THE AHA! MOMENT

A STEP-BY-STEP GUIDE TO YOUR NEXT CREATIVE BREAKTHROUGH

BY NESSA BRYCE

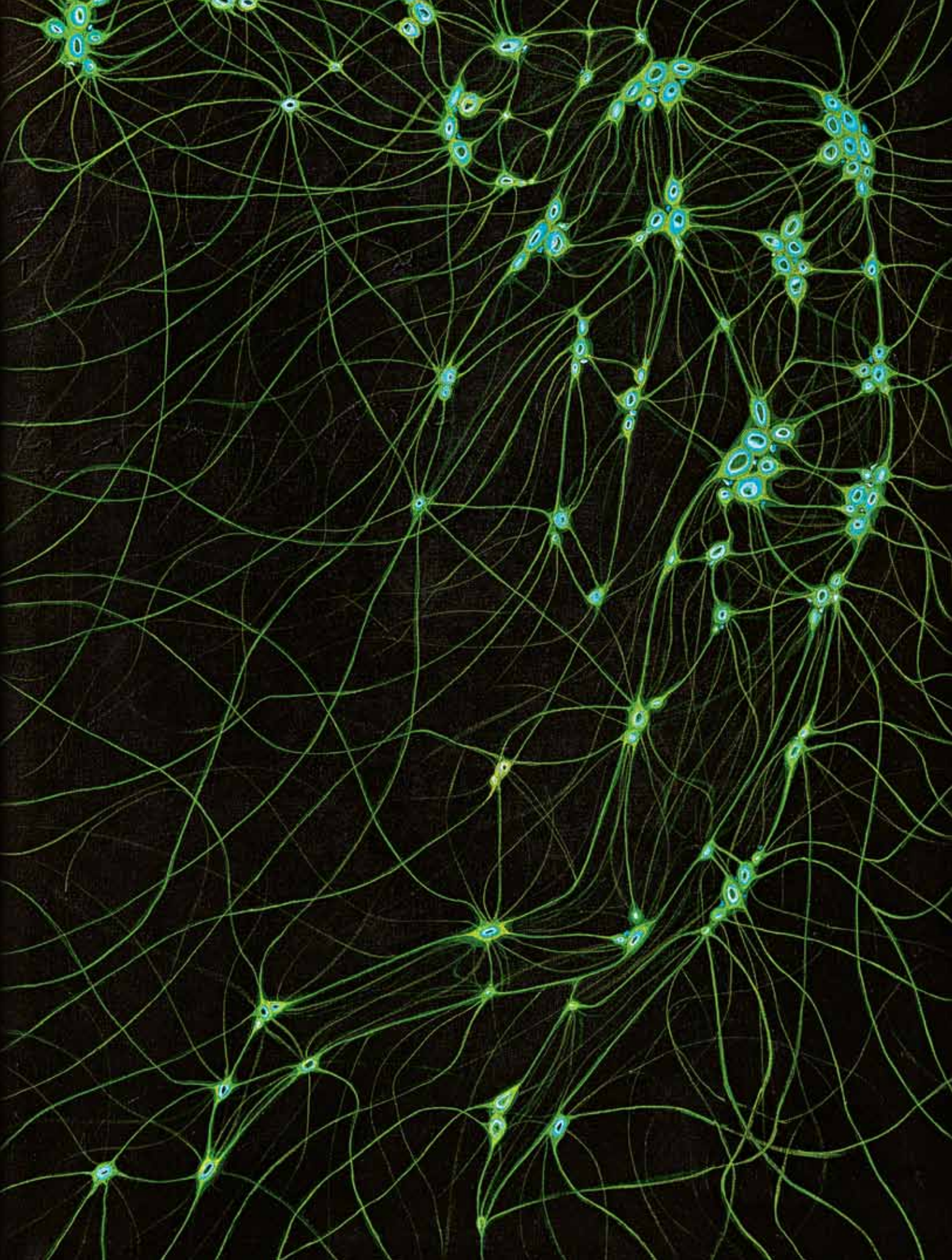
Take a moment to look at the image on the opposite page. What do you see? Just a neural network? Perhaps you spotted the hidden figure. If so, you have just had a moment of insight. You may have felt a similar jolt when discovering the solution to a math problem, understanding a joke or metaphor, or realizing something unexpected about yourself. These aha moments occur when your brain spontaneously reinterprets information to reach a novel, nonobvious conclusion.

