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THE FUTURE OF WARFARE
How Will the World Respond to the Rise of Autonomous Weapons?

A LITTLE SLICE OF HEAVEN RIGHT HERE ON EARTH
The Majesty of the Milky Way Surges into the Sky at This Stargazer's Paradise



Verbal communication is full of power plays:

The strategies we use to speak to a rival can save our skin—

or blow up in our face..

THE SECRET POWER OF WORDS



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Learn to get what you want and avoid being exploited



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The Quest for True Love Is Exhausting, But Finding Your Princess Is Worth It



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You talk, we listen! Here's what you had to say about previous issues of iD. Thanks for your feedback and suggestions. Keep 'em coming.

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LOWDOWN ON FLYING HIGH

The July issue's article on radiation was thought-provoking. I myself was likely exposed to the harmful radiation that exists at high altitudes, as I flew for many years across the Atlantic and Pacific as a Professional Flight Engineer on B-707, DC-8, and DC-10 aircraft. However there is no mention of the constant radiation levels that commercial pilots are subjected to on a daily basis, versus the flying public.

Michael Walsh Hollywood, FL
U.S. Navy Veteran 1957–1963

Thank you for dropping us a line regarding the "How Much Radiation Is There at 39,000 Feet?" article. We're especially glad to receive correspondence from someone who has experience in this field, though we regret the exposure you have endured. Also regrettable is the absence of a mention of the radiation levels to which airline pilots and flight staff are continually subjected. It is a dimension that the article could have indeed touched upon, relying instead on the reader to extrapolate the notion from the information presented.

ENDURING MELANCHOLY

The article "Is Suicide Contagious?" in the July issue was an interesting though very sad piece to read. It provided me with the information I needed to talk to my teenage daughter about suicide and why we will never watch the show *13 Reasons Why*. She has never expressed thoughts of suicide or shown signs of depression, but some of her friends have. She gladly took down the suicide hotline number to pass on to her friends. Thank you for bringing awareness to the public on this issue. I was also curious if there are reports on the story of *Romeo and Juliet* causing copycat suicides like the Werther effect.

Alisha from Texas

*We're very glad our article could be a helpful resource to assist you in having a rather tough conversation with your daughter and that the hotline phone number may have ended up where it can do some good. You have also raised an excellent point: *Romeo and Juliet* fulfills the conditions for propagating the Werther effect too. Drama and tragedy go hand in hand, and*



suicide is used as a plot device in other Shakespearean plays as well (Hamlet, Othello, Antony and Cleopatra, Julius Caesar). The mental contagion that can lead to a suicide epidemic may develop when ending one's life is presented in a way that might be seen as a solution to an intractable problem for vulnerable individuals. But nowadays the formats

in which we consume our entertainment are so rich and immersive, the impact made on viewers is all the greater—especially on those already mired in a depressive state and susceptible to a "nothing left to lose" mind-set. No matter how many eras pass, some human experiences remain constant. And adolescence has always been a turbulent time...

EVADING THE EYES IN THE SKY

Loved your bit "Could a Scarf Make Me Invisible?" [Q&A, September issue]. Can this technology also be used to defeat video camera surveillance?

Kenneth Scott Aberdeen, WA

Yes, there are fashionable ways to outwit video surveillance. These days when we go out in public, more cameras than ever keep track of our movements. But certain patterns confuse facial recognition systems, like those printed on the clothing made by the Hyperface project. That's the brainchild of artist Adam Harvey, the same person behind the CV Dazzle project we covered a while back in our May 2017 article on thwarting surveillance technology, which had featured hairstyles and makeup techniques meant to render machines incapable of recognizing a face. As the systems become more ubiquitous, it's likely such creative responses will become more prevalent.

DISCERNING MANX KITTENS READ iD!

I bought the September issue a few days ago and set it on my chair when I got home. When I came back in the living room, I saw Max (one of my four Manx kitties) perusing the cover. I thought you would want to see it.

Stephanie McEvoy Bristol, VA

Thanks very much, this photo made our day. It was so good, we had to share it with everyone!

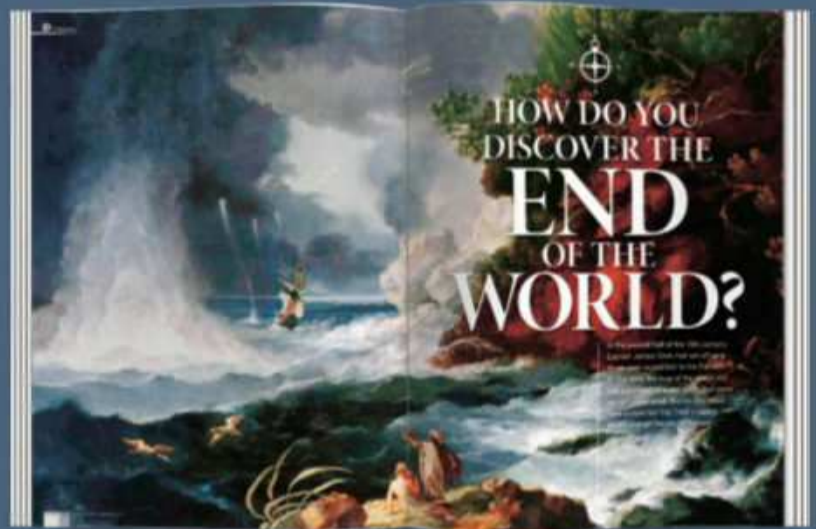


id contents

COVER STORY



These agile and adaptable amphibians leap, climb, and make their presence known on balmy summer nights. But what they long for most is love... **PAGE 10**



In the 18th century, Captain James Cook and his crew set sail into the unknown. Their journeys filled in a huge gap in our knowledge of the globe. **PAGE 18**

COVER STORY



Astronomers and amateurs alike make their way to the Atacama Desert to revel in a rare view of the night sky and catch a glimpse of distant worlds. **PAGE 38**

COVER STORY

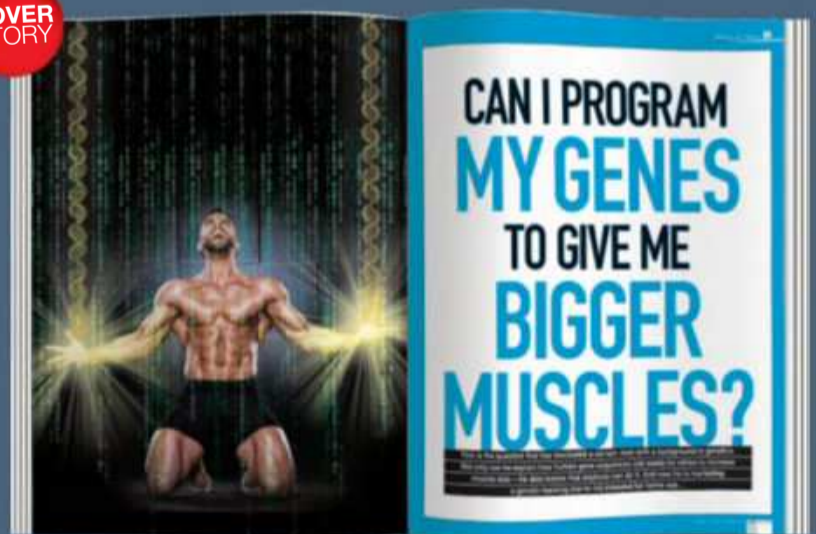


What really governs the workings of our universe? Does randomness reign supreme, or is there such a thing as destiny? Is it possible to know? **PAGE 48**



Tales of crime and punishment always make headlines. But what happens when the culprit in a notorious case isn't culpable in the eyes of the law? **PAGE 62**

COVER STORY



A gene-editing starter kit that lets laypeople hack genes in the comfort of their homes can be purchased online. Is this development a cause for concern? **PAGE 72**

“An investment in knowledge pays the best interest.”

—Benjamin Franklin

COVER STORY



Our words are more powerful than we realize: They can be used as weapons or as a means of defense, and they can also betray our true intentions. **PAGE 28**



Scientists are sounding the alarm about a worrisome trend in weapons technology. Is autonomy a trait that drones should possess? **PAGE 56**



For the animals of Africa's Serengeti Plain the quest for water is a vital endeavor. A skilled photographer shows us a unique view of a life-giving locale. **PAGE 82**

To our readers:

Inadvertence is pervasive. When we speak, we might reveal our true selves without realizing it and betray our intentions. When it comes to AI, we might not be able to put the genie back in the bottle and could accidentally doom humanity. Ditto for gene modifications outside the lab—an errant organism could infiltrate our environment. However, unintended consequences can be positive as well: Captain Cook didn't find what he was looking for, but he did refine our view of the world. Hindsight is 20/20...

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Next issue on stands
November 9





ARE YOU SKIING?

RIDING THE RAZOR'S EDGE

Jérémie Heitz races down 55-degree slopes at speeds close to 80 mph. Where other freeskiers might take 10 turns, he does it in two or three—always with the knowledge that one false move could be fatal.

OR ARE YOU

Extreme skier Jérémie Heitz set out to do something that had never been done before: tackle 15 of the steepest Swiss peaks higher than 13,000 feet at breakneck speed. The life-threatening undertaking took him to the limits of physical strength and endurance...

FALLING?



2-3

HOURS

per year is the only window of time for a potential descent. The best snow conditions are in early summer.

55

DEGREE SLOPES

are among the challenges posed by Ober Gabelhorn, which rises to 13,330 feet in the Valais Alps. All of the over-13,000-foot peaks on Heitz's list have slopes of at least 50 degrees.

TIMING IS EVERYTHING

The Ober Gabelhorn was Heitz's toughest test. He had to spend several nights at the summit in subfreezing temperatures, only to abandon his planned descent at 3 A.M. The reason: The steep north face is iced over almost all year long, making it impassable. But as this photo proves, Heitz did discover the right time and conditions in the end.

80

MPH

is the speed Heitz hits while heading down the steepest slopes on his 6'3" carbon-reinforced freeride skis. He can descend by more than 3,000 feet per minute. This high speed lowers the risk of taking a fall.

F

inally, I'm there! thinks Jérémie Heitz as he turns his gaze toward the abyss below the peak of Ober Gabelhorn. With an ice axe in his

hand, he has spent hours ascending the steep north face of the mountain. Driven purely by adrenaline—and a list on which the peak's name has not yet been checked off—Heitz takes a closer look at the thin blanket of snow deposited on the sheer slope, which descends at an angle of 55 degrees. Freshly fallen, grippy, and still a little wet—the perfect snow conditions for carrying out his plan. Heitz takes one last deep breath before shoving off. In a matter of seconds he has reached a speed of almost 80 miles per hour, his skis slicing into the slope as he leaps over rocky outcroppings as if the laws of gravity don't apply to him. His muscles are struggling against the extreme g forces that tear at his body, and then suddenly he comes to a halt at the foot of the white wall. For the 11th time in his life he has won his perilous dance with a mountain, descending about 3,000 feet in less than a minute.

Still, why all this breakneck racing against the elements? Why would the 29-year-old Swiss skier be willing to risk his life? Heitz just laughs. "It's no more dangerous than traffic in Paris. I've been skiing since I could walk," he says. His grandfather once skied with Sylvain Saudan, the pioneer of extreme skiing. Early on Heitz himself would discover the fascination of the wild side of Alpine skiing: At age 20 he took part in his first Freeride World Tour. But he'd considered that to be a training session for his real goal—"the list." At the start of 2015 he listed 15 of the highest, steepest peaks in the Alps: the Matterhorn, Lenzspitze, Ober Gabelhorn, and a dozen others



SUMMIT STORMER

You have to climb a slope on skis to know whether you can ski back down it. That's why Jérémie Heitz dons his full equipment and scales a mountain all the way to the peak that will be his point of departure.

FREESKIING PIONEER

Heitz grew up in the Valais Alps and went skiing for the first time at the tender age of two. Today the extreme athlete is an absolute ace in the world of freeskiing.

"OF COURSE I'M AFRAID—AND THAT'S GOOD. FEAR SHARPENS YOUR SENSES. WHEN YOU FEEL SAFE, YOU'RE MORE LIKELY TO MAKE A MISTAKE."

that are higher than 13,000 feet with slopes steeper than 50 degrees. His plan: to ski each one at speeds faster than 60 miles per hour with a camera team filming it all. "I wanted to push my skiing ability to the absolute limit," he explains. His talent and his knack for selecting the optimal equipment helped him master 11 of the 15 slopes in only two winters. In summing it up, he says: "Proper preparation is the most important aspect. You have to be able to 'read' the mountain. That's why we spend months analyzing the

weather conditions and use cameras with a powerful zoom lens to choose the slopes that best line up with our requirements. Then I climb the slope on skis and make certain I know the best spots for making a turn, where the snow is as grippy as possible."

There are many other variables to consider beyond snow, sunlight, time of day, and wind conditions. "Even a slight change in a slope's angle can soften the snow," says Heitz, who has already set his sights on a new goal: the Himalayas. "The snow conditions there are radically different from ours. If we can do in Asia what we've been doing here in Europe, we'll have taken things to an entirely new level."





LOCATION, LOCATION, LOCATION!

What turns on a lady tree frog? Two things: a powerful voice—and shiny green skin. There is one sticky wicket, though: Tree frogs change their coloration depending on where they are. On rough ground they get darker. Only when they're on a smooth surface in direct sunlight do they appear to be the radiant green that the ladies admire. In other words, location is everything when it comes to the mating game.



A chorus of countless frogs puts on a concert that resounds in the summer night. But not just any song will do. When a frog sings, it's always about love...

A DAY IN THE LIFE OF

THE



OF A FROG

The sun has just set. It's still quiet down at the pond—until suddenly a voice calls out from the reeds. A timid honking sound pierces the twilight and is quickly joined by a second even louder and more insistent voice. They are soon drowned out by a four-voice choir, and then the entire tree frog chorus chimes in. There will be no peace at the pond this evening—not until midnight at the earliest...

Why do tree frogs start their summer serenade in the twilight hours? Because they're searching for love, for a princess who will make the evening a perfect one. Night after night that hope draws the princes of the pond out from the undergrowth where they relax the days away hidden from view. As strange as it may sound, frogs just can't help themselves. Hope springs eternal in their genes, which program them to heed a powerful instinct: Sing loudly enough and you'll get what you want. Even if it takes all summer. The mating season begins in late March and goes all the way until the end of August. But it takes a stroke of luck to find a pretty green princess right away—one who'll be able to produce hundreds of offspring. Most frogs simply have to keep singing, often for months on end. Frogs are indefatigable croakers, and their persistence pays off in the long term: Amphibians have roamed the Earth for roughly 360 million years. They were the first vertebrates to conquer land and so have seen and survived it all: dinosaurs, asteroid impacts, ice ages, and, much more recently, storks, herons, and egrets. Such birds are their worst enemies, which is why frogs fall silent as soon as a two-legged winged creature approaches the pond. The evolutionary answer to avian danger is the frogs' ability to match their skin color to the surface on which they're sitting—thus on leaves they turn green, and on bark they're brown. And if a bird happens to spot one anyway, frogs have powerful hind legs that enable them to catapult themselves through the air, more than 6 feet in one bound.

