Chapter Six

The Upside of Distraction

The Role of Incubation in Problem Solving

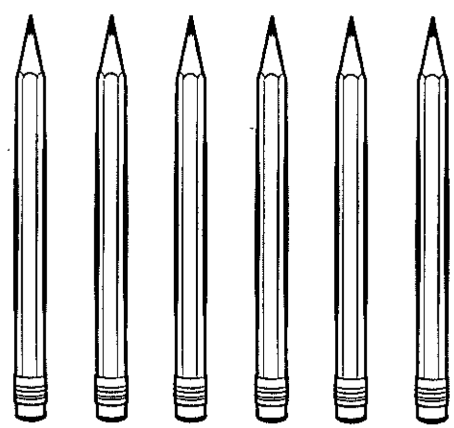
School hits us with at least as many psychological tests as academic ones. Hallway rejection. Playground fights. Hurtful gossip, bad grades, cafeteria food. Yet at the top of that trauma list, for many of us, is the stand-up presentation: being onstage in front of the class, delivering a memorized speech about black holes or the French Resistance or Piltdown Man, and wishing that life had a fast-forward button. I'm not proud to admit it, but I'm a charter member of that group. As a kid, I'd open my mouth to begin a presentation and the words would come out in a whisper.

I thought I'd moved beyond that long ago—until early one winter morning in 2011. I showed up at a middle school on the outskirts of New York City, expecting to give an informal talk to a class of twenty or thirty seventh graders about a mystery novel I'd written for kids, in which the clues are pre-algebra problems. When I arrived, however, I was ushered onto the stage of a large auditorium, a school staffer asking whether I needed any audiovisual equipment, computer connections, or PowerPoint. Uh, no. I sure didn't. The truth was, I didn't have a presentation at all. I had a couple of books under my arm and was prepared to answer a few questions about writing, nothing more. The auditorium was filling fast, with teachers herding their classes into rows. Apparently, this was a school-wide event.

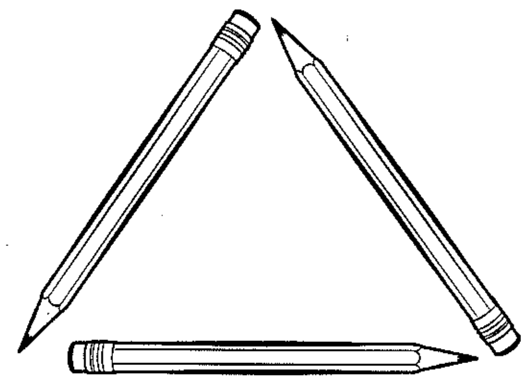
I struggled to suppress panic. It crossed my mind to apologize and exit stage left, explaining that I simply wasn't ready, there'd been some kind of mistake. But it was too late. The crowd was settling in and suddenly the school librarian was onstage, one hand raised, asking for quiet. She introduced me and stepped aside. It was showtime . . . and I was eleven years old again. My mind went blank. I looked out into a sea of young faces, expectant, curious, impatient. In the back rows I could see kids already squirming.

I needed time. Or a magic trick.

I had neither, so I decided to start with a puzzle. The one that came to mind is ancient, probably dating to the Arab mathematicians of the seventh century. More recently, scientists have used it to study creative problem solving, the ability to discover answers that aren't intuitive or obvious. It's easy to explain and accessible for anyone, certainly for middle school students. I noticed a blackboard toward the back of the stage, and I rolled it up into the light. I picked up a piece of chalk and drew six vertical pencils about six inches apart, like a row of fence posts:



"This is a very famous puzzle, and I promise: Any of you here can solve it," I said. "Using these pencils, I want you to create four equilateral triangles, with one pencil forming the side of each triangle." I reminded them what an equilateral triangle is, one with three equal sides:



"So: six pencils. Four triangles. Easy, right? Go."

The fidgeting stopped. Suddenly, all eyes were on the blackboard. I could practically hear those mental circuits humming.

This is what psychologists call an insight problem, or more colloquially, an aha! problem. Why? Because your first idea for a solution usually doesn't work . . . so you try a few variations . . . and get nowhere . . . and then you stare at the ceiling for a minute . . . and then you switch tacks, try something else . . . feel blocked again . . . try a totally different approach . . . and then . . . aha!—you see it. An insight problem, by definition, is one that requires a person to shift his or her perspective and view the problem in a novel way. The problems are like riddles, and there are long-running debates over whether our ability to crack them is related to IQ or creative and analytical skills. A knack for puzzles doesn't necessarily make someone a good math, chemistry, or English student. The debate aside, I look at it this way: It sure doesn't hurt. We need creative ways of thinking to crack any real problem, whether it's in writing, math, or management. If the vault door doesn't open after we've tried all our usual combinations, then we've got to come up with some others—or look for another way in.