I painted *Neurons* a few years ago for an art exhibit. I had designed the piece to portray the idea that our brain's neural networks make us who we are. It was only after joining psychologist James T. Enns's vision laboratory at the University of British Columbia in 2013 that I had my own abrupt realization: I recognized how my art could inform science. Using this piece, along with other hidden-object images, I investigated how an individual's focus and attention change when experiencing an unexpected revelation.

For centuries creative individuals have described their sudden breakthroughs, instances when they recombine information in a new and useful way. Scientists view these flashes of insight as markers of the creative process—and observing them in the laboratory elucidates what happens in the brain during problem solving.

ILLUSTRATIONS BY COLIN HAYES

PAINTING BY NESSA BRYCE



"A story is emerging about all the factors that lead up to an insight," says cognitive psychologist John Kounios, who studies creativity at Drexel University.

What researchers are finding is that the contemporary science of creativity largely bolsters an almost century-old theory. In 1926 political scientist Graham Wallas defined the creative process as four distinct stages: preparation, incubation, illumination and verification. Since then, scientists have broken some of his stages into substages to reveal distinct cognitive processes. For example, preparation now consists of two parts, one involving general learning and the other more focused on skill building. "These stages really seem to be universal, whether you are a scientist, artist, writer or musician," says Harvard University psychologist Shelley Carson, who has interviewed more than 1,000 creative individuals for her research. And creativity is not restricted to a subset of highly talented artists and thinkers, Carson says. These innovative individuals have a distinct style of thinking, and breaking down their approach can allow anyone to re-create the process. Brain research has revealed that we can all get closer to achieving that magical spark of insight with the help of a few simple techniques.

STAGE 1 EXPLORE

Roughly speaking, people solve problems in one of two ways: they either tend to rely on moments of insight, or they prefer to approach them analytically. Answering questions with analysis involves finding solutions through deliberate, methodical trial and error, whereas insight is perceived as an abrupt epiphany. Both methods are useful, but insight is typically seen as the best option for "out of the box" solutions.

In 2008 Kounios and his colleagues monitored the brain activity of 26 study participants using electroencephalography (EEG) while they sat quietly in a room. After recording these electrical signals, the researchers asked the participants to try to solve 180 anagram problems, which involved reorganizing a word, such as "west," to form another word, "stew." Subjects also reported whether they had used an insightful or analytical approach to solve each problem.

Kounios found that the brain activity of people who used insight differed significantly from that of people who preferred the analytical approach. Before they even began solving problems, most members of the insight group exhibited less activity in the occipital lobe, a region involved in visual processing, compared with the analytical set.

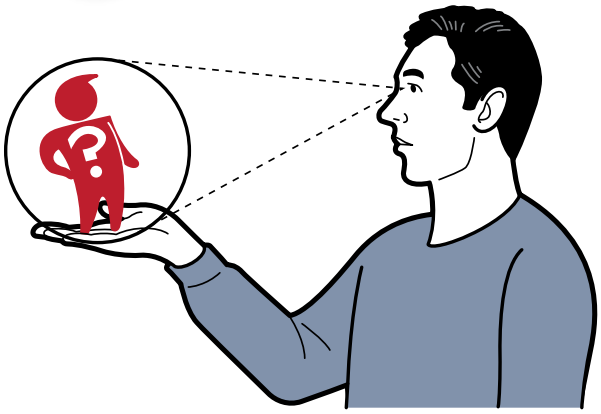
Specifically, the brains in the insight group showed less activity in the so-called alpha-wave range, which reflects neural inhibition, and the beta-1-wave range, which is linked with selective visual attention. In other words, these findings suggest that people who rely on insight tend to experience diffuse visual attention when not actively engaged in a task.