Once the bird has moved on, the little frogs in the cattails regain their composure and resume their singing, and soon the entire chorus joins in. There is no opportunity for a solo performance. Nevertheless, each of the myriad singers has his sights firmly set on finding big love in a little pond. So they keep singing their hearts out until they do.



ALWAYS ON THE HOP

A frog will prey on anything that moves and fits in its mouth. The frogs' hind legs supply tremendous power and leverage: The agile frog, for example, can jump more than 3 feet high and covers a distance of 6 feet. By comparison: A 6-foot-tall adult human would have to jump more than 70 feet high and cover a distance of 180 feet to match a frog's performance.



LUNCH COMES WITH HIGH-SPEED DELIVERY

The little gnat sitting in the grass never saw it coming. And how could it? A tree frog's tongue can move faster than 20 mph—and most frog species are able to catch prey with their tongue more quickly than we can blink. Furthermore, a captive insect is moved toward a frog's mouth at 12 times the acceleration of gravity. By way of comparison: Astronauts typically experience three times the acceleration of gravity during the launch of a rocket.



THEY ALL CROAK ALIKE? DON'T YOU BELIEVE IT!

The roughly 7,000 species of frogs and toads can produce an incredible variety of sounds. Some croak while others chirp, whistle, peep, honk, cluck, bark, or grunt. Over the course of evolution, each species of frog has developed its own distinctive mating call. You can tell just how popular and contested a particular pond is by listening to the number of different sounds its amphibian inhabitants are making.



60 MILLION YEARS PACKED INTO 12 WEEKS

While it took about 60 million years for fish to evolve into land animals, a modern frog requires about 12 weeks for the same transformation. The metamorphosis from egg to tadpole to frog has been classified in 46 developmental stages. Tadpoles are still vegetarian, mostly eating algae and pollen, but an adult frog is a carnivore that consumes live animals from the moment it sets foot on land: The preferred foods at the top of a frog's menu are dragonflies, beetles, and earthworms.



TIME TO CATCH YOUR BREATH

A male tree frog may croak 100 times per minute for hours on end in order to attract a female, and that requires a lot of energy. Some of them can croak at volumes above 100 decibels, which is about as loud as a chainsaw. Frogs are assisted in their powerful sound production by a larynx that is almost a quarter of an inch wide — about one-fifth of their body length.





EARLY MORNING GYMNASTICS

As the name implies, tree frogs like to climb—regardless of the weather. From their elevated vantage points frogs enjoy an excellent view. They also benefit from eyes that provide them with a 360-degree visual field and night vision comparable to that of a cat. That's a big help when trying to spot a potential princess.



PRECISION WORK

Look, leap, land: Jumping onto a branch 1 foot away is child's play for a frog.



How do frogs land?

When jumping from branch to branch frogs employ two different landing techniques: the belly flop and the reach-and-grab. To execute the belly flop, they leap forward and land on the target with their belly before they get a grip with their sticky feet and grasping toes. "That makes it easier to reach the branch, but the strain on

a frog's internal organs is very high," explains amphibian expert Thomas Kleinteich. For the reach-and-grab technique, they grasp the target with their front or back feet, hold on with their toes, and hoist themselves up. The force exerted on the toes is up to 14 times the body weight—that's why heavier frogs prefer the belly flop.



Where do frogs spend the winter?



There are around 90 species of frogs and toads that are native to the continental United States.

They spend winter in holes in the ground that are protected from frost or on the floor of ponds and lakes. They can lower their body temperature to just above freezing to live for months in hibernation. During that time they'll absorb oxygen and moisture through their skin. And when the weather warms up in spring, their body temperature also begins to rise. Then the frogs emerge from their retreats with their minds focused on two goals: eating and reproducing.



Which frog bites off more than it can chew?



Horned frogs are known for their voracious appetite and will eat practically anything in sight. That includes snakes and rats that may be twice the frog's size. This is possible because their mouth is half as wide as the length of their body, which measures 5 to 6 inches. They also have sharp-tipped teeth that are used for holding prey. The disadvantage: The teeth are curved toward the back, which makes it difficult for the frog to turn its prey loose, even if the creature is too large to be swallowed. Therefore many of these frogs die of suffocation long before they can reach their potential maximum age of 15 years.

Toad or frog— how do you tell the difference?



Both frogs and toads are tailless amphibians in the order Anura.

The true toads (genus *Bufo*) are stout-bodied with short legs that limit gait. Their thick dry skin is generally brown and often warty. In contrast, the skin of a frog is usually smooth and moist. In addition, while frogs have teeth, toads have none. Unlike frogs (genus *Rana*), toads are land animals that lay their eggs in water in long jelly tubes, while the largely aquatic frogs lay their eggs in water in clusters or sheets.



ALL IN THE FAMILY

Whereas the skin of most frogs (such as the one on the left) is moist and smooth, the drier skin of toads (above right) is often covered with warts.



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HOW DO YOU DISCOVER THE END OF THE WORLD?

In the second half of the 18th century Captain James Cook had set off on a three-year expedition to the Pacific. At that time the map of the world still had a number of blank spots that were as-yet unexplored. But no one could have suspected that Cook's return would change the world forever...



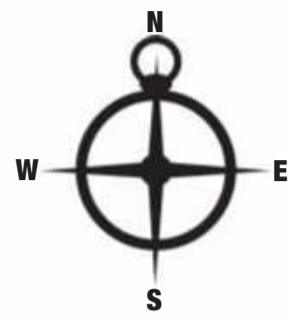
old winds whip through the sails as James Cook enters the bridge of the research ship *Resolution*. For several minutes he stares out into the void. Instead of the fertile continent he had assumed he'd see there stretches a seemingly endless wasteland: the Antarctic ice sheet. At this point the *Resolution* has already been sailing for over two years, and the ship's food supplies have nearly been exhausted. An icy silence dominates the scene, until one of the crewmen dares step forward and interrupt Cook's reverie: "Which course should we take, sir?" The captain's empty gaze is still fixed upon the frozen, fissured landscape. Slowly his lips pronounce the words that are so difficult for him to speak: "Before us lies the end of the world. We're going home." In that moment, Cook's disappointment is very clear. What he does not suspect, however: His presumed misadventure will lead to one of the greatest discoveries in human history—which would forever alter our view of the face of the Earth.

THE LAST OF THE DRAGONSLAYERS

In the 18th century the world was still full of places that explorers had never been to. Even on the most up-to-date maps, many of the areas south of the Equator were still just blank spots—regions that conjured exotic images of adventure and summoned people's wildest theories and visualizations.

The greatest unknown of all was what was referred to as Terra Australis ("the land to the south"—not to be confused with Australia, which had already been discovered). Shrouded in legend, the southern continent appeared on a number of ancient maps and scholars considered it to be the geographical counterpart to the landmasses of the Northern Hemisphere. They expected it to be peopled by a civilization with advanced technological knowledge and a wealth of natural resources. But for a long time the southern continent remained mired in mystery because no explorer had ever come back from an expedition in search of the region. Cartographers filled the blank spots of the southern globe with drawings of sea monsters and dragons. One such object, the Hunt-Lenox Globe that was made in 1510, even bears the inscription "Hic sunt dracones"—"Here are dragons." Not all navigators would be deterred by such warnings of exceptional danger, though. Some of them accepted the challenge and set sail undaunted to pursue the goal of uncovering the myriad mysteries of the Southern Hemisphere, staunchly determined to continue until they had reached the end of the known world. The man who was first to succeed in this endeavor was a British explorer. His name: James Cook.

When the British Admiralty made Cook the captain of a research ship by the name of HMS *Resolution*, he'd already served more than 10 years in the Royal Navy and had sailed once around the world. At the time he was considered to be one of Britain's most experienced sailors in addition to one of the best cartographers of his day. In the summer of 1768, Cook set out on the first scientific expedition to the South Pacific. What his crew did not know: The Admiralty had given Cook a secret mission to find the southern continent—Terra Australis. But though his first voyage did not take him there, Cook did find and chart New Zealand >



**"DO JUST ONCE
WHAT OTHERS
SAY YOU CAN'T
DO, AND YOU
WILL NEVER
PAY ATTENTION
TO THEIR
LIMITATIONS
AGAIN."
JAMES COOK**



NAVIGATION GENIUS
The accuracy of James Cook's logs made it possible for other English explorers to find safe trade routes across the Pacific, which had been largely unexplored before him.

SISTER SHIPS

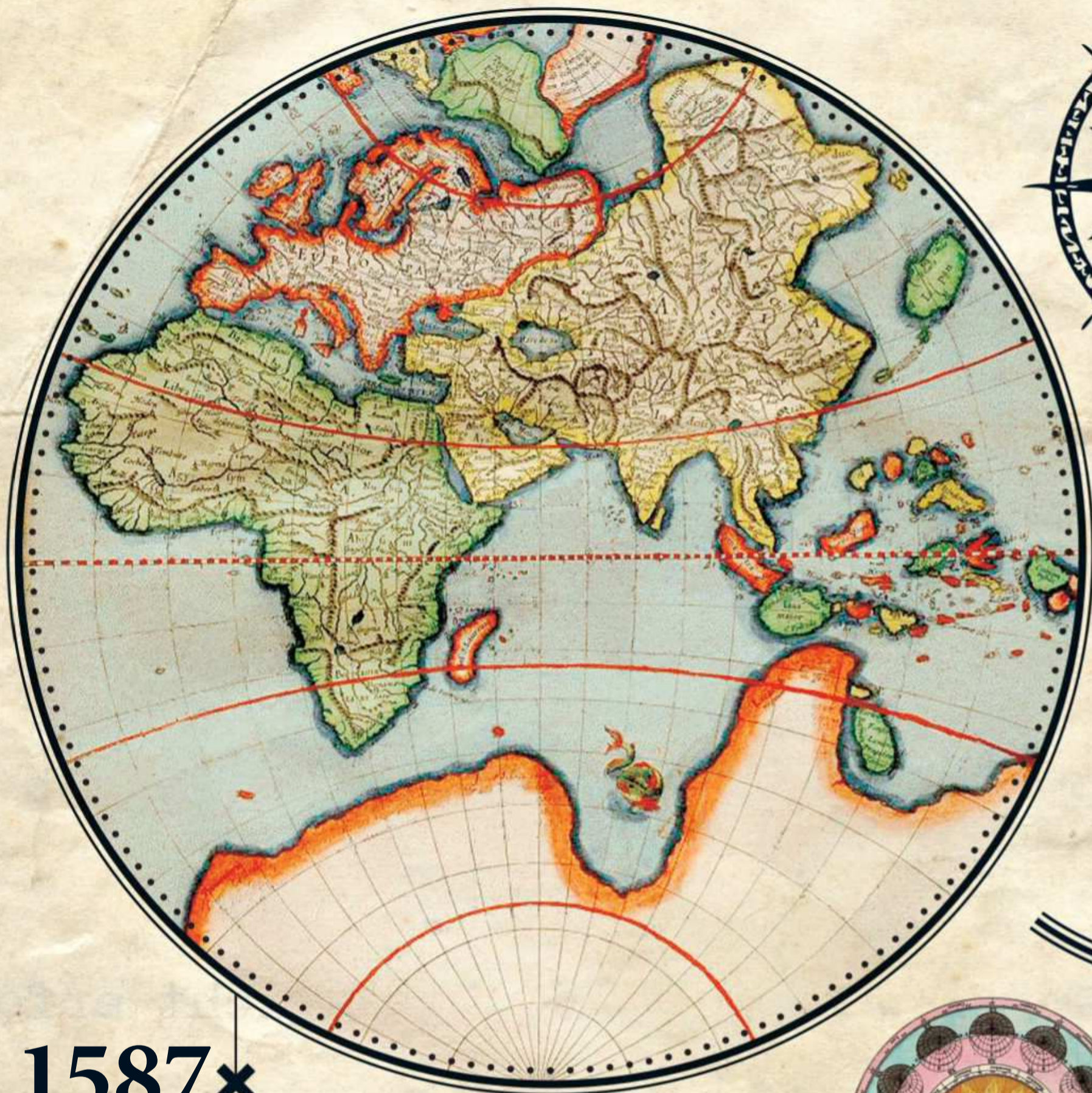
James Cook's *Resolution* had set out on its second expedition accompanied by Tobias Furneaux as captain of the *Adventure*. During the voyage the two ships repeatedly lost sight of each other. In the end, Furneaux decided to sail back to England, returning about a year earlier than Cook.



THE DANGERS OF THE PACIFIC

During the second voyage, the crew of the *Resolution* repeatedly encountered foreign cultures. Not all of the island peoples were well disposed to the explorers.



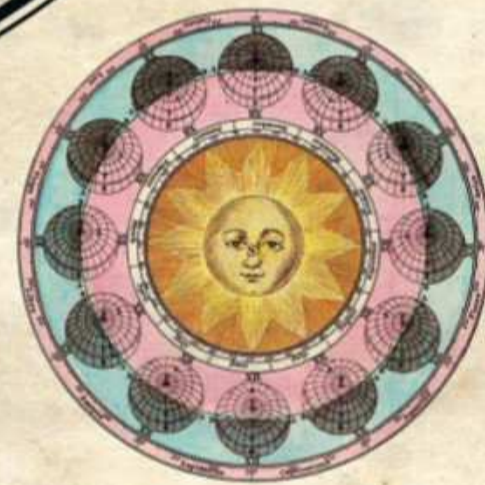


1587✕

THE LEGENDARY TERRA AUSTRALIS

The ancient Greek scholar and polymath Ptolemy (ca. AD 127–145) hypothesized the existence of a giant southern continent—the so-called Terra Australis. He further hypothesized that the continent was inhabited by members of a highly

advanced civilization who possessed a treasure trove of natural resources. These hypotheses are reflected on the world maps of early European explorers (the Southern Hemisphere is outlined in red), and it took James Cook to disprove them.



and successfully navigated the Great Barrier Reef. It would take a second mission to unravel other mysteries.

