





**A free course on “iPhone Tips & Tricks” teaches students a new “power user” tip every other day. The 10-question mini-course aims to make students’ iPhone use easier and more efficient.**

tention for up to two years. Furthermore, students report enjoying spaced education; its website ([www.spaceded.com](http://www.spaceded.com)) even calls it “addictive.”

The website offers, online, the first courses structured in this mode. (Harvard has applied for a patent on the technology, and already licenses it to an Internet start-up company, SpacedEd.) The methodology, which Kerfoot, a urological surgeon, invented, breaks information down into discrete packages and then applies two learning principles that he gleaned from the psychological literature on learning and memory. The first principle is the *spacing effect*—“When you present and repeat information over intervals of time [as opposed to “binges”], you can increase the uptake of knowledge,” he explains. “And it’s encoded in ways that cause it to be preferentially retained.” The second principle is the *testing effect*: “When you present information in a ‘test’ format, rather than just reading it, long-term retention is dramatically improved.”

Kerfoot had his interest in education and educational reform sparked when, as a student, he took part in the Medical School’s New Pathways curriculum. During his residency, he also earned a master’s degree at the Graduate School of Education. He knew that Web-based teaching modules are a gold standard for online education, but in a study done at four medical schools, Kerfoot found that “most students hated them and long-term retention was quite poor. Why waste a week of their time and \$1,000 of

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**HARVARD**  
MAGAZINE

their tuition teaching them about a medical subspecialty when the knowledge will disappear from memory in five to 12 months?"

In contrast, spaced education "turns online education on its head," he asserts. Instead of a test at the end of the course, it presents the material itself entirely in a test-question format. New information appears when the correct answer is explained and elaborated upon. (The online courses have an "answer blog" at the conclusion of each explanation, for students' comments and discussion.) Typically, a

Instead of a test at the end of the course, SpacedEd presents the material itself entirely in a test-question format.

course contains 20 to 40 questions, spread across one to two months. The spacing de-

pends on the student's answers: an incorrectly answered question might repeat one week later, for example, and a correctly answered one after three weeks. After two consecutive correct answers, a question is retired.

Close to home, Kerfoot used Spaced Ed to improve prostate-cancer screening by 95 primary-care providers at the Veterans Administration Medical Center in Jamaica Plain, where he works. Participants showed a 26 percent decrease in inappropriate cancer screenings, saving money and minimizing patients' anxiety.

## BEES' KNEES

## Taming Turbulence

**W** AFT THE SCENT of cinnamon, wintergreen, or eucalyptus into the tropical air of Central and South America and beautifully colored bees in hues of red, gold, green, and blue will appear as if out of nowhere, says Stacey Combes, assistant professor of organismic and evolutionary biology. These male orchid bees will travel almost anywhere in pursuit of exotic fragrances—aromatic hydrocarbons that they collect over a lifetime and store in pockets in their massive hind legs. (Like all males in the order Hymenoptera, they have no stingers.)

So powerful a motivator is the orchid bee's fixation on fragrance (the scents are thought to be used in sexual selection) that it can be used to measure their flying abilities, Combes says. She places a scent in a receptacle in front of a fan, and the bees lock on to it. "I can turn the speed up faster and faster, like a treadmill," she says, "and they keep flying." She had suspected that once the bees reached maximum flight speed, they wouldn't be able to keep up anymore, but it was instability they had trouble with. As the speeds increased, the bees started rolling over and were ejected out of the airstream. To prove that

turbulence, rather than speed, caused the problem, Combes used a grid with squares to disrupt the airflow and a 3-D sonic anemometer to map the resulting turbulence in the air stream. The higher the turbulence, the lower the bees' maximum speed before failure.

Combes also observed a counterintuitive behavior: as the speeds increased

beyond two meters per second, the bees straightened their hind legs—which increased drag as much as 30 percent. By moving the mass in their legs away from their bodies, Combes explains, the bees increase their *moment of inertia*, or resistance to rotation, in the same way figure skaters will emerge from a blurringly fast spin by extending their arms. Flying with straight legs requires more energy, but helps the bees stabilize themselves in the turbulent conditions they may encounter in the upper levels of the rainforest, where the orchids they frequent are most abundant.

"Wind is a universal part of life for all flying animals," says Combes, who is part of a research team working on the development of small-scale mobile robotic devices (see "Tinker, Tailor, Robot, Fly," January-February 2008, page 8.) "Yet we know remarkably little about how animals navigate windy conditions and unpredictable airflows, since most studies of animal flight have taken place in simplified environments, such as in still air or perfect laminar flows. Our work shows clearly that the effect of environmental turbulence on flight stability is an important and previously unrecognized determinant of flight performance."

~JONATHAN SHAW



Visit [harvardmag.com/extras](http://harvardmag.com/extras) to see videos of orchid bees in flight.



Orchid bees navigate turbulence by extending their massive hind legs to prevent rolling.

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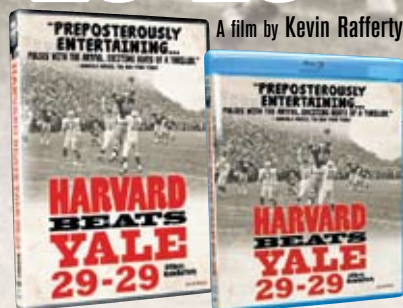
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## RIGHT NOW

(The SpacedEd website offers discussion boards where students can hash out controversial medical practices like the prostate-specific antigen [PSA] test.) Kerfoot is also going global, having just completed a spaced-education randomized trial on urology clinical-practice guidelines involving 1,470 surgeons in 63 countries.

There are now dozens of courses on the SpacedEd website, which went live in May. Many are for doctors and medical students, but there are also offerings on bartending, iPhone tips, and music theory (which includes video of the instructor playing his guitar in each question). Nearly all are free; a few have very modest fees—\$1.99 to \$9.99. Kerfoot feels that the platform can work with almost any type of course, including K-12 educa-

tion, and plans to enlist teachers all over the world to develop the curriculum, with course authors keeping 60 to 80 percent of the revenue if there is a tuition fee. His ambition is to cultivate a "social learning community" where course authors and students interact online, becoming engaged in creative and effective courses and generating comment and discussion on the curricular topic. "Our goal is to get the methodology out beyond the Harvard firewall," he says. He'd also love to see a course in Spanish, which he has studied three times previously. As he says, "I won't have to forget it a fourth time."

—CRAIG LAMBERT

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## IMPRINTING BABY

# A New Twist on Nature/Nurture

**C**OMPARED TO other primates, humans spend a relatively short time nursing, yet take an unusually long time to become adults. An orangutan will suckle its young for seven to eight years, a chimpanzee for about five years; a human mother typically suckles hers for only two. This allows for shorter intervals between pregnancies. Yet long after weaning, human children remain nutritionally (and otherwise) dependent on parents. This unique life pattern may be the result of an evolutionary compromise between the competing interests of mothers, whose "fitness" is measured by how many surviving children they bear, and offspring, whose goal is maximizing access to maternal resources while adapting to a complex social world.



BRUCE ROSCH