I explained some of this in the auditorium that morning, as the kids stared at the board and whispered to one another. After five minutes or so, a few students ventured up to the blackboard to sketch out their ideas. None worked. The drawings were of triangles with smaller triangles crisscrossing inside, and the sides weren't equal. Solid efforts all around, but nothing that opened the vault door.

At that point, the fidgeting started again, especially in the back rows. I continued with more of my shtick about math being like a mystery. That you need to make sure you've used all available information. That you should always chase down what seem like your stupidest ideas. That, if possible, you should try breaking the problem into smaller pieces. Still, I felt like I was starting to sound to them like the teachers in those old *Charlie Brown* movies (WAH-WAH WAH WAAH WAH), and the mental hum in the room began to dissipate. I needed another trick. I thought of another well-known insight problem and wrote it on the board beneath the chalk pencils:

SEQUENC_

"Okay, let's take a break and try another one," I told them. "Your only instruction for this one is to complete the sequence using any letter other than E."

I consider this a more approachable puzzle than the triangle one, because there's no scent of math in it. (Anything with geometric shapes or numbers instantly puts off an entire constituency of students who think they're "not a math person"—or have been told as much.) The SEQUENC_ puzzle is one we all feel we can solve. I hoped not only to keep them engaged but also to draw them in deeper—put them in the right frame of mind to tackle the Pencil Problem. I could feel the difference in the crowd right away, too. There was a competitive vibe in the air, as if each kid in that audience sensed that this one was within his or her grasp and wanted to be the first to nail it. The teachers began to encourage them as well.

Concentrate, they said.

Think outside the box.

Quiet, you guys in the back.

Pay attention.

After a few more minutes, a girl near the front raised her hand and offered an answer in a voice that was barely audible, as if she was afraid to be wrong. She had it right, though. I had her come up to the board and fill in the answer—generating a chorus of *Oh man!* and *You're kidding me, that's it?* Such are insight problems, I told them. You have to let go of your first ideas, reexamine every detail you're given, and try to think more expansively.

By this time I was in the fourth quarter of my presentation and still the Pencil Problem mocked them from the board. I had a couple hints up my sleeve, waiting for deployment, but I wanted to let a few more minutes pass before giving anything away. That's when a boy in the back—the "Pay attention" district—raised his hand. "What about the number four and a triangle?" he said, holding up a diagram on a piece of paper that I couldn't make out from where I was standing. I invited him up, sensing he had something. He walked onto the stage, drew a simple figure on the board, then looked at me and shrugged. It was a strange moment. The crowd was pulling for him, I could tell, but his solution was not the generally accepted one. Not even close. But it worked.

So it is with the investigation into creative problem solving. The research itself is out of place in the lab-centric world of psychology, and its conclusions look off-base, not in line with the usual advice we hear, to concentrate, block distractions, and *think*. But they work.

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What *is* insight, anyway? When is the solution to a problem most likely to jump to mind, and why? What is happening in the mind when that flash of X-ray vision reveals an answer?

For much of our history, those questions have been fodder for poets, philosophers, and clerics. To Plato, thinking was a dynamic interaction between observation and argument, which produced "forms," or ideas, that are closer to reality than the ever-changing things we see, hear, and perceive. To this, Aristotle added the language of logic, a system for moving from one proposition to another—the jay is a bird, and birds have feathers; thus, the jay must have feathers—to discover the essential definitions of things and how they relate. He supplied the vocabulary for what we now call deduction (top-down reasoning, from first principles) and induction (bottom-up, making generalizations based on careful observations), the very foundation of scientific inquiry. In the seventeenth century, Descartes argued that creative problem solving required a retreat inward, to an intellectual realm beyond the senses, where truths could surface like mermaids from the deep.

This kind of stuff is a feast for late night dorm room discussions, or intellectual jousting among doctoral students. It's philosophy, focused on general principles and logical rules, on discovering "truth" and "essential properties." It's also perfectly useless for the student struggling with calculus, or the engineer trying to fix a software problem.

These are more immediate, everyday mental knots, and it was an English intellectual and educator who took the first steps toward answering the most relevant question: What actually happens when the mind is stuck on a problem—and then comes unstuck? What are the stages of solving a difficult problem, and when and how does the critical insight emerge?

Graham Wallas was known primarily for his theories about social advancement, and for cofounding the London School of Economics. In 1926, at the end of his career, he published *The Art of Thought*, a rambling meditation on learning and education that's part memoir, part manifesto. In it, he tells personal stories, drops names, reprints favorite poems. He takes shots at rival intellectuals. He also conducts a wide-ranging analysis of what scientists, poets, novelists, and other creative thinkers, throughout history, had written about how their own insights came about.