This study, along with Carson's reports from highly creative individuals, suggests that to prime your brain for creativity, you should first wander the world with an open mind. "Gathering a broad base of knowledge is the first stage of the creative process, which usually comes naturally to people through intellectual curiosity," Carson says. Another way to break your thought habits is by asking questions such as "How can I do this differently?" and by stepping outside your comfort zone. A poet with writer's block, for example, might be advised to take up a new hobby such as scuba diving or dance lessons. Neuroscientist-turned-artist Greg Dunn discovered an entirely different way to depict the brain when he began studying Sumi-e art, an Asian style of painting. His experimentation with the style's free-flowing ink led to a simple yet elegant new method for painting neurons.

FAST FACTS
ON YOUR WAY TO EUREKA

1. Psychologists study the moment of insight, or the abrupt realization of a new solution, as a marker of the creative process.
2. Researchers have broken down the discovery of insightful solutions into stages, including preparation, incubation, illumination and verification.
3. Recognizing the distinct cognitive processes underlying each stage can help everyone use an insightful approach to find innovative solutions.

STAGE 2 FOCUS



Psychologist Dean Keith Simonton of the University of California, Davis, has linked creativity with the acquisition of expertise. In 2000 Simonton compared the cumulative years of experience of 59 opera composers with their aesthetic success. He measured aesthetic achievement in eight different ways—tallying the number of times an opera was recorded and performed in major opera houses, for example, as well as the number of pages devoted to the work in opera histories.

Simonton found that a composer's years of musical experience were a powerful predictor of an opera's acclaim. He also found that if the composer had already created a number of other works within the same genre, this would actually hurt the opera's critical reception and legacy. In other words, solutions to great problems demand practice, skill and study, yet creative solutions occur when someone applies their experience to new domains.

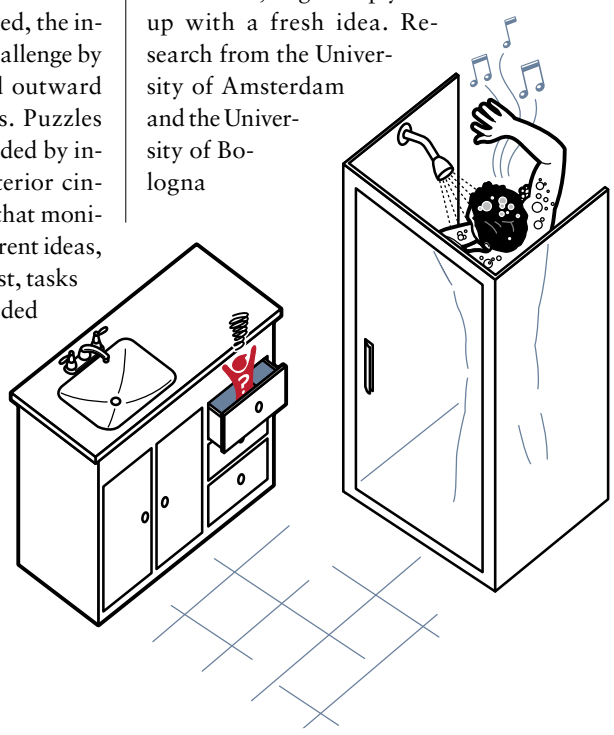
Whether you are proving Fermat's last theorem or planning a birthday party, finding novel solutions involves a little advance research. How much preparation you need will vary, but the more you know about a problem, the better equipped you are to solve it. Some of the most creative minds the world has ever seen, from Leonardo da Vinci to Beethoven to Einstein, were masters of their respective fields. Given that these people spent large amounts of time immersed in their studies, one of the best ways to maximize your creativity is to find an area in which you would like to develop expertise. Then follow that passion.

STAGE 3 INCUBATE

Once you have immersed yourself in a problem, the best way to come up with a creative solution is to stop consciously thinking about it. In 2006 Kounios and his colleagues used functional magnetic resonance imaging (fMRI) to record the brain activity of 44 men and women as they solved 185 remote-association problems. These word puzzles require finding a single word that can turn three seemingly unrelated words into familiar compound phrases; for example, the solution to "foam," "deep" and "salt" is "sea." After finding an answer, the subjects reported whether they had solved the problem using insight or analysis.

Kounios found that in the two seconds before a problem appeared, the insight users prepared for the challenge by shifting from their scattered outward attention to an inward focus. Puzzles solved insightfully were preceded by increased activation in the anterior cingulate cortex, a brain region that monitors internal attention to different ideas, among other things. In contrast, tasks solved analytically were preceded by significant activation in the occipital lobe, which, as mentioned before, handles visual processing. This increase indicates that the analytical solvers concentrated more on what they were looking at.