In 1772, when Cook set out for the Pacific for the second time, he was determined to sail farther southward than any explorer before him. His goal

once again was to become the first European to set foot on Terra Australis and thus to reveal the mystery of the legendary southern continent. He was accompanied on this meticulously planned expedition by a number of top specialists. In an effort to prepare

for any eventuality, Cook loaded his vessel with all manner of scientific measuring instruments and the most modern weapons of the day. The full crew of the *Resolution* consisted of 112 members, who included not just experienced sailors and craftsmen

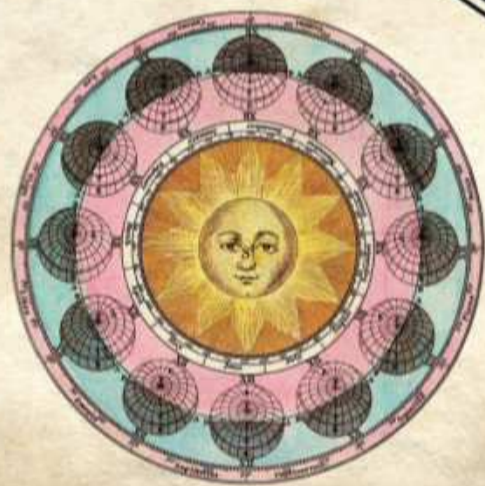


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THE REVISED VIEW OF THE WORLD

James Cook's second voyage to the South Seas revolutionized navigation and invalidated the accuracy of all previous nautical charts to boot. The cartographer Henry Roberts accompanied Cook on this second expedition, and on Cook's

instructions he created the first map of the world that took Cook's discoveries into account. It is the first document to show the world's continents in their proper place. Today the map remains a symbol of the human spirit of discovery.



but also astronomers, naturalists, and elite soldiers. Cook's second voyage brought together people of greatly varied backgrounds and skills, but they were all united by a common goal: to fill in the last blank spots on the world map and thereby dispel the

myths of sea monsters and dragons once and for all.

A SEAFARING REVOLUTION

Cook assumed that Terra Australis had to extend from the South Pole to about 30 degrees south latitude.

His plan was to cross this line until he was as far south as New Zealand (Wellington lies at 41 degrees south) and then circle the globe from there in search of land. In this manner, his second voyage would pick up where the first had left off and allow him to >



PACIFIC APPRENTICESHIP

Georg Forster was just 17 years old when he boarded the *Resolution* on July 13, 1772.

His father, Johann Reinhold Forster, had been asked to participate in Cook's second Pacific expedition and took his son along as an apprentice. Previously the father had led an expedition for Catherine the Great. Under his father's guidance, the younger Forster had deepened his scientific knowledge and cataloged more than 400 plant and animal species that were previously unknown. He later described his experiences in a travel book that is still considered one of the most important in that genre.

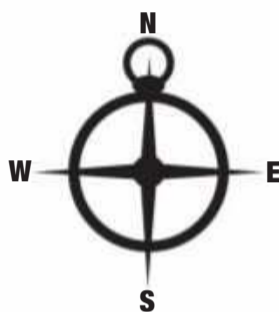


map a portion of the southern seas that was largely unknown. He allotted three years for the trip—an ambitious plan that many of Britain’s admirals considered insane. For a voyage of such duration posed enormous risks in that day and age. The monotonous, unbalanced diet aboard most vessels often left the crew members suffering from nutritional deficiency diseases. The most dangerous of these was scurvy, which is caused by a lack of vitamin C. In the 18th century, scurvy was by far the most frequent cause of death among sailors. The earliest symptoms usually appeared after about three months at sea. Sailors first complained of chronic fatigue, followed shortly thereafter by muscle pains and bleeding beneath the skin. The subsequent symptoms included spontaneous bleeding, high fever, and convulsions, which could be fatal. It wasn’t until 1932 that scientists finally found the connection between scurvy and vitamin C deficiency. At the time Cook was planning his expedition, the knowledge that scurvy could be prevented or cured by ingesting citrus fruits was relatively new. But Cook was familiar with the observations of a number of ship’s doctors who had noted that a diet of sauerkraut and fruit juice could provide relief. Thus Cook had more than 60 barrels of sauerkraut placed in the hold of the *Resolution*. And his plan succeeded: Cook became the first captain in the history of British navigation whose crew was widely protected from this scourge. It was a truly outstanding achievement at a time when up to three-quarters of a ship’s crew might die of scurvy during a long voyage.

THE JOURNEY THAT REVOLUTIONIZED SCIENCE

The *Resolution*’s crew didn’t have to depend solely on sauerkraut to keep them healthy. Cook frequently made stops at the numerous Pacific islands to stock up on supplies for the trip.

While he supervised the loading of fresh food and the trade with the local population, the scientists aboard the *Resolution* would explore the islands. Among them was a young German naturalist named Georg Forster who had emigrated to England as a child. No one could have imagined that the



**“I INTEND
TO GO FARTHER
THAN ANY
MAN HAS BEEN
BEFORE ME.”**

JAMES COOK

writings of this young man would have such a profound and lasting impact on European science and literature. Forster was overwhelmed by the beauty of the Pacific and its endless diversity of flora and fauna. He made impressive drawings of the previously undiscovered plants and animals and described their characteristics and features in great detail. By the end of the voyage, he’d cataloged more than 400 species that Europeans had not known of. Upon his return to Europe he wrote a book, *A Voyage Round the World* (1777), which established him as one of the most advanced and

accomplished thinkers and stylists of his time. The book is still regarded as one of the greatest travel accounts ever to be written.

THE END OF THE WORLD

The *Resolution* had been at sea for almost two years when it left New Zealand and headed eastward, still in search of Terra Australis. With each passing day the weather deteriorated, and as the cold increased, the morale of Cook’s men declined. Finally, after two weeks of sailing, the lookout in the ship’s crow’s nest sighted a large ice floe for the first time. Only a few days later, the *Resolution* reached the pack ice of the Antarctic Circle. There Cook was forced to admit that his journey had come to an abrupt end. Instead of a continent rich with natural resources, he had discovered an inhospitable desert of ice. He had reached the end of the world that was accessible to humankind at the time. (Not until 1911 would an expedition finally cross the Antarctic ice to reach the South Pole.) Utterly disheartened, Cook had no choice but to order his men to set sail for England.

After a voyage of some 1,100 days, the *Resolution* returned to its home port of Plymouth. The crew had spent more than 900 days at sea, covering a distance of nearly 75,000 miles—the equivalent of sailing around the world three times. Of the 112 crew members who had set out from Plymouth, only four had died, which is an unusually low number for that time. Nonetheless, after his arrival in England Cook was still very disappointed that he’d found nothing more than a few small islands. But he had discovered something far more important: Cook’s explorations of the Southern Hemisphere regions proved Terra Australis does not exist. This pivotal realization would forever change the maps of the world, filling in the blank spots some 200 years before the first satellite photos would provide an accurate view of our planet.



Who discovered the Date Line?

15 sec Between 1519 and 1522, the expedition led by Portuguese explorer Ferdinand Magellan was the first to sail around the world. There was quite a bit of confusion when the voyagers discovered they had arrived home a day later than their log books indicated. But it wasn't long before the explanation was found: They had circumnavigated the world from west to east, sailing against the sun and thereby losing an entire day. Initially various locations were considered to be an unofficial date boundary, but in 1884 delegates from 27 nations agreed on the system we use today, with 24 main time zones and the International Date Line set at the 180th meridian of longitude.



Who really found America?

15 sec Everyone recognizes the name Christopher Columbus, who, as we all know, “discovered” America in 1492. And many are also aware of the Viking Leif Erikson, who crossed the Atlantic to visit North America around the year 1000. However even he was probably not the first to discover the double continent. There is substantial evidence there were previous contacts between the inhabitants of Polynesia and South America. And even the ancient Egyptians may have visited America—researchers have shown that their reed boats should have been capable of crossing the ocean.

How many kinds of life-forms are known?

15 sec Thus far scientists have cataloged more than 1.2 million different species of organisms. That sounds like a lot, but it isn't when you compare it with the total number of species believed to exist. Projections suggest there are 8.7 million forms of life on our planet, of which 2.2 million are marine species. That would mean 86% of terrestrial species and 91% of marine organisms remain to be described.

Are there still blank spots on our map of Earth?



15 sec Even with more than 1,000 active satellites orbiting the planet, we still do not have a complete set of photographs—not even of all the land. Satellite cameras cannot, for example, penetrate the dense canopy of the rain forests, which means that the Amazon basin remains one of the least-known regions of the globe. In addition, there may be thousands of undiscovered caves that no one has ever set foot in—and the same applies to many of the mountains in the Himalayas as well as areas of the Antarctic.

LOVE iD?

Want to help spread the word about it?



We're going to test the concept presented in the Q&A of the May 2017 issue.

We're looking for people to take a few copies of iD and leave them in places where others might come across them, such as a doctor's office waiting room or a café. This vectoring initiative requires a good geographic distribution across the country, so please email us at questions@ideasanddiscoveries.com if you're interested. (We'll be keeping track of the sales data in these areas and will share our results.)





Our words may be our most powerful tools—and when need be, they can be our best weapons as well. Yet our choice of words and manner of speech can also work against us by exposing us for who we really are...

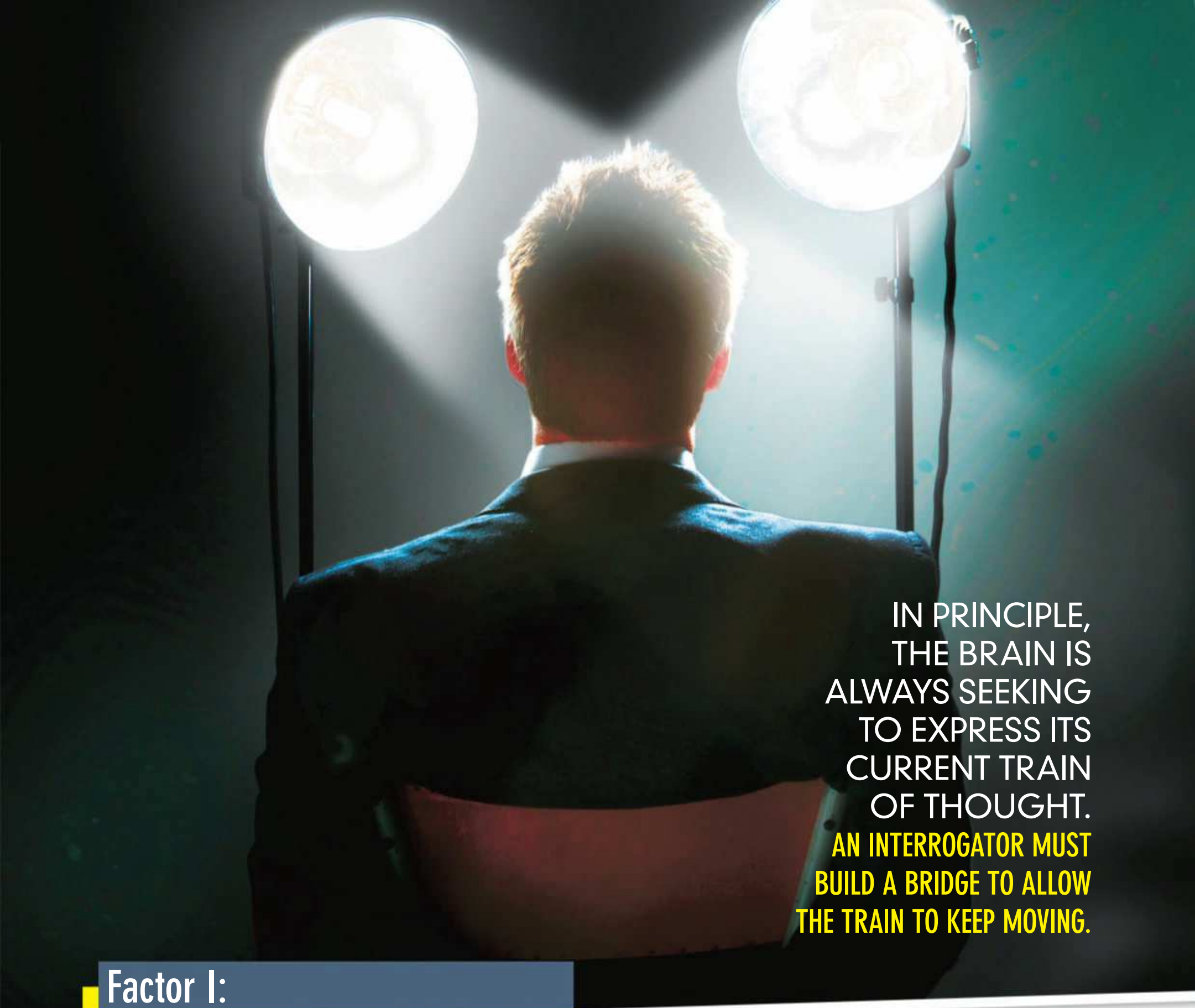
THE SECRET POWER OF WORDS



“You have a time bomb ticking in your body.” These nine words spoken to Thomas Kaberg by his physician will ultimately work like a lethal injection... *Cancer*. He doubles over as the diagnosis hits him like a punch to the gut. He can’t get the phrase his doctor said to him out of his mind. His condition quickly deteriorates, and just six months later he is dead. But when the autopsy is performed, the coroner is in for a surprise: Kaberg’s tumors are tiny and have not metastasized.

Endocrinologist Clifton Meador has investigated a number of such cases and has an explanation: “People sometimes die not because of cancer but because they believe cancer is going to kill them.” If Kaberg’s doctor had not spoken about a “ticking time bomb” but instead focused on describing the treatment options, the patient might still be alive...

We often underestimate the power of words, but they are perhaps the most powerful tools we have for manipulating the behavior of others—apart from money, weapons, and the threat of violence. Spoken words are no more than a set of vibrations produced by a warm stream of air that moves the vocal cords in our throats to make them oscillate, typically at a frequency between 85 and 255 hertz. But only 140 milliseconds after the sound enters a listener’s ear, the brain has already processed all of the spoken words. The effect is immediate and powerful. So powerful—as we will discover in this article—that it takes an enormous feat of concentration to resist it. The words used to bully people can drive them to suicide. On the battlefield words can drive soldiers to fight “to the last drop” of their blood. Words can reprogram our psyche without our being aware of it and make us share our most intimate secrets—or the contents of our bank account. By using the right words, a speaker can establish dominance or ward off an attack. That’s true today more than ever before. The man who came up with the phrase “Yes we can!” for Barack Obama—his speechwriter at the time, Jon Favreau—was paid a salary of \$172,000 a year, making him the second-highest-paid employee in the entire White House after the president himself. But what makes words so powerful? Why are they so vital to our survival? And how can we use that power to our advantage? In the pages that follow we’ll examine the seven power factors of words.