Wallas was not content to reprint those self-observations and speculate about them. He was determined to extract a formula of sorts: a *specific series of steps* that each of these thinkers took to reach a solution, a framework that anyone could use. Psychologists at the time had no language to describe these steps, no proper definitions to work with, and thus no way to study this most fundamental human ability. To Wallas, this was appalling. His goal was to invent a common language.

The raw material Wallas cites is fascinating to read. For example, he quotes the French mathematician Henri Poincaré, who had written extensively about his experience trying to work out the properties of a class of forms called Fuchsian functions. "Often when one works at a hard question, nothing good is accomplished at the first attack," Poincaré had observed. "Then one takes a rest, longer or shorter, and sits down anew to the work. During the first half hour, as before, nothing is found, and then all of a sudden the decisive idea presents itself to the mind." Wallas also quotes the German physicist Hermann von Helmholtz, who described how new ideas would bubble up after he'd worked hard on a problem and hit a wall: "Happy ideas come unexpectedly, without effort, like an inspiration," he wrote. "So far as I am concerned, they have never come to me when my mind was fatigued, or when I was at my working table . . . they came particularly readily during the slow ascent of wooded hills on a sunny day." The Belgian psychologist Julien Varendonck traced his insights to daydreaming after a period of work, sensing that "there is something going on in my foreconsciousness which must be in direct relation to my subject. I ought to stop reading for a little while and let it come to the surface."

None of these quotes is especially informative or illuminating by itself. Read too many of them, one after another, without the benefit of expertise in the fields or the precise calculations the person is working out, and they begin to sound a little like postgame comments from professional athletes: *I was in the zone, man; I felt like I was seeing everything in slow motion.*

Wallas saw, however, that the descriptions had an underlying structure. The thinkers had stalled on a particular problem and walked away. They could not see an opening. They had run out of ideas. The crucial insights came after the person had abandoned the work and was deliberately *not* thinking about it. Each insight experience, as it were, seemed to include a series of mental steps, which Wallas called "stages of control."

The first is *preparation:* the hours or days—or longer—that a person spends wrestling with whatever logical or creative knot he or she faces. Poincaré, for example, spent fifteen days trying to prove that Fuchsian functions could not exist, an extensive period of time given his expertise and how long he'd played with the ideas before sitting down to construct his proof. "Every day I seated myself at my work table, stayed an hour or two, tried a great number of combinations and reached no result," he wrote. Preparation includes not only understanding the specific problem that needs solving and the clues or instructions at hand; it means working to a point where you've exhausted all your ideas. You're not stalled, in other words. You're stuck—ending preparation.

The second stage is *incubation,* which begins when you put aside a problem. For Helmholtz, incubation began when he abandoned his work for the morning and continued as he took his walk in the woods, deliberately *not* thinking about work. For others, Wallas found, it occurred overnight, or during a meal, or when out with friends.

Some mental machinations were clearly occurring during this downtime, Wallas knew, and they were crucially important. Wallas was a psychologist, not a mind reader, but he ventured a guess about what was happening: "Some kind of internal mental process," he wrote, "is operating that associates new information with past information. A type of internal reorganization of the information seems to be going on without the individual being directly aware of it." That is to say, the mind works on the problem *off-line,* moving around the pieces it has in hand and adding one or two it has in reserve but didn't think to use at first. One way to think of this is in terms of a weekend handiwork project. There you are, for example, replacing an old, broken door handle and casing with a new one. It looks like an easy job, but there's a problem: The casing sits off-center, the bolt and latch don't line up right. You don't want to cut new holes, that'll ruin the door; you futz and futz and see it's not going to happen. You give up and break for lunch, and suddenly think . . . wait, why not use the *old* casing, put the new hardware in that? You threw the old casing away and suddenly remembered you still had it—in the garbage.

That's the general idea, at least, and in Wallas's conception, incubation has several components. One is that it's subconscious. We're not aware it's happening. Another is that the elements of the problem (the Pencil Problem, for example, presented at the school) are being assembled, taken apart, and reassembled. At some point "past information," perhaps knowledge about the properties of triangles we hadn't initially recalled, is braided in.

The third stage of control is called *illumination.* This is the aha! moment, the moment when the clouds part and the solution appears all at once. We all know that feeling, and it's a good one. Here's Poincaré again, on the Fuchsian functions problem giving up its secrets:

"One evening, contrary to my custom, I drank black coffee and could not sleep. Ideas rose in crowds; I felt them collide until pairs interlocked, so to speak, making a stable combination. By the next morning . . . I had only to write out the results."

The fourth and final stage in the paradigm is *verification*, checking to make sure those results, indeed, work.