Other studies suggest that activities that shift your focus inward, such as meditation, might help you come up with a fresh idea. Research from the University of Amsterdam and the University of Bologna



THE AUTHOR

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in Italy has demonstrated that sleeping on a problem or stepping away from it and then immersing yourself in an alternative activity can help you unconsciously cultivate creative solutions.

Taken together, the findings reveal a benefit to forcing your brain to shift gears or look within. One reason might be that your attention can then be captured by a surprising solution your unconscious mind has been ruminating on. So take a nap or try your hand at something new.

History is replete with examples of creative individuals who describe being hit with inspiration when daydreaming or attending to a different task. Writer Robert Louis Stevenson and musician Paul McCartney, for instance, used dreams as starting points for new works. Many day-to-day problems can be solved this way, which explains why so many people recall stumbling on ideas while taking a shower, driving to work or simply walking down the road.

STAGE 4 INSIGHT

When insight hits, certain changes happen in the brain. Psychologist Mark Beeman of Northwestern University led a study in 2004 that measured people's brain activity with fMRI and EEG during the moment of insight. As in Kounios's studies, participants tackled remote-association problems and then indicated if they had cracked the problem using insight. The results showed significantly increased activity in the anterior superior temporal gyrus of the right hemisphere at the critical moment when the solution appeared, in comparison to problem solvers who did not experience such an aha moment. This gyrus is a prominent ridge on the cortex of the right hemisphere and plays a fundamental role in recognizing distant connections between words.

The activity surge in the right but not the left lobe may also be meaningful. According to the researchers, the right hemisphere interprets information more coarsely than the left hemisphere does. This means that the information is less sharply defined, allowing you to access other concepts more readily, which is a key component of creativity. Both hemispheres are working all the time, but your right brain might loosely define a cat as a mammal, making it is easy to see how a cat relates to, say, an elephant. Your left brain, however, might describe a cat as a small, carnivorous mammal with soft fur, a short snout and retractile claws—something very different from an elephant.

Research has suggested that you can tip the scales toward looser, right-brain understanding by describing objects or issues in unusual ways. For example, by thinking of a hanger as a long, twisted wire instead of as a metallic instrument for hanging coats, you might discover other uses for it. Try this technique every so often as you are actively working to solve your problem. It might help prime your brain to forge connections between distant concepts.

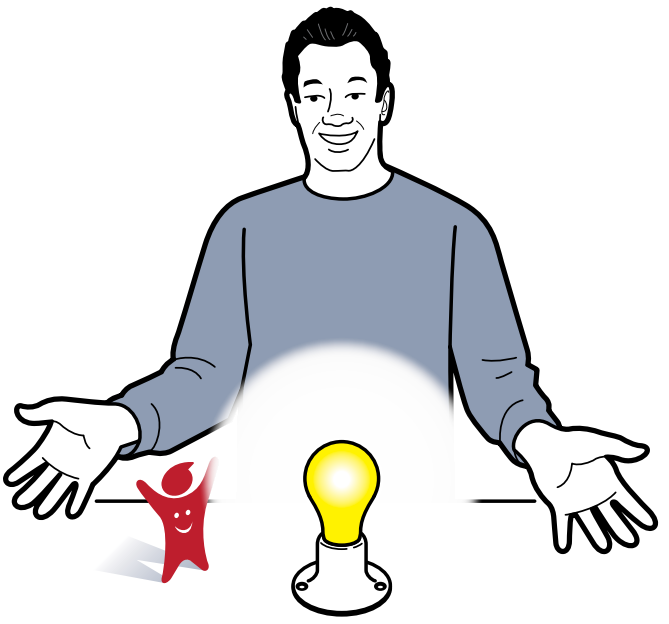
The moment of insight is also accompanied by a burst of alpha activity in the visual cortex, according to Beeman's study. Alpha activity, as mentioned earlier, inhibits neuron firing, meaning that during a breakthrough, your brain is less involved in processing visual information—perhaps because visual stimuli can be distracting. These findings suggest that you could help your brain discover an insight simply by closing your eyes.