IN PRINCIPLE,
THE BRAIN IS
ALWAYS SEEKING
TO EXPRESS ITS
CURRENT TRAIN
OF THOUGHT.
**AN INTERROGATOR MUST
BUILD A BRIDGE TO ALLOW
THE TRAIN TO KEEP MOVING.**

Factor I:

HOW DO YOU GET A SUSPECT TO TALK?

Michael Buchanan* is being interrogated in a tiny windowless room. The charge: homicide. *They've got nothing on me*, he thinks. *As long as I don't slip up now*. In his mind he goes over his alibi for the night in question for the umpteenth time. Detective Thomas Hauser* is seated across the table from him. Hauser realizes that all of the evidence so far is only circumstantial. There is nothing to prove that Buchanan committed the crime. But a look at the statement Buchanan gave police tells Hauser the suspect is hiding something. And only a few hours after the interrogation is completed, Buchanan makes his confession...

*Names have been changed by the editors.

Was this confession the result of torture? Of blackmail or threats? Completely unnecessary. In principle, the brain is always seeking to express its current train of thought. To guard against making incautious statements, the brain has a kind of monitor that rationally evaluates whether we ought to say something or not. We'll either conclude: "Yes, that's okay, I can say that," or "No, bad idea, that will have negative consequences."

Stress, alcohol, and sleep deprivation weaken the brain's monitor function.

This barrier in the brain can be broken down, especially when we are under the influence of alcohol or suffering from sleep deprivation. Under such circumstances, we tend to reveal secrets involuntarily. Stress and conflict can also loosen the tongue. In order to make subjects of an

interrogation nervous and encourage them to slip up, it's often enough to speak rapidly, curse, frequently interrupt the suspect, or criticize the person and hurl allegations.

Police detectives like Thomas Hauser use these tricks during an interrogation when their suspicions are raised because of the suspect's choice of words and a lack of detailed information. (See the Dictionary of Manipulation on page 37.) "Using the RPM method, the interrogator encourages the suspect to express what he's thinking," explains police superintendent Karsten Schilling. (RPM stands for rationalization, projection, and minimization.) First Hauser presents plausible reasons to justify why the suspect committed the crime: "It was an extreme situation. Under the circumstances, you acted completely normally." Then comes projection, which essentially means holding someone else responsible for the action by transferring the burden of the guilt. For instance: "Clearly you were provoked. It was your only way out of a bad situation." Minimization is an attempt to trivialize the event: "It's not that bad. Around the world, something like this happens a hundred times a day." Thus the homicide becomes an accident, a mistake. The RPM process effectively creates a kind of red carpet for the brain to parade its thoughts. In the end, Michael Buchanan took the bait and confessed.

Pressure and deceit are used in the Reid technique. Its sole purpose is to obtain a confession. It can lead even the toughest criminals to break their silence. . .

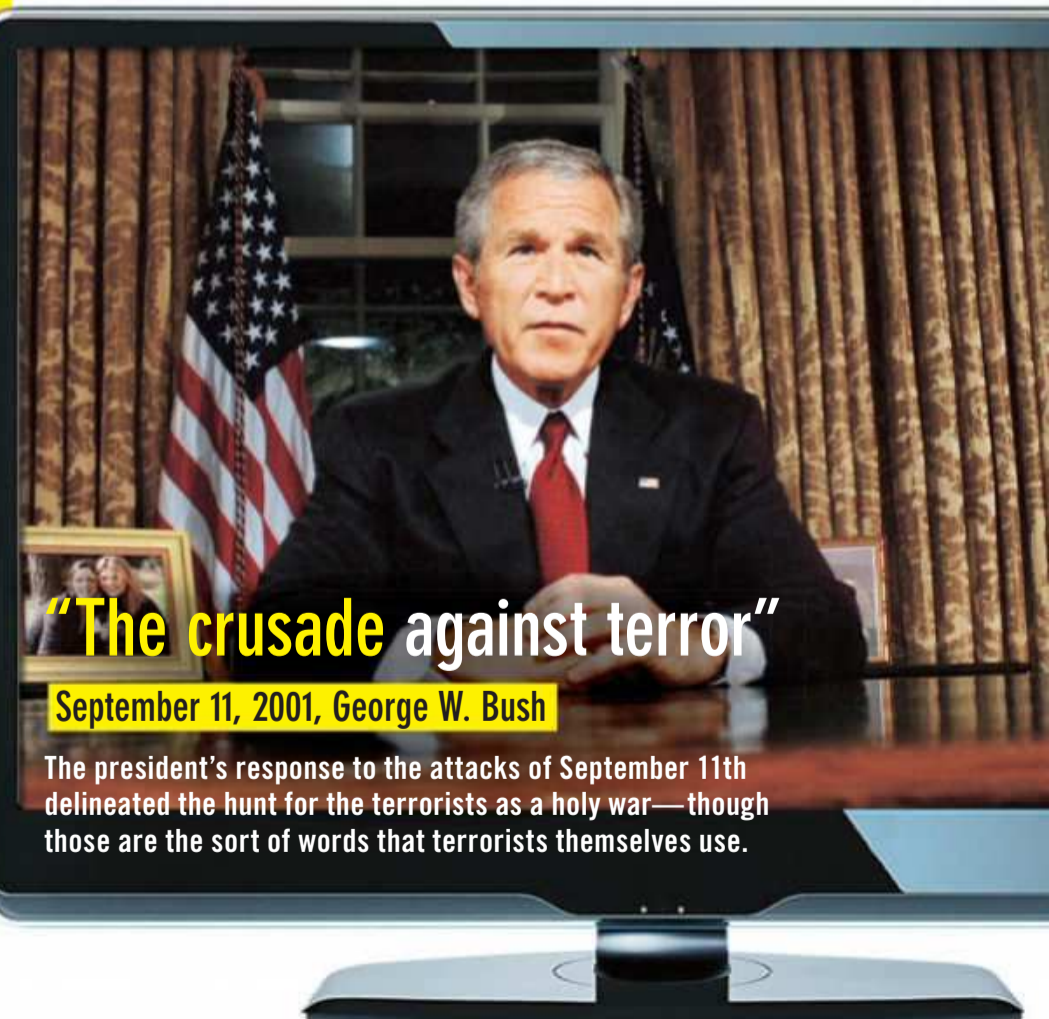
Even more effective than the RPM method is the Reid technique, named after former Chicago police officer and polygraph expert John E. Reid. It consists of a series of steps that use psychological pressure and deceit to extract a confession. First the interrogator tells the suspect that the guilt is obvious, thereby creating a stressful situation. If the suspect denies guilt, the interrogator abruptly ends the session with a warning of the consequences of further denial. In the next session the interrogator steps up the psychological pressure—for example, by confronting the suspect in ever-closer proximity—making it all the more difficult to think clearly. The "bad cop" can tell that the pressure is working by assessing the suspect's posture, which should reflect defeat and resignation. Then the "bad cop" is replaced by a "good cop," who provides the suspect with two alternatives: One version of the story offers a morally acceptable reason for the crime, while the other would be considered highly reprehensible. Both alternatives require the suspect to make a confession. By using this interrogation technique, John Reid became celebrated for his ability to get a confession out of even the most hardened criminals.

Factor II:

CAN A METAPHOR BE FATAL?

At 8:46 A.M. on September 11, 2001, a hijacked airliner crashes into the North Tower of New York's World Trade Center. Just 17 minutes later, a second airliner collides with the South Tower. Within seconds of the first strike, rescue units have been dispatched to the WTC. The scope of the disaster will prove to be enormous. Everyone aboard the planes dies along with almost 2,800 additional people on the ground. Initially the government talks about the high number of "victims." But soon the diction changes to "losses"—an important distinction. Crimes result in victims while wars are numbered in losses. Within hours of the attacks, the events are transformed linguistically from a civilian to a military footing. By 8:30 P.M., President George W. Bush is already speaking of standing together "to win the war against terrorism." It won't be long before he is referring to a "crusade"—a word that conjures images of Christian military expeditions to the Holy Land in the Middle Ages.

Figurative language in the form of metaphors influences our attitudes. It has an effect on what we want and what we do. "Metaphors don't just win elections," says linguist George Lakoff, a retired University of California professor of cognitive science and linguistics. "Metaphors can kill." >



Lera Boroditsky, a psychologist at Stanford University, has demonstrated the power of words in an experiment. Study participants heard one of two versions of a text describing the rising rate of crime in a fictional city called “Addison.” Only one word was different in the two texts. One said: “Crime is a beast ravaging the city,” while the other substituted “virus” for the word “beast.” The study subjects were then asked for solutions that would lower the crime rate in the city. The results: 71% of participants who had read “beast” called for stricter law enforcement compared with 54% who’d read “virus.” The latter group’s members were much more likely to seek out the cause of the problem and treat it by enacting social reform. Even more striking: Though the texts were identical apart from that single word, all of the participants underscored their respective arguments by citing the exact same statistics.

Metaphors work behind the scenes to affect thoughts. “Metaphors structure and influence the information we use to make decisions,” says Boroditsky. “All of the other information is subordinated to this concept.” We sweep any facts that fail to fit with the concept under the rug.

George Lakoff says metaphors can conceal as well as illuminate. Linguistic images—in the form of words—have such an intense effect because they address our brains on many different levels. The more effective the stimulus, the greater the number of senses that will be stimulated. An assertion that something is cold, for example, is only targeted at our conscious thoughts. The statement “the coffee is cold,” on the other hand, additionally stimulates our sense of smell. This will make the statement far more



Lera Boroditsky, psychologist

“There are key words that can push our minds in a definite direction.”

powerful because memories of stale cold coffee provoke a sensation of distaste. The same thing occurs when we hear a sentence such as: “The test was a real letdown.” These words not only activate the prefrontal cortex, which regulates our goal-related thoughts and actions, but also the motor cortex, which is responsible for the execution of voluntary movements. “Though we may be thinking in metaphors, in the brain the literal meaning of the words is resonating,” says neuroscientist Friedemann Pulvermüller.

Factor III:

HOW DO WORDS MANIPULATE THE BRAIN?

We can test the power of words on ourselves. Think of something that would promptly elicit a positive response from you. For example: “Would you help your best friend?” In making your response (“Of course I would”), try shaking your head in a negative gesture at the same time. How long does it take you to do that successfully? On average, it takes a few seconds to get it right no matter how hard you may be concentrating. If it was easy for you, perhaps you have a talent for lying or particularly good control of your body. Words can steer the body in a certain direction very fast, often overriding rational contradictory thoughts.

GIVE QUICK RESPONSES TO THE FOLLOWING QUESTIONS:

WHAT FALLS FROM THE SKY IN WINTER?

WHAT COLOR IS A WEDDING DRESS?

WHAT DO COWS DRINK?

“Snow,” “white,” “milk”—that’s how about 90% of people answer these questions, although the correct answer to the third question is “water.” The reason: The first two questions lead us to an association with the color white. When the brain catches the signal word “cow” in the third question, it immediately thinks of “milk,” which is white. Advertising makes very good use of these subconscious mechanisms, which can even trick our taste buds. Which of these teas would you rather drink: “Tropical Sensation” or “Fireside Warmth”? Researchers at the University of Applied Studies and Research in Germany devised a test to assess people’s preference. Result: “Tropical Sensation” tasted more exotic, fruity, and refreshing than “Fireside Warmth”—even though both of the teas were identical. Manfred Gotta, also known as “the king of names,” makes a living by thinking up the perfect monikers for products: The combination of letters does not have to make sense, it just has to sound good and be patentable and easy to pronounce anywhere in the world. Product descriptions have rules of their own that are equally arbitrary. Various studies have shown that consumers think baked goods taste better if the package claims they are “made from grandma’s recipe” or that they are simply “traditional” in manufacture. But all the cookies in the studies were the exact same goods with two different kinds of packaging.



Factor IV:

HOW DO YOU HANDLE A HOSTAGE TAKER?

Yes I understand,” says the woman on the phone. “I hear you, Ricky.” The man on the other end of the line has just threatened to shoot someone unless he gets a helicopter within one hour. For Captain Kip Rustenburg, such conditions are part of her job. She is a crisis negotiator with the Maricopa County Sheriff’s Office in Phoenix and a true professional when it comes to dealing with hostage takers. Her sworn duty is to thwart all of their demands and ensure each deadline passes without incident. Because if a hostage taker gets away, many more lives could be in danger—at this point, there is still “only” one to worry about.

“There are three acceptable outcomes in this scenario,” explains Rustenburg. “The hostage taker gets arrested.



Gary Noesner, former FBI agent

“In our conversations we work to build trust step by step.”

He gets killed during a rescue attempt. Or he kills himself.” Rustenburg’s task is to ensure it ends the first way. Why? “Because studies show that the survival rate for everyone involved is about 97 percent,” says James DeSarno, the

former head of the FBI’s Los Angeles field office. By way of comparison: Armed rescue missions have a fatality rate of more than 10%.

Above all, time is the deciding factor: For the roughly 4,000 people taken hostage worldwide in a typical year, the chance of survival increases with each passing hour. “A negotiator adopts the vocabulary of the hostage taker along with his style of speech and speaking speed,” says Gary Noesner, a former top hostage negotiator for the FBI.

THE TWO PEOPLE INVOLVED HAVE TO SWAP ROLES. A NEGOTIATOR HAS TO USE WORDS TO PAINT THE HOSTAGE TAKER AS PART OF THE SOLUTION RATHER THAN PART OF THE PROBLEM.

In practice it would go something like this: “Ricky, I want you to know that while the guy [no personal name used] has been shot [passive voice, no accusation] in the foot [not a critical wound], in a situation like this anything can happen by accident [not intentionally]. But the way you’ve taken control since then is great—no one else has been hurt. [The hostage taker is part of the solution instead of the problem.] That’s commendable, and we’re all aware of it [implying lesser charges]. Let’s see if we can find a peaceful resolution so we can all [not just the hostages] get out of here safely.” The most important rule: “Whatever we promise them, we have to stay true to our word and deliver on,” says Rustenburg. “Because if they think we’re lying, we’ve lost our mightiest weapon: the spoken word.” >



“

**OBAMA IS dead,
I don't care.”**

GERALDO RIVERA

SLIP OF THE TONGUE

Confusing Barack Obama with Osama bin Laden ended harmlessly for Fox News host Geraldo Rivera. But under other circumstances, a slip of the tongue can trigger a war or force a company into bankruptcy—if the listeners don't realize it was a mistake.