Wallas's principal contribution was his definition of incubation. He did not see this as a passive step, as a matter of the brain resting and returning "fresh." He conceived of incubation as a less intense, subconscious continuation of the work. The brain is playing with concepts and ideas, pushing some to the side, fitting others together, as if absentmindedly working on a jigsaw puzzle. We don't see the result of that work until we sit down again and notice an entire corner of the jigsaw puzzle is now complete—revealing a piece of the picture that then tells us how to work with the remaining pieces. In a sense, the letting go allows people to get out of their own way, giving the subconscious a chance to toil on its own, without the conscious brain telling it where to go or what to do.

Wallas didn't say how long incubation should last. Nor did he specify what kinds of downtime activity—walks, naps, bar-hopping, pleasure reading, cooking—were best. He didn't try to explain, in scientific terms, what might be happening in our brains during incubation, either. The goal wasn't to lay out a research agenda, but to establish a vocabulary, to "discover how far the knowledge accumulated by modern psychology can be made useful for the improvement of the thought-processes of a working thinker." He expressed a modest hope that his book could induce others "to explore the problem with greater success than my own."

He had no idea.

. . .

The subsequent study of creative problem solving was not your typical white-coated lab enterprise. In the early days, in fact, it was more like shop class. To study how people solve problems, and to do so rigorously, psychologists needed to devise truly novel problems. This wasn't easy. Most of us grow up on a steady diet of riddles, jokes, wordplay, and math problems. We have a deep reservoir of previous experience to draw on. To test problem solving in the purest sense, then, scientists needed something completely different—ideally, not "academic" at all. So they settled on puzzles that demanded the manipulation not of symbols but of common household objects. As a result their labs looked less like labs than your grandfather's garage.

One of the more inventive of these shop class labs belonged to the University of Michigan psychologist Norman Maier, who was determined to describe the mental machinations that directly precede seeing a solution. In a 1931 experiment, Maier recruited sixty-one participants and brought them into a large room one at a time. Inside, each participant found tables, chairs, and an assortment of tools, including several clamps, a pair of pliers, a metal pole, and an extension cord. Two ropes hung from the ceiling to the floor, one in the middle of the room and the other about fifteen feet away next to a wall. "Your problem is to tie the ends of those two ropes together," they were told. The participants quickly discovered that it wasn't possible to grab one rope and simply walk over and grab the other; it didn't reach far enough. Maier then explained that they were free to use any object in the room, in any manner they chose, to tie the two together.

The puzzle had four solutions, some more obvious than others.

The first was to tie one rope to a chair and then walk the other rope over. Maier put this in the "easy" category. He considered two others slightly more difficult: Tie the extension cord to one of the ropes to make it long enough to reach, or use the pole to pull one rope to the other. The fourth solution was to swing the rope in the middle of the room like a pendulum and catch it as it neared the wall. Maier considered this the most advanced solution, because in order to make it happen you had to tie something heavy (like the pliers) to the rope so it would swing far enough.

After ten minutes, 40 percent of the students had landed on all four solutions without any help. But it was the remaining 60 percent that Maier was interested in: those who got at least one of the possibilities but not the hardest one, the weighted pendulum. At the ten-minute mark, they were stumped. They told Maier they'd run out of ideas, so he gave them a few minutes' break. In Wallas's terminology, these students were *incubating*, and Maier wanted to figure out what exactly was happening during this crucial period of time. Did the fourth solution appear as a completed whole? Or did it reveal itself in stages, growing out of a previous idea?

To find out, Maier decided to nudge the stumped students in the direction of the pendulum solution himself. After the break, he stood up and walked toward the window, deliberately brushing against the rope in the center of the room, causing it to swing ever-so-slightly, taking care to do so in full sight of the participants. Within two minutes, almost all of the participants were creating a pendulum.

When the experiment was over, Maier asked them how they arrived at the fourth answer. A few said that they'd had a vague notion to move the rope somehow, and the hint simply completed the thought. The solution appeared to them in stages, that is, and Maier's nudge made it click. Nothing new in that, we've all been there. Think of the game show *Wheel of Fortune,* where each letter fills in a blank of a common phrase. We feel ourselves nearing a solution, letter by letter, and know exactly which letter lights the lamp.

The rest of the group's answers, however, provided the real payoff. Most said that the solution appeared in a flash, and that they didn't get any hints at all—even though they clearly had. "I just realized the cord would swing if I fastened a weight to it," one said. The solution came from a previous physics class, said another. Were these participants just covering their embarrassment? Not likely, Maier argued. "The perception of the solution of a problem is like the perceiving of a hidden figure in a puzzle-picture," he wrote. "The hint was not experienced because the sudden experience of the solution dominated consciousness." Put another way, the glare of insight was so bright, it obscured the factors that led to it.

