily increases the chance of retrieving the same word again, to the exclusion of as yet unrecalled words. A biased retrieval set builds up for the already retrieved words, blocking recall of other list words that were memorized. This effect is referred to as output interference (e.g., Smith & Vela, 1991) and has been used to describe the self-limiting nature of recall (Roediger, 1978). It is also possible to induce output interference by providing the subject with a subset of the words from the memorized words just as the recall test is beginning (e.g., Rundus, 1973); the nonprovided words will be blocked from memory. This blocking technique is called part-list or part-set cuing inhibition. Part-set cuing inhibition has important implications for idea-generation procedures, such as brainstorming, particularly if one thinks of the ideas expressed by others in one's group, causing the buildup of a biased retrieval set and thereby blocking other, potentially useful ideas from consciousness.

The theory that a biased retrieval set can inhibit or interfere with memory retrieval, and which predicts and explains similar effects in problem solving and creative idea generation, has been used to explain related effects in brainstorming groups. In the course of a brainstorming session, the fluency of idea production declines over time (Diehl & Stroebe, 1991). Nijstad (2000) has explained this decline in terms of the same retrieval bias theory. A major advantage of this theoretical approach to idea production in brainstorming is that the theory

predicts that certain remedies, such as time delays and context shifts, should be effective at reducing some production deficits in brainstorming groups.

Blocking in Problem Solving

The same sorts of blocking effects and the same theoretical mechanisms found in memory research are also found in problem-solving research. Just as negative primes seen prior to word fragments hindered solutions to the word fragments, so too do blocker words hinder solutions to problems.

One example of this blocking effect in problem solving was demonstrated by Smith and Blankenship (1989), who showed fixation effects in solving rebus problems, a special type of picture word problem. In a rebus problem, the configuration of letters and words shown in the problem depicts a common phrase. For example, the rebus "you just me" is solved with the common phrase, "just between you and me," because the word *just* is between the words *you* and *me*. Smith and Blankenship tested for fixation effects by including some misleading "clues" designed to draw attention to incorrect solutions. Figure 2.2 shows some rebus problems with blockers and correct solutions. For example, the blocker DESTROY is intended to lead to retrieval of the incorrect phrase *search and destroy*, diverting retrieval from the correct answer, *search high and low*.

Smith and Blankenship (1989) found that the presence of blockers impeded solutions of corresponding rebus problems. Furthermore, the blocking effect was weakened over time, consistent with restructuring theory. That is, with increasing time between attempts, subjects were more likely to forget the original fixated approach that led to a block and were more able to think of the correct solutions to the rebuses.

Another example of a blocking effect in problem solving was reported by Smith and Blankenship (1991) using Remote Associate Test (RAT) problems, which are sometimes used in tests of creativity. Each RAT problem consists of three words (e.g., APPLE, FAMILY, HOUSE), and the solution is a single word that makes a compound word or phrase with each of the three test words (e.g., *tree*: APPLE-*tree*, FAMILY-*tree*, and *tree*-HOUSE). In the fixation condition of Smith

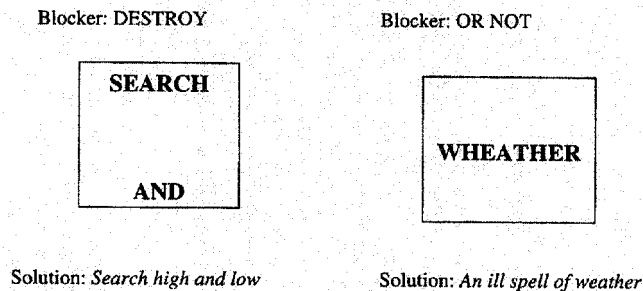


Figure 2.2. Rebuses, Solutions, and Blockers (Smith & Blankenship, 1989)

and Blankenship's study, subjects first saw blocker words (e.g., black) and later saw RAT problems (e.g., CAT, SLEEP, BOARD). Subjects were unable to avoid or escape the deleterious effect of the blocker word (see Table 2.4 for some examples).

Just as in Smith and Tindell's (1997) study of implicit memory blocks, the Smith and Blankenship (1991) problem-solving study shows involuntary retrieval of incorrect blockers and an inability to escape or avoid the blocking effect. Thus, the same theoretical mechanisms at work in memory paradigms can be used to explain fixation and blocking in problem solving.

Fixation and Conformity in Creative Idea Generation

The artificial means of introducing blockers in the memory and problem-solving experiments described so far have a natural counterpart when it comes to creative idea generation: the effects of examples. In the course of creative idea generation, we are often given examples to help us get started, to exemplify the types of solutions that are desired, and to provide ideas for creative combinations. In brainstorming groups, in particular, example ideas are constantly generated by others in one's brainstorming team. Might such examples serve as blockers in creative idea generation?