Factor V:


**WHY DOES THE TONGUE
SOMETIMES DEFEAT
THE BRAIN?**

“Obama is dead, I don't care,” said Geraldo Rivera with the cameras rolling after he heard that Navy SEALs killed Al-Qaeda leader Osama bin Laden. *Oops*—a slip of the tongue? Or had Rivera been speaking from the heart? The Republican TV personality had been a fierce critic of the Democratic president. Was Chancellor Angela Merkel expressing her actual opinion when she “accidentally” called her conservative opponent at the time, Roland Koch, by the name of Roland Kotz? (In German “kotz!” means “barf!”—used as an expletive.) “Do I agree with Freud that all slips are Freudian? No. But I do think that there is such a thing,” says Michael Motley, a psychologist at the University of California, Davis. He demonstrated it in an experiment in which the presence of a young woman “in a short skirt and translucent blouse” induced young male subjects to utter more spoonerisms with sexual implications (e.g., saying “fast passion” instead of “past fashion” and “happy sex” instead of “sappy hex”) than the men in a control group. When the participants in yet another group were told they might receive an electric shock during the experiment, they made mistakes such as saying “cursed wattage” instead of “worst cottage.”

The brain must work at full tilt in challenging situations, such as when it's being ordered not to think of something.

This “white bear problem” was noticed by the Russian author Fyodor Dostoyevsky, who realized that when told specifically not to think of a polar bear, the mind can think of nothing else. In the 1980s, Harvard psychologist Daniel Wegner noted that subconscious processes in our brain are constantly working to keep our innermost desires from surfacing in the form of speech and creating a personal disaster. This effort makes most people experience a slip of the tongue once or twice per every thousand words. Talking at a rate of 150 words a minute means we misspeak every seven minutes. Most of these are inconsequential. Chances are you don't even remember more than one thing you'd said by accident in the past week.

But what's taking place in the brain when we misspeak? When we prepare to utter a thought, the average person draws upon a stored vocabulary of perhaps 42,000 words. (The top 5% of English speakers know 52,000, the bottom 5% some 27,000, according to a recent study.) Normally the brain's cerebral cortex—the area that governs thought and language—is in firm control. But sometimes another part of the brain will win out and we create a new word. Similar to a mutation in DNA, new material is fabricated from the old as we swap around vowels and consonants. The effect is only positive if it enriches our language.



Daniel Wegner, psychologist

“Our subconscious mind is programmed to always think the worst.”

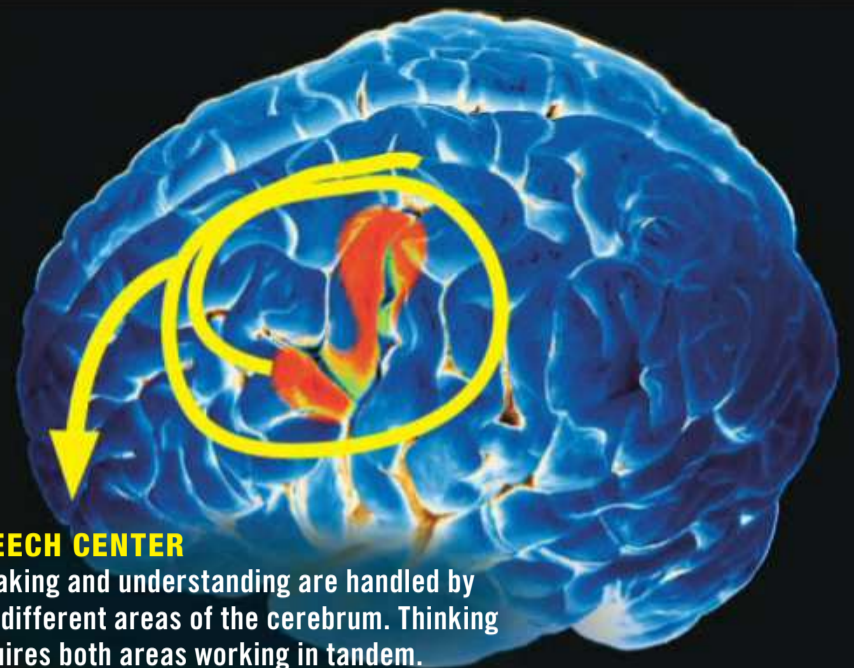
Factor VI:

CAN WORDS HEAL A PATIENT?

“**A**t that point I didn’t have the ability to think about the future—to worry, to anticipate or perceive it—at least, not with words. For the first four or five weeks I just existed,” recalls Claude Scott Moss. In 1972 a stroke left the psychologist unable to speak, making him feel almost like he were dead in his living body. But how could the incident affect perception so radically? Why do we lose our sense of self when we lose our words?

SIMPLE WORDS CAN SHIFT THE LIMITS OF THE BODY

Without language, thinking is impossible. Each thought is in effect a short monologue. Brain scans show that while we are considering a proposition, the Broca area of the brain (involved in speech function) and the Wernicke area (involved in the understanding of speech) are constantly playing a kind of ping pong. Nevertheless, the brain has a protective mechanism to prevent us from formulating a spoken answer to our own questions. If nothing else, that furthers our speed of thought: It takes between 300 and 700 milliseconds to pronounce a word, but we can think at least twice as fast. However sometimes the protective mechanism fails and we do not always immediately notice. In a 2006 study conducted by psychologist Adam Winsler at George Mason University, 46 out of 48 female subjects admitted to talking to themselves once in a while. Perhaps this is a technique the brain uses to increase performance. In a later study, Winsler found that children who talked to themselves were more successful at completing a task. “Inner speech is one of the most important tools we use to become aware of the self,” says psychologist Alain Morin of Canada’s Mount Royal University. Such “pep talks” can even improve the body’s capacity for work. University of Worcester sports scientist Christian Edwards tested the performance of athletes who used self-talk before trying to jump as high as possible. Saying “I can jump higher” led them to jump with greater force than those who didn’t talk to themselves. Detailed instructions can also influence performance, according to Eleni Zetou, a sports scientist at Democritus University in Greece. A group of volleyball players described their movements in detail as they practiced serving. A control group remained silent. In the end, “self-talkers” scored 44 out of 50 points for skill while the quiet group scored only 35 on average.



SPEECH CENTER

Speaking and understanding are handled by two different areas of the cerebrum. Thinking requires both areas working in tandem.

Healing through the use of language is now part of the training of aspiring physicians. Each of the approximately 200,000 physician-patient consultations that the average doctor is involved in during a long career represents both a risk and an opportunity: Words have been found to be capable of helping but also of harming patients. Studies show that a given medication tends to work better if the doctor emphasizes its benefits instead of its side effects. In addition, patients receiving a shot feel less pain if the doctor or nurse talks about why the injection is needed rather than warning of the prick of the impending “jab.” “I know of few remedies that are more effective than a well-chosen word,” says American cardiologist and Nobel laureate Bernard Lown.

But words can also be deleterious and make people ill: In the case of depression the inner voice is working against the body. Constant brooding and mulling over depressive thoughts and feelings can cause a person’s psyche to be reprogrammed in a negative way. Patients suffering from hallucinations are not able to recognize the inner voice inside their head as their own. Sometimes this condition can occur within an otherwise healthy individual as well.

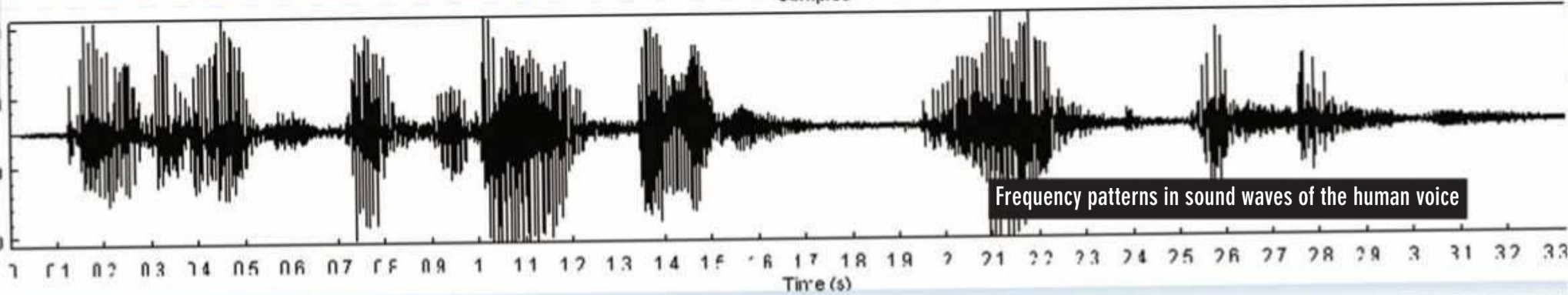


Bernard Lown, cardiologist

“A well-chosen word can have a medicinal effect.”

Charles Fernyhough directs the Hearing the Voice project at Durham University in the UK. According to his studies, “Around 5 to 15 percent of regular people have had some infrequent or one-off voice-hearing experiences.”

It’s clear that language has an incredible power over us. Usually we only notice this power if we happen to lose it. Like Claude Scott Moss, who had to learn to speak again—taking one tiny step after another until he was, once again, the person he’d been before. >



Frequency patterns in sound waves of the human voice



A deeper voice can mean \$187,000 more in annual income.

Result of a study by Duke University and UC San Diego

Factor VII:

CAN A WORD REVEAL MY PERSONALITY?

“Hello.” It takes less than half a second to say the word, yet a listener instantly forms an opinion of the speaker’s personality based on the sound. That’s the result of a study by psychologist Phil McAleer at Scotland’s University of Glasgow. He recorded 64 people reading the word “hello” and then played the recordings to 320 study participants to get their reactions. He found that they generally agreed about the speakers’ personalities—whether these were felt to be trustworthy, aggressive, confident, or warm, for example.

Thus a single word can have a multitude of meanings depending on how it is pronounced. Our vocal cords and mouths do the work in creating the impression. Whenever we speak or sing, our vocal cords vibrate as we expel air from our lungs—440 times per second to produce the “A” that orchestras use for tuning. By the way, in extreme cases the human vocal range extends beyond the highest and lowest notes on a piano, which normally has 88 keys. With the exception of the eyes, the muscles of the human larynx have more nerves than any other part of the body.

The sound of the voice can also emphasize or obscure a message: Adolf Hitler rarely said anything novel, but his

powerful voice and rhetorical skill made fanatics of many of his listeners. Al Gore’s voice put him at a disadvantage: As a presidential candidate he was acknowledged to be bright—but his voice was considered boring. Many experts believe Gore’s manner of speaking was partly responsible for his loss to George W. Bush in the 2000 election. While Bush may have sounded less articulate and informed, voters found those faults easier to forgive.

A DECREASE OF 20 HERTZ RAISES THE CREDIBILITY OF A MESSAGE

Voice experts agree that a deep voice makes a positive impression, is considered a sign of capability, and inspires respect. An experiment conducted by researchers at Duke University and the University of California, San Diego, found that people with deeper voices are more likely to get ahead. The same message delivered at a pitch 20 hertz lower is deemed more effective. After hearing two different voices, the study’s 100 participants—both male and female—said they would rather vote for the person with the lower voice, which they considered more trustworthy. The conclusion was confirmed in the American business sector as well: In an analysis of almost 800 speech samples from top male executives, researchers found those with a deeper voice (lower by 22.1 hertz) received annual compensation that was \$187,000 higher per year on average.

A DICTIONARY

of Manipulation

Often a single word can completely change a sentence. A word that points the listener in the right or wrong direction. A word that indicates the speaker is lying. Making clever use of the power of words can provide decisive advantages in both professional and everyday life...

WHICH WORDS HELP ME GET WHAT I WANT?

WE conveys commonality and belonging. Our brain produces the “happiness hormone” dopamine when we feel we’re part of a group. A public speaker who uses “we” automatically elicits a positive response.

A PERSON’S OWN NAME makes the listener feel less anonymous. Whether the name is used to address a public official, a business contact, or simply a friend or an acquaintance, addressing people by their name increases the speaker’s likelihood of success. Not only do people enjoy hearing their name—it also evokes the good reputation that they’re eager to protect.

YES is spoken almost reflexively in response to a statement that corresponds with our views. A skilled rhetorician usually first tests the waters with a general statement that is easy to say “yes” to. Step by step, such speakers then state their position more concretely, ensuring the listener’s brain stays in “yes” mode. At this point, saying “no” means withdrawing our affirmation of the previous statements—and is felt to be a contradiction.

BECAUSE OF and **DUE TO** satisfy our human expectation for a reason. That was shown in a surprising experiment designed by psychologist Ben Zion Chanowitz: People waiting to use a copy machine were asked to give up their place in line in two different ways. “May I use the machine?” led to 60% of respondents saying “yes.” Providing additional information that the request is urgent (“May I use it because I’m in a hurry?”) raised the positive response rate to 94%. Thus public transportation delay announcements are often accompanied by justifications like “due to a technical problem”—people just like to know why.

IMMEDIATELY and **RIGHT AWAY** are words that provoke an almost drug-like positive response in our brains. McMaster University psychologist James MacKillop used brain scans to demonstrate how the mere prospect of immediate satisfaction provokes a pleasurable subconscious response. But having to wait until “later” activates the conscious mind in the frontal cortex. We think what we can have now is better—even if there may be a more advantageous option down the line.

WHICH WORDS ARE TABOO?

UNFORTUNATELY has a negative effect because it is often followed by reasons as to why something is not working. Our hearing switches to “pass-through mode” and the brain begins to search for alternatives or solutions to the perceived problem.

BUT and **NONETHELESS** provoke inner resistance. When they appear at the beginning of a sentence, they can trigger aggression. Rhetoric expert Rolf Ruhleder says such words are “explosive” because they throw people into a defensive state.

MONEY is a symbol of material goods and makes us more selfish. Psychologist Daniel Kahneman conducted a (silent) experiment in which the participants reacted to a bundle of banknotes on a monitor by becoming substantially less willing to help others.

WORRY, TROUBLE, and **SUFFERING** have an effect akin to physical torture. In an experiment at the University of Jena, the participants’ pain memories were activated simply by hearing these words.

WHICH WORDS EXPOSE A LIAR?


YOU and **ONE** are indicators of a deliberate change in perspective: “Most liars avoid using the word ‘I,’” says University of Texas psychologist James Pennebaker. Normally the words “I,” “me,” and “my” make up about 6% of our speech (one word out of 16). If someone uses them a lot less often, look out! Liars try to avoid making clear statements and prefer formulating things in an impersonal way. Instead of saying, “I was not out at 11 P.M.,” they’re more likely to say, “One would not go out alone late at night.” It helps to pin them down: “Did you go or not?”

THEN, DURING, and **NEXT.** Liars like to keep things in chronological order because lying is complicated: There is too much to remember. “Most liars tell the truth up to the point where they want to conceal information, skip over the withheld portion, and then tell the truth again,” says retired FBI agent Jack Schafer. Text bridges like the transition words above serve as markers for where withheld information begins. In that part of the story, the liar provides few details. So if concrete elements suddenly become sparse, a listener should beware. A useful trick: Ask the person to tell you the story in reverse. Liars often can’t do it.