Maier's experiment is remembered because he'd shown that incubation is often—perhaps entirely—subconscious. The brain is scanning the environment, outside of conscious awareness, looking for clues. It was Maier who provided that clue in this experiment, of course, and it was a good one. The implication, however, was that the incubating brain is sensitive to any information in the environment that might be relevant to a solution: the motion of a pendulum clock, a swing set visible through the window, the swaying motion of the person's own arm.

Life is not always so generous with hints, clearly, so Maier hadn't completely explained incubation. People routinely generate creative solutions when no clues are available at all: with their eyes closed, in basement study rooms, in tucked-away cubicles. Successful incubation, then, must rely on other factors as well. Which ones? You can't ask people what they are, because the action is all offstage, and there's no easy way to pull back the curtain.

But what if you—you, the scientist—could block people from seeing a creative solution, in a way that was so subtle it went unnoticed. And what if you could also discreetly *remove* that obstacle, increasing the odds that the person saw the answer? Would that reveal anything about this hidden incubation? Is it even possible?

A young German psychologist named Karl Duncker thought so. Duncker was interested in how people became "unblocked" when trying to crack a problem requiring creative thinking, too, and he'd read Maier's study. In that paper, remember, Maier had concluded, "The perception of the solution of a problem is *like the perceiving of a hidden figure in a puzzle-picture.*" Duncker was familiar with picture puzzles. While Maier was conducting his experiments, Duncker was studying in Berlin under Max Wertheimer, one of the founders of the Gestalt school of psychology. Gestalt—"shape," or "form" in German—theory held that people perceive objects, ideas, and patterns whole, before summing their component parts. For example, to construct a visual image of the world—i.e., to see—the brain does a lot more than piece together the patches of light streaming through the eyes. It applies a series of assumptions: Objects are cohesive; surfaces are uniformly colored; spots that move together are part of the same object. These assumptions develop early in childhood and allow us to track an object—a baseball, say—when it disappears momentarily in the glare of the sun, or to recognize a scattering of moving spots behind a thicket of bushes as our lost dog. The brain "fills in" the form behind the bushes, which in turn affects how we perceive the spots.

Gestalt psychologists theorized that the brain does similar things with certain types of puzzles. That is, it sees them as a whole—it constructs an "internal representation"—based on built-in assumptions. When I first saw the Pencil Problem, for instance, I pictured an equilateral triangle on a flat plane, as if drawn on a piece of paper, and immediately began arranging the remaining pencils around that. My whole life, I'd worked geometry problems on paper; why should this be any different? I made an assumption—that the pencils lie in the same plane—and that "representation" determined not only how I thought about possible solutions, it also determined how I interpreted the given *instructions*. Many riddles exploit just this kind of automatic bias.*

Duncker suspected that Gestalt-like biases—those "mental representations"—could block people from seeing solutions. His innovation was to create puzzles with built-in—and removable—"curtains," using everyday objects like boxes, boards, books, and pliers. The best known of these was the so-called candle problem. In a series of experiments, Duncker had subjects enter a room—alone—that contained chairs and a table. On this table were a hammer, a pair of pliers, and other tools, along with paper clips, pieces of paper, tape, string, and small boxes filled with odds and ends. One contained thumbtacks; another contained small candles, like you'd see on a birthday cake; others had buttons, or matches. The assignment: fasten three of the candles to the door, at eye height, so they could be lighted, using anything from the table. Each participant was given ten minutes to complete the assignment.

Most tried a few things, like pinning the candles to the door with the tacks, or fastening them with tape, before stalling out. But Duncker found that the success rate shot way up if he made one small adjustment: taking the tacks, matches, and other items *out* of the boxes. When the boxes were sitting on the table, empty, subjects saw that they could fasten those to the door with tacks, creating mini-platforms on which to mount the candles. Duncker hadn't changed the instructions or the available materials one bit. Yet by emptying the boxes, he'd altered their mental representation. They were no longer merely *containers*, incidental to the problem at hand; they were seen as available for use. In Duncker's terminology, when the boxes were full, they were "functionally fixed." It was as if people didn't see them at all.

This idea of fixedness infects our perceptions of many problems we encounter. We spend five minutes rifling through drawers searching for a pair of scissors to open a package when the keys in our pocket could do the job just as well. Mystery novelists are virtuosos at creating fixed ideas about characters, subtly prompting us to rule out the real killer until that last act (Agatha Christie's *The Murder of Roger Ackroyd* is a particularly devious specimen of this). Fixedness is what makes the SEQUENC_ puzzle a puzzle at all: We make an automatic assumption—that the "_" symbol represents an empty space,

*Here's a famous one that used to crease the eyebrows of my grandparents' generation: A doctor in Boston has a brother who is a doctor in Chicago, but the doctor in Chicago doesn't have a brother at all. How is that possible? Most people back then just assumed that any doctor must be a man, and thus came up with tangled family relations based on that mental representation. The answer, of course, is that the doctor in Boston is a woman.

a *platform* for a letter—and it's hard to shake that assumption precisely because we're not even aware that we've made it.