This question was addressed by Smith, Ward, and Schumacher (1993), who experimentally examined the constraining effects of examples on creative idea generation. Whereas most laboratory tasks in cognitive psychological research are closed in the sense that they quantify accurate and inaccurate responses, these authors wanted to examine the more open-ended task of creative idea generation: the production of multiple nonveridical responses from a very large set of possibilities. In one task, they asked subjects to invent new toys they had never seen before; in another, subjects were asked to draw and describe new life forms

Table 2.4. Remote Associate Test Problems and Blockers

<i>Remote Associate Test Problems</i>		<i>Solutions</i>	<i>Blockers</i>
SHIP	SUIT	PARKING	space jump
SALAD	HEAD	GOOSE	egg lettuce
ELECTRIC	HIGH	EASY	chair wire
BED	DUSTER	WEIGHT	feather room
APPLE	HOUSE	FAMILY	tree green
CAT	SLEEP	BOARD	walk black
WATER	SKATE	CUBE	ice sugar
DECK	RECORDER	SCOTCH	tape flight
HOT	CATCHER	LICENSE	dog plate
ARM	COAL	STOP	pit rest
STORM	WHITE	BALL	snow cloud
TOP	SHOE	CAR	box horn

that might evolve on a planet similar to Earth. Prior to the creative generation task, half of the subjects saw three examples of ideas that were attributed to fictitious previous subjects. Although the three examples were different from each other, each contained three critical features in common. In the case of the creature generation task, all three of the fanciful, crudely drawn creatures had four legs, two antennae, and a tail; in the toy generation task, all three examples were electronic, involved a high degree of physical activity, and used a ball. Subjects in the Fixation Group saw all three examples just prior to the generation task, whereas the Control Group subjects saw no examples.

Smith et al. (1993) found that the Fixation and Control Group subjects generated the same number of ideas, on average, but the Fixation Group's ideas were far more likely than those in the Control Group to incorporate the three exemplified features in their own generated ideas. Smith et al. referred to this as a conformity effect, the tendency of generated creative ideas to include features seen in the examples. The conformity effect occurred in their experiments for the generation of toys and for the generation of creatures, and it even occurred when subjects were asked to generate ideas as different from the examples as possible. That is, subjects were unable to reject the examples when they tried to imagine novel ideas. This inability to reject inappropriate (blocker) ideas resembles the involuntary detrimental effects of priming inappropriate words in implicit memory (Smith & Tindell, 1997). In both cases, recent exposure to inappropriate responses is involuntarily retrieved and cannot be deliberately rejected, thereby continuing to hinder retrieval of more appropriate responses (see Figure 2.3).

A more realistic and applied version of such conformity effects in creative idea generation was reported by Jansson and Smith (1991), who observed and described a phenomenon called design fixation in engineering design students and professional design engineers. Some aspects of the conceptual design process closely resemble the creative idea generation paradigms used by Smith et al. (1993) in that a rough description of the design needs are described, and the designer must generate multiple ideas that address the general guidelines that are given. Jansson and Smith gave engineering design students open-ended design tasks, asking them to design a bicycle rack, a measuring cup for the blind, or an inexpensive spill-proof coffee cup. In each experiment, half of the students (the Design Fixation Group) first saw a sample design, and the other half (the Control Group) saw no example. In all experiments, students generated equal numbers of design ideas, regardless of their experimental treatment group assignments. However, in all experiments, the designs of students in the Fixation Group were far more likely than those in the Control Group to incorporate features of the examples in their design ideas. This design fixation effect occurred even when the features of the example were negative features. For example, in Experiment 2, the sample measuring cup for the blind needed an overflow device but had none (see Figure 2.4), yet students who saw that example were likely to omit the overflow device. In Experiment 3, negative fea-