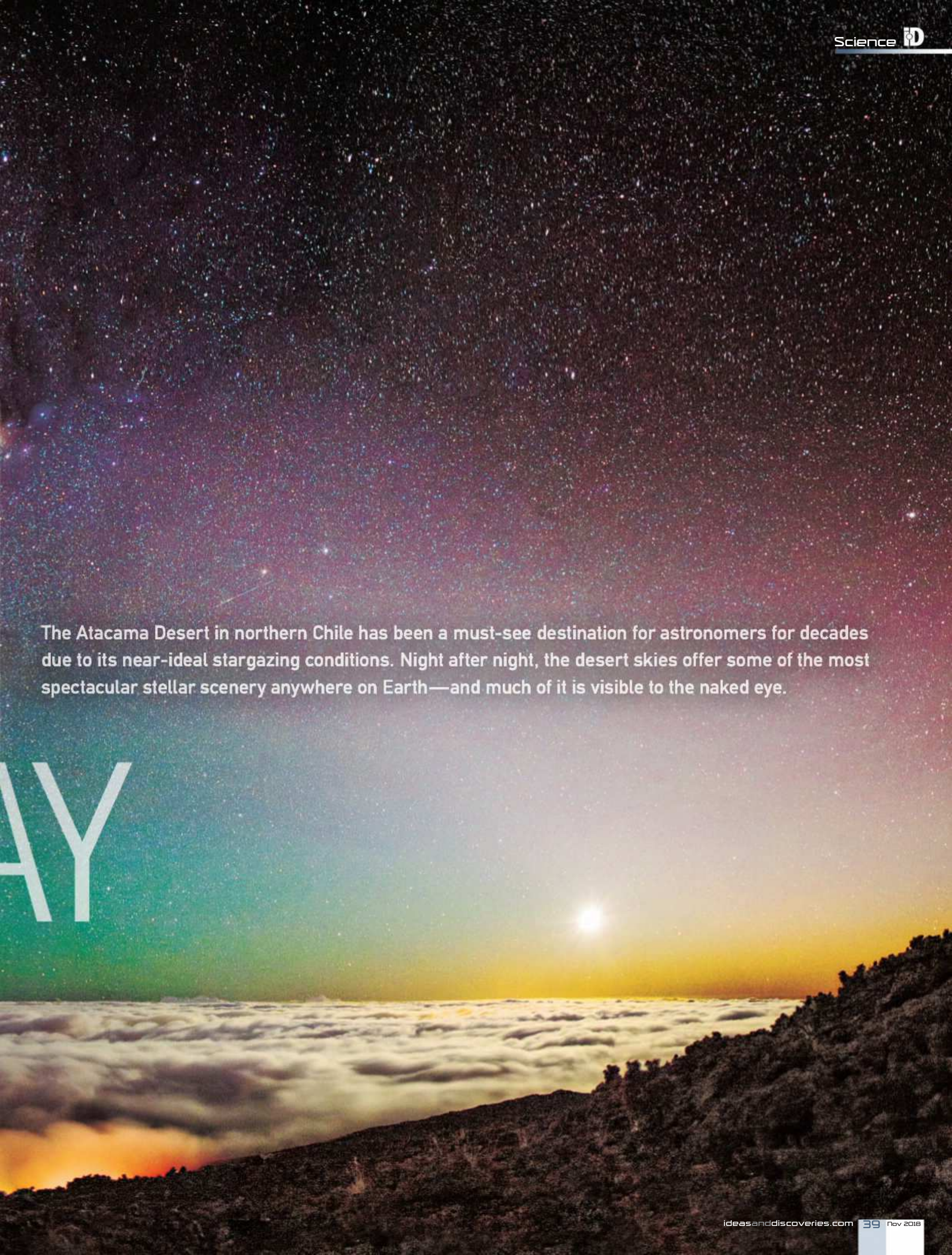
BELIEVE ME and **HONESTLY** are typical signs of lying. The liar is running low on content and getting nervous. Liars seek to force their listener to accept the veracity of their lies.

ROUGHLY, PERHAPS, and **PROBABLY.** Beating around the bush like this is a danger signal to the skilled listener: The speaker does not have a solid story to tell and is trying to leave a back door open to escape from his lies. This tactic of not remembering clearly is popular in the courtroom. If new facts emerge over time, this strategy allows the speaker flexibility to adjust the previous statements and deny having lied. This technique can be countered by forcing the speaker to commit to clearly stating the facts.





THE SUMMIT
WHENCE THE
MILKY WAY
RISES FORTH

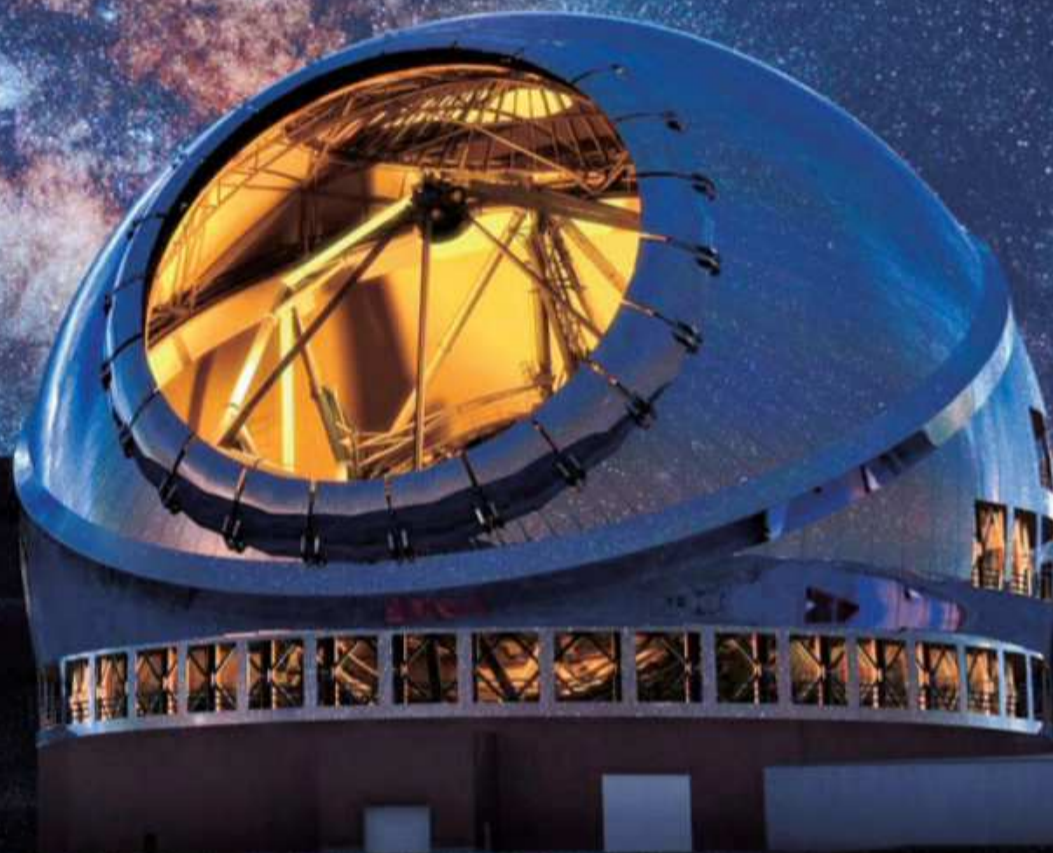


The Atacama Desert in northern Chile has been a must-see destination for astronomers for decades due to its near-ideal stargazing conditions. Night after night, the desert skies offer some of the most spectacular stellar scenery anywhere on Earth—and much of it is visible to the naked eye.

AY

PEERING INTO THE COSMOS

The Paranal Observatory in Chile is equipped with the most modern telescopes in the world. Built by the European Southern Observatory (ESO) research organization, their purpose is to help astronomers explore the Milky Way and other galaxies.

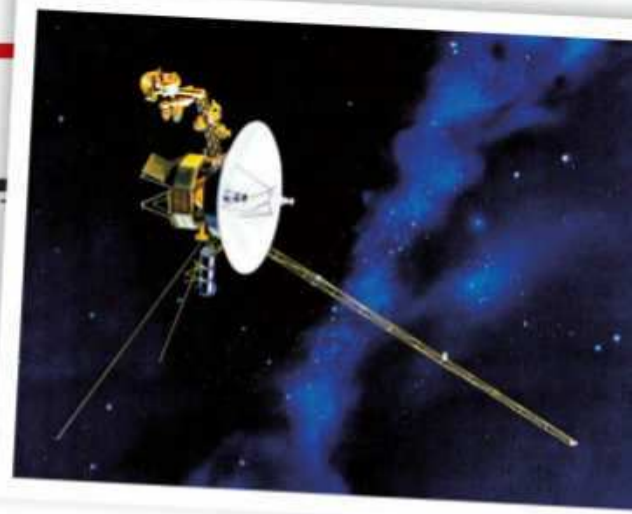


✕ It's like being in another world. Here on Chile's high plateau, the Altiplano, which in some places rises to almost 13,000 feet above sea level, everything is different. The air is thinner, the light is more intense, and the landscape is simply incomparable to any other on the planet. Wild alpacas crisscross the seemingly endless expanse of this high mountain plateau, which is nearly as big as the state of Florida. The lakes here are among the oldest on Earth. The Atacama Desert is the arid heart of the Altiplano, a region where it almost never rains. But to only visit this breathtaking landscape during the day means missing out on the best part of it. The real magic doesn't reveal itself until after dark.

The sky here is cloudless nearly every night. And the clarity of the mountain air is practically unparalleled. Just a few moments ago, when the sun was still shining, the temperature was a pleasant 68°F. Now the mercury has started falling steadily by the minute and will soon drop below freezing. Once the last rays of sunshine have disappeared below the summit of Cerro Paranal—the

mountain that is home to the Paranal Observatory—the Milky Way appears to rise into the sky. Visitors can see their breath in the cold as they look up, spellbound, to stare in astonishment. Thousands of stars are visible to the naked eye. The mountain's slopes and valleys are bathed in silvery light. Gazing into the night sky above a large city, you might see perhaps 50 points of light, if you're lucky. But here in the isolation of the Altiplano, the stars seem closer to us than anywhere else on Earth.

This attribute has made the Altiplano a destination not only for ordinary star seekers but also for astronomers. The biggest telescope on Cerro Paranal is the Very Large Telescope (VLT), consisting of four separate instruments that can combine their images to serve as a fifth, even more powerful telescope. Astronomers from around the world have flocked here for decades to take advantage of the clean dry air that allows the Paranal telescopes to provide a glimpse of distant worlds that would otherwise remain hidden. The profoundly impressive view includes galaxies that are 13 billion light-years away from us.



Where is Voyager 1 headed?



Since its launch on September 5, 1977, the space probe Voyager 1 has been steadily exploring our solar system for more than 40 years. In August of 2012 it

became the first human-made object to leave our solar system and enter interstellar space. But that was not the end of Voyager's journey. The space probe continues to fly toward the star Gliese 445, which is 17.6 light-years from Earth and moving toward Voyager 1 and our solar system. By the time the probe reaches the distant star, Gliese 445 will be only 3.4 light-years from us. But don't get too excited—that will take another 40,000 years.



Can an astronaut see the difference between East and West Berlin?



Before he returned to Earth from his final space flight on May 14, 2013, Canadian astronaut Chris Hadfield posted photos from the International Space Station (ISS) on his Twitter account. Among them was a photo of Berlin, which showed a clear line of demarcation between the former eastern and western parts of the city. The primary difference was in the street lighting: East Berlin started using sodium-vapor lamps with their yellow glow while it was still a part of the German Democratic Republic (GDR); West Berlin had mostly fluorescent and mercury-vapor lighting, which both produce white light. The difference is still clearly visible—at least to astronauts.

Can we see distant galaxies with the naked eye?



The Milky Way consists of at least 100 billion stars. If you were to collect all of the euro coins in circulation now, from one-cent pieces to two-euro coins, the total would be close to that number. But it's actually possible to see even more stars than that with the naked eye—all it takes is the right conditions. If you are in an absolutely dark place on a clear night, such as Cerro Paranal in Chile, and the weather conditions are optimal, you could catch a glimpse of another galaxy too. The Andromeda Galaxy, for example, is 2.5 million light-years from Earth—but thanks to its diameter of 220,000 light-years, it is visible from Earth with the naked eye.

How long would it take to cross the Milky Way?



Our home galaxy, the Milky Way, has a diameter of 100,000 light-years. This staggering figure is equal to 620,000,000,000,000 miles or 24,800,000,000,000 times around the Equator. If you wanted to fly from one end of the galaxy to the other with a modern rocket, the journey would

take approximately 100 billion years. By way of comparison: Our universe is only 13.8 billion years old, while our Sun is a relatively young 4.6 billion years—and it's now about halfway through its life. Scientists estimate it has another 5 billion years or so of activity left in it.

100,000 light-years



QUESTION

DO YOU HAVE A QUESTION FOR OUR TEAM OF EXPERTS?

Just send us an email!
questions@ideasanddiscoveries.com

CAN SHIPS HAVE LEGS?

■ The America's Cup is the oldest trophy in international sporting events. Although the schedule is irregular (every three to four years since 2000), the fastest sailboats in the world have been competing for the Cup since 1851. The next competition, the 36th, will be taking place in 2021. Much has changed in the 167-year history of the competition. The biggest recent change was the admission of AC72 wingsail catamarans in 2013. The innovation: The catamarans are outfitted with appendages called hydrofoils and rigid wingsails. Thus equipped, the racing vessels can reach twice the speed of the wind and can hydrofoil on water. These new design elements are critical to racing success. The foils are L-shaped swords beneath the catamarans and function like aircraft wings. They create so much lift that the 6.5-ton boat is raised out of the water when it reaches 20 mph.

This drastically decreases drag, making it possible for the catamaran to fly across the water at speeds of up to a mile a minute. But these foils not only increase the speed; they also greatly improve the boat's maneuverability. If the skipper does it right, the hull is rarely in the water. But it's not so easy: Sometimes grievous mishaps have happened, including one in 2013 in which a crew member lost his life in a training accident. Since then, new rules have required each sailor to have personal flotation, a helmet, a harness, at least one knife, and a personal air supply of at least 12 gallons.



ideas & answers

Ask a simple question, get a simple answer? Think again! Scientists often have to work meticulously to come up with explanations for basic processes—and sometimes they inadvertently discover marvels that can change our perception of the world.