Duncker ran comparison trials with all sorts of puzzles similar to the candle problem and concluded, "Under our experimental conditions, the object which is not fixed is almost twice as easily found as the object which is fixed." The same principle applies, to some extent, in Maier's pendulum experiment. Yes, the people trying to solve that problem first had to think of swinging the rope. Then, however, they had to devise a way to swing the rope far enough, by attaching the pliers. The pliers are pliers, a tool for squeezing things—until they become a weight for the pendulum. Until they become unfixed.

Between them, Maier and Duncker had discovered two mental operations that aid incubation, picking up clues from the environment, and breaking fixed assumptions, whether about the use of pliers, or the gender of a doctor. Here's the rub: They had demonstrated those properties by helping their stumped subjects along with hints. Most of us don't have a psychologist on call, ready to provide deskside incubation assistance whenever we're stuck. We've got to make it happen on our own. The question is, how?

. . .

You're shipwrecked. You swim and swim until finally you wash up on a desert island, a spit of sand no more than a mile around. As you stagger to your feet and scan the coastline, you realize: You've read about this place. It's the Isle of Pukool, famous for its strange caste system. Members of the highest caste never tell the truth; members of the lowest always do; and those in the middle are sometimes honest and sometimes not. Outwardly, the castes are indistinguishable. Your only chance of survival is to reach the hundred-foot Tower of Insight, a holy site of refuge where you can see for miles and send out a distress signal. You follow a winding footpath and arrive at the one intersection on the island, where three Pukoolians are lounging in the heat. You have two questions to ask (Pukool custom, you know) to find your way to that tower.

What do you ask?

I like this puzzle for several reasons. It captures the spirit of insight in a visceral way, for one. At first glance, it seems hairy—it echoes a famous problem in math logic, involving two guards and a man-eating lion*—yet absolutely no math expertise is required. If anything, math expertise is likely to get in the way. A five-year-old can solve it. Better still, we can use it as a way to think about the most recent research on incubation and problem solving, which has branched out like a climbing vine since its duct-tape-and-thumbtack days.

To review, Wallas's definition of incubation is a break that begins at the moment we hit an impasse and stop working on a problem directly, and ends with a breakthrough, the aha! insight. Maier and Duncker shone a light on what occurs mentally during incubation, what nudges people toward solutions. The question that then began to hang over the field in the last half of the twentieth century was *how*. Under what circumstances is incubation most likely to produce that aha! moment in real life? Wallas, Maier, and Duncker had incorporated breaks into their theories, but none specified how long of a break was ideal, or which *kind* of break was best. Should we hike in the woods, like Helmholtz? Go jogging for forty-five minutes? Stare into space? Some people prefer a nap, others a videogame. And there are students—I wish I were one of them—who will break from the knotty calculation they're stuck on and turn to their history reading, a different species of break altogether. The religious reformer

*You find yourself in a stadium, in front of a crowd, a pawn in a cruel life-or-death game. The stadium has two closed doors, a guard standing in front of each one. All you know is that behind one door is a hungry lion, and behind the other is a path out of the stadium—escape. One guard always tells the truth, and the other always lies, but you don't know which is which. You have one question you can ask of either guard to save your life. What's the question?

Martin Luther is said to have had some of his deepest insights on the toilet, as did the prolific French essayist Michel de Montaigne. Should we be parking ourselves there when trying to incubate?

To try to answer these kinds of questions, psychologists have used old-fashioned trial and error. In more than one hundred experiments over the past fifty years, they have tested scores of combinations of puzzles, incubation durations, and types of study breaks. For instance, are people able to solve more anagrams when they take a five-minute break to play a videogame, or when they take a twenty-minute break to read? Daydreaming for a few minutes might be better than both, one study found; so might a Ping-Pong match. The most productive type of break might change entirely with other kinds of puzzles—riddles, rebus diagrams, spatial problems—and then change again when hints are given. This shifting, multidimensional experience is what scientists are trying to characterize in labs. One well-known experiment will illustrate how they do so.

This experiment, conducted by two psychologists at Texas A&M University named Steven Smith (whom we've met before) and Steven Blankenship, used a simple word puzzle called a Remote Associates Test, or RAT. The subjects were given three words—"trip," "house," and "goal," for example—and the challenge was to find a fourth that completed a compound word with each. (*Field* was the solution to this one: "field trip," "field house," and "field goal.") Smith and Blankenship chose these puzzles in part because they could easily manipulate the level of difficulty by providing good hints, like "sports" for the example above (two of them are sports-related, and all you need is to find one and try it for the others) or bad hints, in the form of wrong answers, like "road," which works with "trip" and "house" but not "goal." The first kind of hint is akin to Maier's swinging rope. The second is like Duncker's filled boxes, creating a level of fixedness that is hard to overcome.