Example Toys

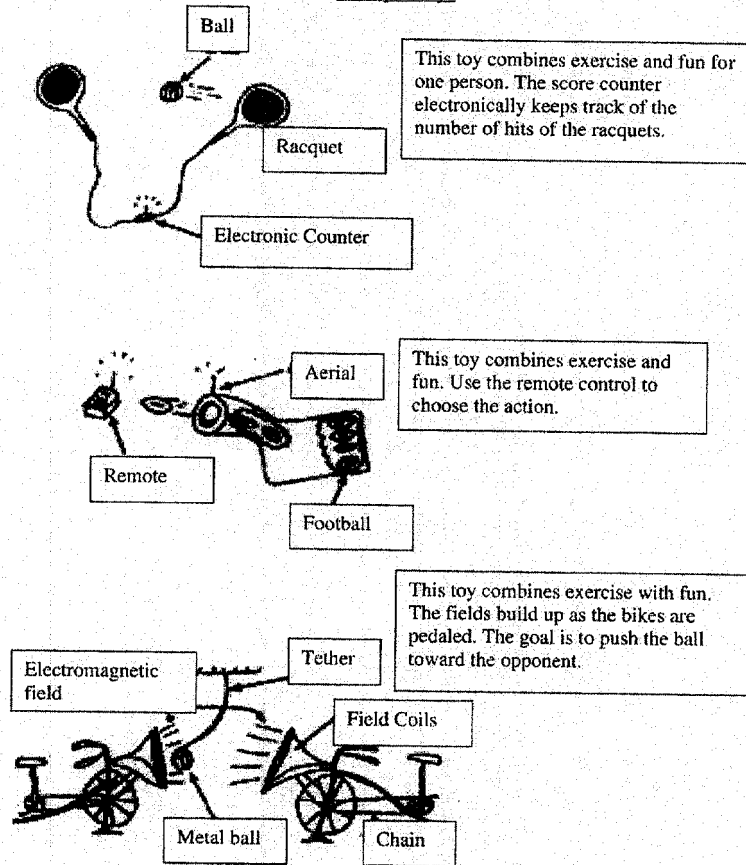


Figure 2.3. Toy Examples and Ideas (Smith et al., 1993)

tures of the sample spill-proof coffee cup (mouthpieces and leaky straws) were explicitly pointed out and forbidden (Figure 2.5); nonetheless, designs of students who had seen the sample could not avoid incorporating those features in their conceptual designs, even if they had been explicitly warned not to use straws or mouthpieces. Not only was design fixation measured in Experiment 4, but measures of creative thinking, fluency, flexibility, originality, and practicality were also calculated for the designs. These measures indicated that the designs of the Fixation Group were less creative than those of the Control Group. Finally, Experiment 5 showed design fixation effects in professional engineering designers, underscoring the ubiquity and importance of the design fixation effect.

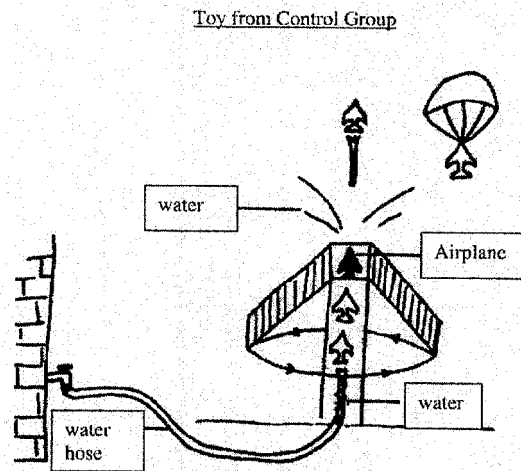
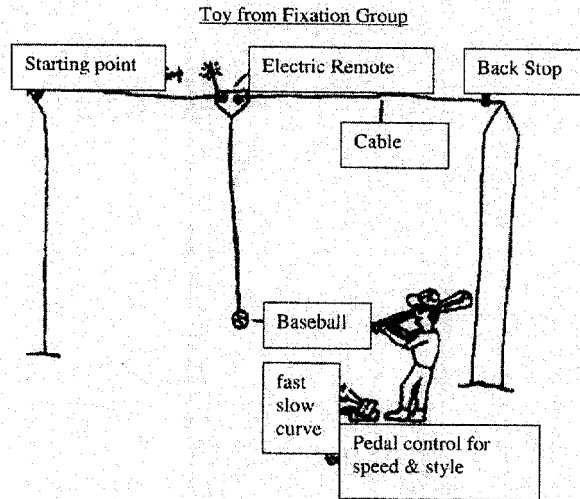


Figure 2.3. (continued)

Remedies

The conclusion of these creative idea generation experiments is that recently encountered ideas can sometimes block or constrain the creativity of subsequently generated ideas. It should be noted, however, that this conclusion is merely one aspect of a larger principle: that implicit assumptions can block creative idea generation. The memory experiments, in particular, indicate that the effects of the examples are in fact implicit, and that the implicitly retrieved ex-

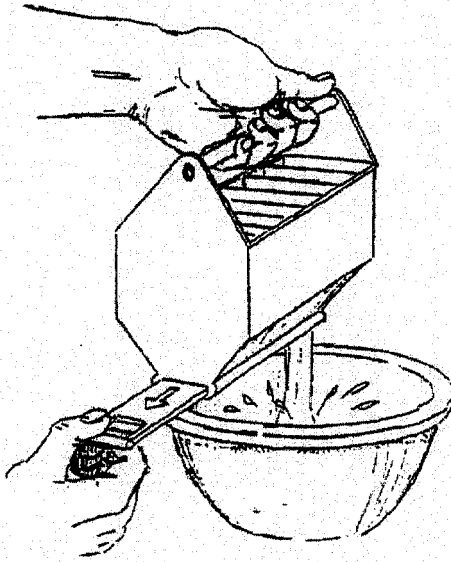


Figure 2.4. Example Measuring Cup for the Blind
(Jansson & Smith, 1991)