DEFENDING CHAMPION

In 2013 the sailors of *Oracle Team USA 17* defended their America's Cup title. In 2017 Oracle Team USA was the favorite once again—but lost in the end to *Aotearoa*, sailed by the Emirates Team New Zealand. In the 36th event that's scheduled for 2021, *Aotearoa* will be defending the title.

TRIED AND TRUE

The peoples of the southwestern Pacific developed large double-hulled vessels as early as 1500 BC. This type of boat was largely unknown in the West before the Scottish inventor Patrick Miller had the idea of making a steam-powered double-hulled pleasure boat, which was successfully tried in the late 1780s.

HYDROFOILS

The foils work like an airplane's wings—and give the catamarans added lift. Once a speed of about 20 mph has been achieved, they raise the boat out of the water, allowing it to reach a top speed of 60 mph.



How much does **the key to happiness** cost?

In November 1922, when Albert Einstein learned that he had won the Nobel Prize for Physics, he was preparing to leave for Tokyo. Upon his arrival he stayed at the Imperial Hotel, where he received a message from a courier. Einstein was embarrassed that he did not have any change for a tip, so instead he wrote down his theory of happiness on a sheet of hotel stationery and handed it to the man: “A calm and modest life brings more happiness than the pursuit of success combined with constant restlessness.” In October 2017, this piece of paper was sold at auction for \$1.56 million. A second Einsteinian message saying “Where there’s a will, there’s a way” has fetched \$240,000.



Can animals be **left-pawed** or **right-finned**?

For a long time researchers believed that “handedness” existed only in great apes, which include human beings. Now scientists at the University of California, Santa Cruz, have discovered that blue whales turn much more frequently to the left in shallow depths. This adds to evidence of “handedness” after scientists reported that two species of Australian kangaroo use their left paws almost exclusively to eat and groom themselves. Although handedness is believed to be rare in quadrupeds, sheep have been found to have better facial recognition when using their left eye.

THE 10 TYPES OF CELLS THAT LIVE THE LONGEST

Though the cells of the human body generally live for an average of 7 to 10 years, some of them survive for a considerably longer (or shorter) time than that.



1 PANCREATIC CELLS

These cells live for only about 1 year. Nonetheless, they survive a lot longer than skin cells, which have a life expectancy of just 19 days.



2 LIVER CELLS

Among its other functions, the liver is responsible for the detoxification of poisonous substances in the body. These cells need to be replaced every 300 to 500 days.



3 BLOOD STEM CELLS

Hematopoietic stem cells are generalized stem cells from which all blood cells form. They live for 5 years.



4 FAT CELLS

Our body’s fat is designed for energy storage, and the cells can live for a long time: up to 8 years.



5 SKELETAL MUSCLE CELLS

Skeletal muscle cells are replaced approximately every 15 years. Other muscle cells may live even longer.



6 INTESTINAL CELLS

While the cells of our intestinal mucosa live for only about 5 days, other cells in our intestines can survive for almost 16 years.



7 CARDIAC MUSCLE CELLS

Researchers have discovered that the cells of the heart are rarely replaced. They live for about 40 years.



8 EGG CELLS

Egg cells (ova) live for 50 years. During the interval of time between a woman’s birth and menopause, these cells are not regenerated.



9 EYE LENS CELLS

The cells of the inner lens of the eyes were created when we were still in the embryonic stage—and these same cells will die with us.



10 BRAIN CELLS

In a rodent study, researchers discovered transplanted brain cells can live twice as long as the organism from which they’re taken. Human cells could live for 200 years.



WHY WOULD YOU SPLIT A SKYSCRAPER?

The illustrious Iraqi-born British architect Zaha Hadid passed away on March 31, 2016, but one of her most impressive buildings was not finished until two years later. The Leeza SOHO tower in Beijing's Lize Financial District is an architectural masterpiece and a real eye-catcher. Special feature: The tower is split into two halves, making it look like two intertwined towers with a large space in the middle. And that space makes it a world champion: At a height of 623 feet, this is the highest atrium in the world. But the design has a greater purpose than simply setting a world record. Hadid had another important concern: The tower was built above a subway tunnel, which passes beneath the atrium. Thus Leeza SOHO is becoming a new public transport hub for Beijing.

×
679

feet is the height of the Leeza SOHO, making it one of Beijing's tallest skyscrapers. But the real highlight of the building is its record-setting atrium, which is 623 feet high.

IS THERE A **SECOND GREAT SPHINX?**

Along with the Pyramids of Giza, the Great Sphinx is among Egypt's most familiar landmarks. It dates back to the time of the Pharaoh Khafre (about 2500 BC) and consists of a lion's body with a human head. It is the most famous sphinx in the world, and at a height of 66 feet and a length of 240 feet it's the largest as well. But this monumental structure is different in yet another way: It stands alone. Usually sphinxes (or sphinges) were built in pairs. And now researchers believe they have found a

second sphinx on the Giza Plateau—within sight of the most famous one. Satellite images have revealed an inconspicuous hill that could enclose the counterpart to the Great Sphinx. And in fact, historical Greek, Roman, and Arab sources actually mention a second sphinx. Egyptologist Bassam El Shammaa believes it may have been damaged or destroyed by a lightning strike because it was often depicted with a metal crown, which would have conducted electricity to the ground.



In 1378 a Sufi Muslim named Muhammad Sa'im al-Dahr had reportedly destroyed the Sphinx's nose—and was subsequently executed for vandalism.



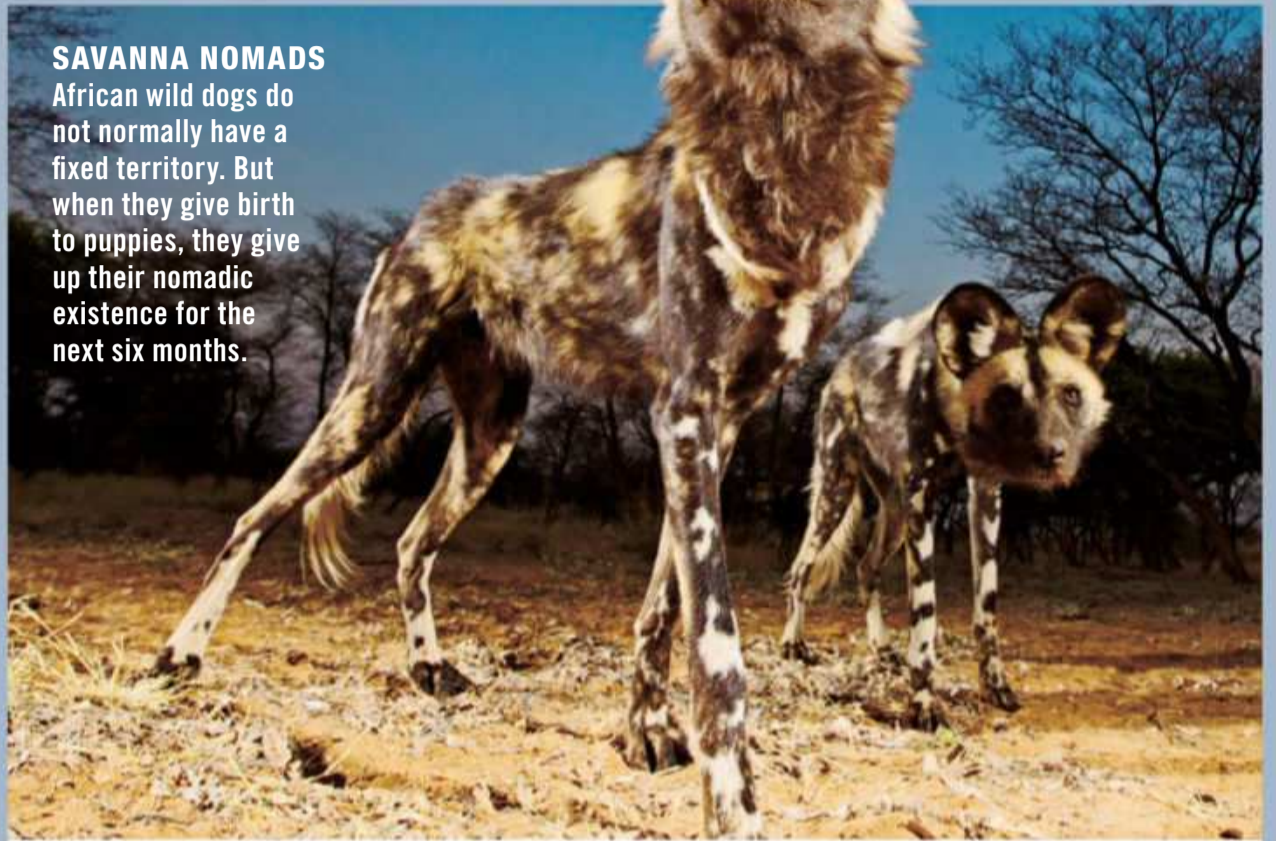
HOW CAN YOU DIVE BENEATH A CLOSED SHEET OF ICE?

It's like being in a different world: swimming in ice-cold water with a thick layer of ice above your head. Ice diving holds obvious hazards for the diver. Getting lost is the biggest one: It is very difficult for divers to keep their orientation. That's why even the most experienced divers never go alone and always have a tether to help them find their way back out. The line is secured to something on the surface, a boat or a tree on shore. A support team monitors the line and stands by to send out a rescue for any divers who are in danger.

Brainteaser The solution will appear in the next issue, on stands November 9, 2018.

I'll ask you a question for which there is one clearly correct answer—either yes or no—but it will be impossible for you to answer my question. Perhaps you may know the correct answer, but you will not give it to me. Anyone else might be able to provide the answer, but not you.

Solution from the September 2018 issue: When Oli looks at the odometer again after having driven for about an hour, the reading it shows is 79097. Therefore he has driven 110 miles.



SAVANNA NOMADS

African wild dogs do not normally have a fixed territory. But when they give birth to puppies, they give up their nomadic existence for the next six months.

DO WILD DOGS VOTE?

African wild dogs (aka painted dogs) live in packs and stick together even when they aren't hunting. Now behavioral scientists from Australia and the United States have found that the animals will sneeze to "vote" when the pack is making a decision, such

as whether it's time to head off for a hunt. But the practice is not as democratic as it sounds, as some animals are more equal than others: When the dominant male and female are involved in the sneezing, it takes less time to decide.



Where did Oumuamua come from?

The interstellar object called Oumuamua is different from anything astronomers have seen before and it's the first object known to have originated outside of our solar system and flown so close to Earth. When it streaked past in October 2017, scientists estimated the object is about half a mile long, which is 10 times its width. It was moving at almost 200,000 miles per hour—so fast that the source of its

speed could not have been our Sun. Its trajectory is elliptical, and therefore once it leaves our solar system it will never come back again. It was initially believed to be a comet, but comets in our solar system typically have a lot of dust and none was detected around Oumuamua. So where did it come from? It seems that it came from another solar system in the galaxy, but scientists don't know which one.

THE DEATH OF TWO ICONS

Two presidents, two assassinations, two historic American tragedies: Were John F. Kennedy and Abraham Lincoln somehow connected by the bonds of fate? A list of the things they shared in common might suggest it. Or do these similarities simply show that it's always possible to find a link if you search long and hard enough?



Abraham Lincoln was **elected president in 1860.**

John F. Kennedy **was elected president** 100 years later, **in 1960.**

Both were fatally **shot on a Friday**, each by a bullet to the head.

Lincoln was succeeded by a vice president named **Johnson** who was born in 1808.

Kennedy was succeeded by a vice president named **Johnson** who was born in 1908.

Lincoln's killer, John Wilkes Booth, **fled a theater** and was **caught in a warehouse.**

Kennedy's killer, Lee Harvey Oswald, **fled a warehouse** and was **caught in a theater.**

Lincoln was shot at **Ford's Theatre.**

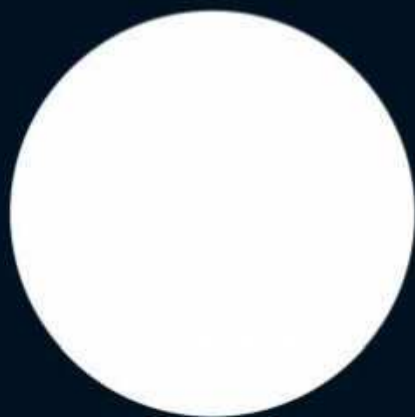
Kennedy was shot in a **Lincoln** made by the **Ford Motor Company.**

Both of the assassins, Booth and Oswald, were **killed before they could stand trial.**



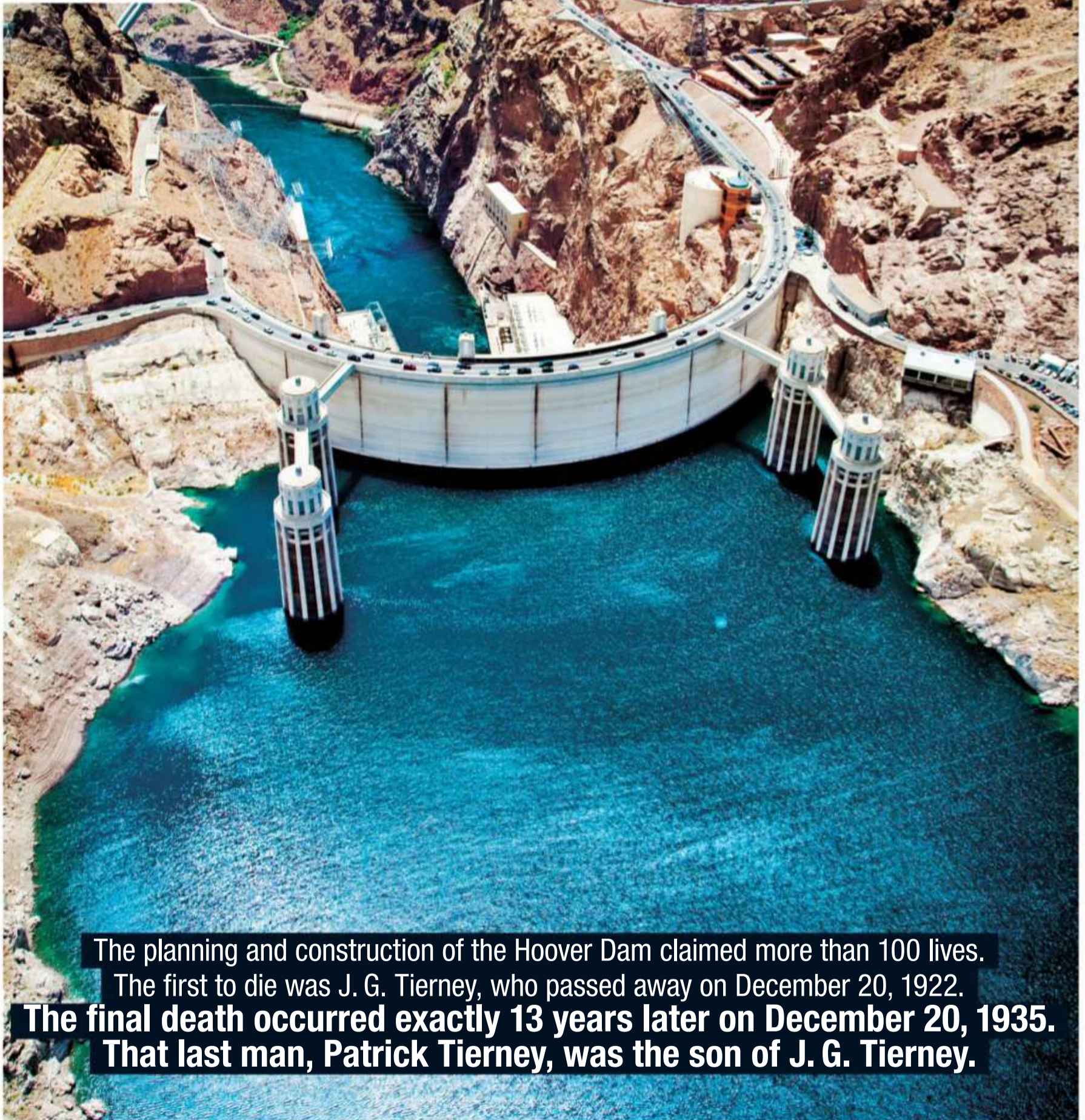
COINCIDENCE OR DESTINY?