This experiment used the second kind, the bad clue. Smith and Blankenship wanted to know whether a short incubation break affects people differently when they're given bad hints—when they're "fixed," if you'll excuse the expression—versus when they're not. They recruited thirty-nine students and gave them twenty RAT puzzles each. The students were split into two groups. Half were given puzzles that had misleading words in italics next to the main clues (DARK *light* . . . SHOT *gun* . . . SUN *moon*), and the other half worked on the same puzzles, but without words next to the clues (DARK . . . SHOT . . . SUN). Both groups had ten minutes to solve as many puzzles as they could, and neither group did very well. Those who worked on the fixed ones solved two, on average, compared to five for the unfixed group.

The psychologists then gave their participants another ten minutes to work on the puzzles they hadn't solved the first time through. This time around, each group was subdivided: half took the retest immediately, and the other half got a five-minute break, during which they read a science fiction story. So: Two groups, one fixed and one not. Two conditions within each group, incubation and no incubation.

The result? The incubation break worked—but only for those who got the bad clues. They cracked about twice as many of their unsolved puzzles as the unfixed group who got a break.

The authors attributed the finding to what they called "selective forgetting." A fixating (misleading) word temporarily blocks other possible answers, they argued, but "as more time elapses, after the initial failed attempts, the retrieval block may wear off." It's as if the students' brains were temporarily frozen by the bad hints and the five-minute break allowed for some thawing out. This occurs all the time in normal daily life, most obviously when we get unclear directions—"the pharmacy is right at the end of Fowler Road, you can't miss it"—and we arrive at the given spot, backtracking, circling, rechecking the street names: no pharmacy. We're sure we're missing it somehow. Finally, we sit down on a bench, stare at the birds for a few minutes, and it hits us: *Oh, wait: maybe he meant the* other *end of*

Fowler Road. Or, the pharmacy moved. Or he has no idea what he's talking about. The initial assumption—the pharmacy must be around here, somewhere—no longer has a stranglehold on our mind. Other options have floated in. Romantic entanglements are another classic example: We become infatuated, we think we're in love, but time loosens the grip of the fixation. We come to see exasperating flaws. Maybe she's not the one, after all. What was I thinking?

In previous chapters, we've seen how forgetting can aid learning actively, as a filter, and passively, allowing subsequent study to ramp up memory. Here it is again, helping in another way, with creative problem solving.

As Smith and Blankenship were quick to note, selective forgetting is only one possible explanation for incubation, *in these specific circumstances* (RATs, fixed words, five-minute reading break). And theirs was just one experiment. Others have produced slightly different results: Longer breaks are better than shorter ones; playing a videogame is as good as reading; writing may help incubation for certain kinds of problems, such as spatial ones like the Pencil Problem. In each case—in each specific study—scientists have floated various theories about what's happening in the buildup to that aha! moment. Maybe it's selective forgetting. Maybe it's a reimagining of the problem. Maybe it's simple free-associating, the mind having had time to wander in search of ideas. No one knows for sure which process is the most crucial one, and it's likely that no one ever will. Our best guess? They all kick in at some level.

What does that mean for us, then? How do we develop a study strategy, if scores of experiments are saying various, often contradictory, things?

To try to make sense of the cacophony, let's return to the Isle of Pukool. How to find our Tower of Insight? The three Pukoolians are pointing in different directions, after all. It's hard to know who's being honest and who's not.

What to do?

Easy. *Look up.* The tower is one hundred feet tall, and the island is flat, and the size of a city park. No complex math logic required: The tower is visible for miles. Try this on a group of friends when they're in the mood. You'll notice that some people see the answer right away, and others never come close. I didn't come close. I spent hours concocting absurd, overly complex questions like, "Which way would those two fellow islanders say that you would say . . . ?" I wrote out the various possible answers on paper, using a math notation I'd forgotten I knew. When I finally heard the solution, it seemed somehow unfair, a cheap trick. On the contrary. Taking a step back and *looking around*—seeing if we've used all the available information; attempting to shake our initial assumptions and start from scratch; doing a mental inventory—is a fitting metaphor for what we have to do to make sense of the recent work on incubation. Looking at each study individually is like engaging the Pukoolians one-on-one, or staring so closely at a stereogram that the third dimension never emerges. You can't see the forest for the trees.

Thankfully, scientists have a method of stepping back to see the bigger picture, one they use when trying to make sense of a large number of varied results. The idea is to "pool" all the findings, positive and negative, and determine what the bulk of the evidence is saying. It's called meta-analysis, and it sometimes tells a clearer story than any single study, no matter how well done. In 2009, a pair of psychologists at Lancaster University in the United Kingdom did precisely this for insight-related research, ransacking the available literature—even hunting down unpublished manuscripts—and producing a high-quality, conservative meta-analysis. Ut Na Sio and Thomas C. Ormerod included thirty-seven of the most rigorous studies and concluded that the incubation effect is real, all right, but that it does not work the same in all circumstances.