Probably the most famous moment of insight in history is Archimedes' "Eureka!" Legend has it that the ancient Greek mathematician had been challenged to figure out whether a crown that King Hiero II of Syracuse had commissioned was made out of solid gold. Archimedes was preparing a bath when he discovered how to measure an object's volume, and thus its density, after noticing the displacement of water as he climbed into the tub. Although the story may be apocryphal, it has gone down in history in part because it illustrates perfectly how insight strikes.

FLASHES OF INSIGHT ARE MARKERS OF THE CREATIVE PROCESS AND MAY HELP ELUCIDATE WHAT HAPPENS IN THE BRAIN DURING CREATIVE PROBLEM SOLVING.

STAGE 5 FOLLOW-THROUGH

Once you have had a moment of insight, you might find yourself feeling elated. A 2013 study by Tufts University researcher Tad Brunyé showed that subjects who came up with broad associations between words, such as associating "pipe" with "flute" rather than with "smoke," experienced a boost in mood. Take advantage of the positive mood to check whether your solution works. "When you have an insight, it comes with a lot of conviction," Carson says. "So you really have to be objective and evaluate that idea."



Melissa Ellamil, a cognitive neuroscientist at the University of British Columbia, led a study in 2011 that uncovered the brain processing involved in the evaluation, as opposed to generation, of creative ideas. Ellamil asked 15 art students to produce illustrations for a book while lying in an fMRI scanner. In six trials, participants produced and evaluated five drawings. Ellamil found that during the evaluation phase, the brain recruited the regions of the temporopolar cortex and prefrontal cortex associated with executive function. These areas support critical thinking and decision making.

This stage is an ideal time to bounce ideas off of trusted friends—their feedback and support could help you determine how well your solution works [see "Creativity Is Collective," by S. Alexander Haslam, Inmaculada Adarves-Yorno and Tom Postmes, on page 26]. Do not be discouraged, though, if your personal eureka is less than perfect. Creative people often describe going through many failures before reaching a successful solution. Those failures help to inform the end result, making them a necessary step in the process. When a student asked chemist and two-time Nobel laureate Linus Pauling how he came up with so many good ideas, he replied, "I have a lot of ideas and throw away the bad ones."

In practice, each stage does not always follow easily from the one before it—many people have to revisit earlier steps several times before hitting on inspiration—but ultimately the process is very rewarding. Creativity not only makes creators happy but also benefits all those who will enjoy their creations.

The joys of an aha moment may even serve a deeper purpose. In 2013 psychologists Claudia Muth and Claus-Christian Carbon of the University of Bamberg in Germany found that participants who identified a hidden face in a picture liked the image more than those who did not identify the face. Muth hypothesizes that insight is rewarding for evolutionary reasons. She says, "It could explain why we explore the world and why we have interest in things that are new."

Being curious and pursuing creative endeavors provides you with the opportunity to discover new interests, explore unfamiliar territory, develop expertise and, crucially, take breaks. In short, working to develop and maximize your creativity serves to enrich your life. As Carson puts it, "Once you realize that you can be creative, it opens up this whole new world." M

FURTHER READING

- **Shedding Light on Insight: Priming Bright Ideas.** Michael L. Slepian et al. in *Journal of Experimental Social Psychology,* Vol. 46, No. 4, pages 696–700; July 1, 2010.
- **The Cognitive Neuroscience of Creativity: A Critical Review.** Keith Sawyer in *Creativity Research Journal,* Vol. 23, No. 2, pages 137–154; 2011.
- **Stepping Out of History: Mindfulness Improves Insight Problem Solving.** Brian D. Ostafin and Kyle T. Kassman in *Consciousness and Cognition,* Vol. 21, No. 2, pages 1031–1036; June 2012.
- **Incubation and Creativity: Do Something Different.** Ken J. Gilhooly, George Georgiou and Ultan Devery in *Thinking & Reasoning,* Vol. 19, No. 2, pages 137–149; 2013.

From Our Archives

- **The Unleashed Mind.** Shelley Carson; May/June 2011.
- **Your Creative Brain at Work.** Evangelia G. Chrysikou; July/August 2012.
- **The Science of Genius.** Dean Keith Simonton; November/December 2012.