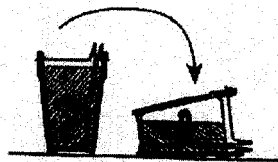
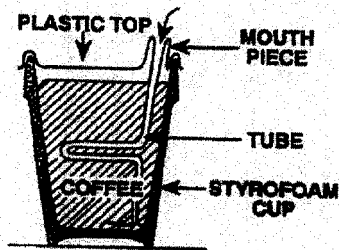


Figure 2.5. Example Spill-Proof Coffee
Cup (Jansson & Smith, 1991)

amples cannot be voluntarily rejected to make way for more appropriate responses. Of course, implicitly retrieved ideas can arise from sources other than recent experience; they can also come from perceptual characteristics of stimuli or from long-term knowledge. In all cases, one of the most insidious aspects of blocks is that they are implicit and that they therefore are difficult to detect and identify. It is not always necessary, however, to detect and identify sources of blocks; what is more important is to escape or avoid the effects of the blocking assumptions.

In creative idea generation, the initial step is the critical one, because it can occur in a context that invites limiting assumptions, or it can occur more profitably in a novel context that is less likely to encourage such blocking constraints. When recently encountered examples are the source of constraining effects, an approach to avoiding or escaping such blocks is to take a break from the task and try to approach the problem with a fresh context. The effects of breaks and fresh contexts are usually referred to as incubation effects. Incubation is a mysterious and counterintuitive phenomenon because it is not time spent working on a problem that helps, but rather time *away* from the problem that is the key. Furthermore, the reason incubation helps one escape fixation is not always obvious. Although incubation effects are often attributed to unconscious autonomous processes, there is no evidence that such unconscious processes benefit incubation (Smith, Sifonis, & Tindell, 1998). The more likely cause is that an initially thwarted attempt can avoid fixation if a break and a novel context lead one to a different initial step in idea generation, one that is less likely to lead to previously encountered dead-end lines of thinking. Incubation effects have been shown to help people overcome initial impasses in memory (e.g., Smith & Choi, 2001; Smith & Vela, 1991), in problem solving (e.g., Smith & Blankenship, 1989, 1991), and in creative idea generation (e.g., Smith, 1995b).

No remedies for fixation, including incubation breaks and context shifting, are sure-fire methods, but it is logical to infer other solutions for fixation. One plausible notion is to make use of the perspectives of other individuals, such as members of a brainstorming group. Limiting assumptions that are implicit or invisible to one person might seem more apparent or obvious to other group members. Thus, having varied perspectives and backgrounds among brainstorming group members might help overcome fixation, both by identifying and breaking unsuccessful or limiting mental sets and by providing new approaches to problems. How to compose a brainstorming group to make optimal use of multiple perspectives and how to encourage the use of multiple knowledge bases and perspectives in the group should be important goals for successful brainstorming groups.

Implications for Brainstorming Groups

The patterns of cognition described for situations involving memory retrieval, problem solving, and creative idea generation have direct implications for brain-

storming. In brainstorming groups, each participant generates ideas in the presence of others, the intention being to promote novel combinations of divergent ideas. An emphasis is placed on the number and imaginativeness of ideas. Thus, it is important to attend to the ideas generated by other participants in one's group. The benefits of attending to others' ideas, however, may not come without a cost, and that cost may be the breadth or flexibility of ideas generated. Memory retrieval can be biased or blocked by involuntary retrieval of other memories, problem solving can be fixated when inappropriate material is involuntarily retrieved, and creative idea generation can be constrained by implicit retrieval of examples. Therefore, it seems likely that seeing or hearing the ideas of others in one's group would likewise constrain idea generation in group participants. Such would not be the case in individual brainstorming, where one's ideas would not be involuntarily constrained from hearing and seeing ideas generated by other participants. Of course, individual brainstorming, unlike group brainstorming, may not benefit from exposure to the different knowledge and perspectives of others in one's group. One solution to the problem is to combine the individual and group methods, having individuals alternately generating ideas alone and as members of a group. Generating ideas when one is alone might make an individual's range of ideas broader because the ideas might suffer less output interference from the expressed ideas of other group members. This greater range of ideas can be explored from multiple perspectives by the group, and the broad range of knowledge bases that different group members generate can provide the foundation for more novel combinations of ideas.

As a final note, it is worth acknowledging that one should not always, or even usually, reject prior knowledge. The ideas of others, especially one's predecessors, are essential in most discoveries. To imply otherwise would be foolish. The purpose of the present chapter is to point out that there are sometimes situations in which the use of prior ideas can unnecessarily constrain the scope of ideas that one can generate.

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