Sio and Ormerod divided incubation breaks into three categories.

One was relaxing, like lying on the couch listening to music. Another was mildly active, like surfing the Internet. The third was highly engaging, like writing a short essay or digging into other homework. For math or spatial problems, like the Pencil Problem, people benefit from any of these three; it doesn't seem to matter which you choose. For linguistic problems like RAT puzzles or anagrams, on the other hand, breaks consisting of mild activity—videogames, solitaire, TV—seem to work best.

Sio and Ormerod found that longer incubation periods were better than short ones, although "long" in this world means about twenty minutes and "short" closer to five minutes—a narrow range determined by nothing more than the arbitrary choices of researchers. They also emphasized that people don't benefit from an incubation break *unless they have reached an impasse.* Their definition of "impasse" is not precise, but most of us know the difference between a speed bump and a brick wall. Here's what matters: Knock off and play a videogame too soon and you get nothing.

It's unlikely that scientists will ever give us specific incubation times for specific kinds of problems. That's going to vary depending on who we are and the way we work, individually. No matter. We can figure out how incubation works for ourselves by trying out different lengths of time and activities. We already take breaks from problem solving anyway, most of us, flopping down in front of the TV for a while or jumping on Facebook or calling a friend—we take breaks and feel guilty about it. The science of insight says not only that our guilt is misplaced. It says that many of those breaks *help* when we're stuck.

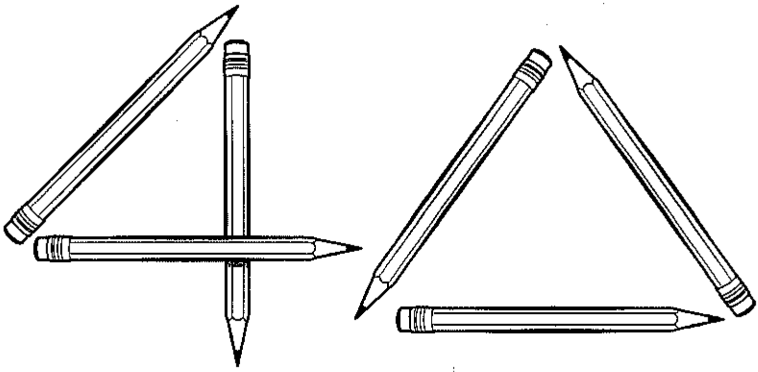
When I'm stuck, I sometimes walk around the block, or blast some music through the headphones, or wander the halls looking for someone to complain to. It depends on how much time I have. As a rule, though, I find the third option works best. I lose myself in the kvetching, I get a dose of energy, I return twenty minutes or so later, and I find that the intellectual knot, whatever it was, is a little looser.

The weight of this research turns the creeping hysteria over the dangers of social media and distracting electronic gadgets on its head. The fear that digital products are undermining our ability to think is misplaced. To the extent that such diversions steal our attention from learning that requires continuous focus—like a lecture, for instance, or a music lesson—of course they get in our way. The same is true if we spend half our study time on Facebook, or watching TV. The exact opposite is true, however, when we (or our kids) are stuck on a problem requiring insight and are motivated to solve it. In this case, distraction is not a hindrance: It's a valuable weapon.

As for the kid in the auditorium on the morning of my presentation, I can't know for sure what it was that helped him solve the Pencil Problem. He clearly studied the thing when I drew those six pencils side by side on the chalkboard—they all did. He didn't get it right away; he was stuck. And he had several types of incubation opportunities. He was in the back with his friends, the most restless part of the auditorium, where kids were constantly distracting one another. He got the imposed break created by the SEQUENC_ puzzle, which held the audience's attention for a few minutes. He also had the twenty minutes or so that passed after several students had drawn their first (and fixed) ideas, attempting to put all the triangles onto a flat plane. That is, he had all three types of the breaks that Sio and Ormerod described: relaxation, mild activity, and highly engaging activity. This was a spatial puzzle; any one of those could have thrown the switch, and having three is better than having just one, or two.

Let's reset the problem, then: Given six identical pencils, create four equilateral triangles, with one pencil forming the side of each triangle. If you haven't solved it already, try again now that you've been at least somewhat occupied by reading this chapter.

Got the answer yet? I'm not going to give it away, I've provided too many hints already. But I will show you what the eleven-year-old scratched on the board:



Take that, Archimedes! That's a stroke of mad kid-genius you won't see in any study or textbook, nor in early discussions of the puzzle, going back more than a hundred years. He incubated that one all on his own.