It dominates our lives, governs the ways of the world, and steers the workings of the cosmos. Chance may be the greatest force in the universe—or perhaps we should say fate, instead? Researchers are now deciphering the system behind the events of the past 14 billion years...



FAMILY TRAGEDY

More than 100 people died during the planning and construction of the Boulder Dam (eventually renamed Hoover), which was built between 1931 and 1936. While it is not statistically impossible that the first and last to die would be father and son, it is still extremely unlikely. So was there a logical explanation? Or did the death of the father somehow seal the fate of the son?



The planning and construction of the Hoover Dam claimed more than 100 lives.

The first to die was J. G. Tierney, who passed away on December 20, 1922.

The final death occurred exactly 13 years later on December 20, 1935.

That last man, Patrick Tierney, was the son of J. G. Tierney.

P

ark ranger Roy Sullivan set one of the world's most electrifying records: In the course of duty he was struck by lightning seven times. In February 2016, *Time* magazine reported that an Indian bus driver, V. Kamaraj, had set a new and tragic record: He died of his injuries after being struck by a meteorite—the first and only time such an event has been recorded. Hilda Mayol was similarly unlucky. A waitress at a ground-floor restaurant in the World Trade Center, she had survived the collapse of the Twin Towers in September 2001. But two months later she boarded American Airlines Flight 587, which crashed shortly after takeoff from JFK Airport and killed Hilda Mayol along with the other 259 people on board the plane as well as five people on the ground. And because so many people in the metro area refused to believe it was a coincidence, they used the flight's number, 587, to play the New Jersey Lottery drawing held later that day—and won. There were an astonishing 27,829 winning tickets.

Was it all just coincidence, or does fate actually exist—some natural law that lends deeper meaning to these seemingly random events? To answer this question, we must understand the

nature of coincidence. Consider this: A man and a hedgehog are about to cross a busy road. The hedgehog darts out without looking. The little animal is unable to assess the danger posed by the cars that are streaking past it—the hedgehog's life depends entirely on the luck of the draw. But the likelihood can be calculated by taking into consideration the width of the road, the pace of the hedgehog, and the speed and frequency of the cars—such data make it possible to calculate an average survival rate for an average hedgehog on an average day. Nevertheless, it is left to chance whether the hedgehog will reach the other side of the road in one piece. A prudent pedestrian, on the other hand, looks to the left and right before stepping into the road to make sure no cars are coming. In doing so, the pedestrian considerably increases his chance of survival. One might say: The pedestrian has outfoxed fate.

HOW DOES KNOWLEDGE COUNTERACT COINCIDENCE?

The history of science and technology may be viewed as a struggle against coincidence—an effort to moderate its effects or eliminate them entirely. Airbags, for example, reduce the risk of being injured in an accidental car crash. Antibiotics diminish the danger of dying from a randomly acquired illness. But often it is knowledge itself that protects us from the power of chance and its effects.

As long as humankind remained ignorant of the causes of infectious diseases, we were powerless against them. Thus the history of the Great Plague in Europe is a story of tragic coincidences. But for those alive at the time, it was not a coincidence at all but rather “the will of God”—or simply “fate.” For those of us looking back today, there is clearly a reason some people had succumbed to the plague while others survived. At the time, however, there was no scientific

explanation for the disease, so people were searching for other reasons—in a process that is not all that different from the one we use today. The human brain requires plausible explanations, thus we are constantly searching for patterns that might account for what we're experiencing. When we cannot find an explanation, we often turn to conspiracies. It wasn't until 1894 that French bacteriologist Alexandre Émile Jean Yersin discovered the plague bacillus, *Yersinia pestis*. Next it was discovered that this microorganism gets transmitted by the rat flea. Once the pattern had been found, it became possible to take measures to prevent accidental transmission of the plague. “In Europe the principles of hygiene became prevalent in the second half of the 19th century, saving more lives than any other medical achievement,” explains British medieval historian Carole Rawcliffe.

However, where science reaches its limits, coincidence takes over. That applies equally to everyday life as it does to science itself. Albert Einstein put it like this: “When our calculations fail, we call it coincidence.” Therefore coincidence is oftentimes merely an explanation for something that we do not (yet) understand. We are simply lacking in knowledge.

THE LAW OF LARGE NUMBERS

So is there an explanation for when someone is struck by lightning or a meteorite? In any case, the likelihood of these incidents taking place can be mathematically calculated. The odds of being struck by lightning are about 1 in 700,000, while in the case of being hit by a meteorite the odds are about 1 in 1.6 million. And so it is statistically highly unlikely—but not impossible—that such an event could occur. Anyone who has been affected by a very unlikely event is apt to think he is the victim of fate. But stochastic experts—mathematicians who study probability—take a more sober view. >

**WHEN CAN
AN ACCIDENT
LOOK LIKE FATE?**

Park ranger Roy C. Sullivan was struck by lightning seven times. However, his job took him outdoors much of the time—in Shenandoah National Park, an area that sees about 40 days of thunderstorms each year. So was Sullivan thus tempting fate?



Roy C. Sullivan was **struck by lightning** seven times. There is less than a one-in-a-million chance of being struck by lightning. The likelihood of being struck seven times, however, is 1 in 16 septillion.

Given that some 7.5 billion people are alive on Earth today, the occurrence of even the most unlikely event is not just a probability, but a certainty: “The greater the number of people involved, the more likely it becomes that an improbable event will occur,” says catastrophist Gordon Woo. He sees “death by meteorite” not as fate but rather as an extremely unfortunate coincidence—it comes down to being in the wrong place at the wrong time. But does the same principle apply to any strange series of events?

In his book *Why Mathematics Makes Us Happy*, author Christian Hesse relates the story of the Finnish twin brothers Lauri and Elmer Impola, who died on the same day in 2001. The brothers lived together in the small Finnish city of Raahe, where Lauri straddled his bicycle on the morning of March 5 and headed out into a snowstorm toward Highway 8. At 9:25 a truck collided with Lauri at an intersection—he died at the scene. Unaware of his brother’s death, Elmer set off on his bicycle two hours later, heading home from the barbershop. A short time later he too was fatally hit by a truck only a little more than half a mile from his brother’s accident. Was this a mere coincidence—or is there more to it than that?

THE GENETIC CODE: WHEN COINCIDENCE BECOMES FATE



In fact, the research that has been conducted on twins has revealed a number of astonishing (apparent) coincidences. Two twins might get married on the same day without the other knowing. They might fall ill or even die on the same day and at the same hour. Pure randomness would seem to be excluded here. But if there are laws that govern the destiny of twins, they remain unclear. A possible scientific explanation: The fate of a pair of twins could be determined by genetic patterns with structures that have yet to be decoded.

“WHEN OUR CALCULATIONS FAIL, WE CALL IT COINCIDENCE.”

—Albert Einstein



In the genetic material of humans there are instances when coincidence and predestination appear to collide. The exact combination of our father’s and mother’s genes at conception is coincidental—so our personalities are similarly a matter of coincidence. But the reservoir of information that could be transmitted from mother or father to son or daughter is not accidental. The information must be present in the genetic makeup of one parent or the other. These genes have a definite influence on the fate of an individual. It is not coincidental that the children of an alcoholic parent are more likely to become addicted to alcohol or that the offspring of violent criminals tend to be violent themselves—even when they have never met their parents. There is no way of knowing how great the influence of a parent will be and what the chances are of escaping a parent’s fate—at least, not yet. Only when medical science comprehends all of the genetic predispositions of a person will there be an opportunity to purposefully influence the genetic component of fate.

THE PSYCHOLOGY OF COINCIDENCE



But sometimes the power of chance can be disrupted without concrete knowledge of what lies behind it.

Psychologists use the term intuition to describe the ability to react to a potential danger without being fully aware of it. Neurologists explain that our subconscious mind is constantly analyzing potential hazards without our ever even being aware that this is occurring. It’s fair to say that the brain scans all our sensory impressions for patterns that indicate possible danger.

One example is provided by Carl Ziegler.* The engineer was eager to catch the next flight home but wound up booking a later flight just before he was to board the original aircraft. “I suddenly had a bad feeling. It was an impulse,” he recalls. This impulse would save his life: The plane had a mechanical problem that caused it to crash just a few minutes into the flight. It was only later, after a series of sessions with a psychotherapist, that Ziegler realized his survival had been neither coincidence nor fortune. He vaguely remembered having seen a disturbance on the tarmac in which mechanics were gesticulating, as well as the sweat-soaked shirt of the pilot who got to the gate at the last minute. In fact, a heated discussion had just taken place about the condition of one of the plane’s engines, unbeknownst to the passengers. Ziegler’s brain had registered these scene snippets and interpreted them as danger signals. His observations protected him from dying an “accidental” death.

THE CREATIVE ENERGY OF SPACE

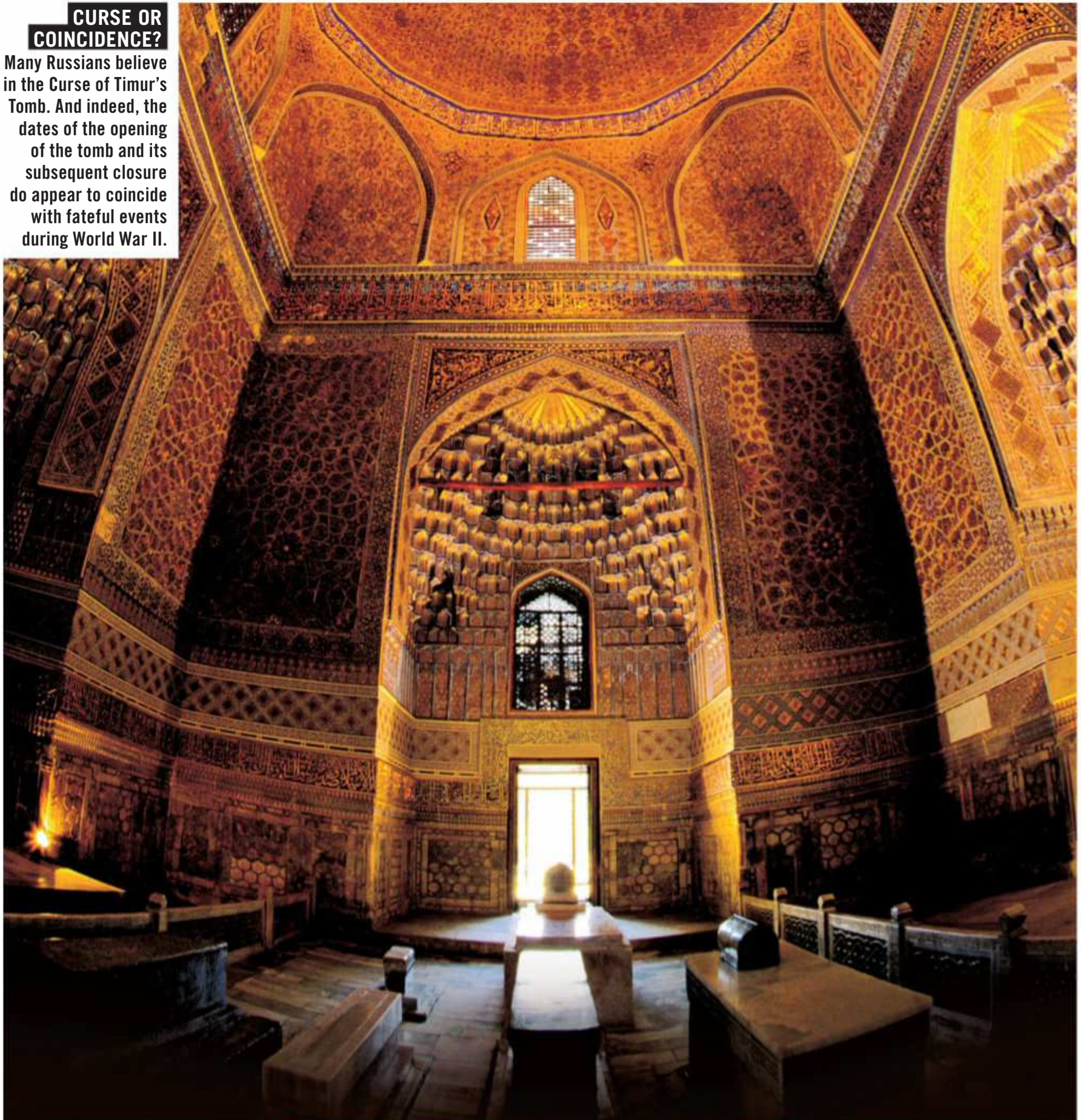


For astrophysicist and Nobel laureate John C. Mather, chance is the most fascinating force in the universe: “If you want to look chance in the face, just tilt your head back and look up at night. The distribution of stars and matter in the universe is, largely, the result of tremendous coincidence.” Mather won the 2006 Nobel Prize in Physics after he and his colleague George Smoot found indications that the spectrum of cosmic background radiation corresponds to that emitted >

*Name has been changed by the editors.

CURSE OR COINCIDENCE?

Many Russians believe in the Curse of Timur's Tomb. And indeed, the dates of the opening of the tomb and its subsequent closure do appear to coincide with fateful events during World War II.



“Whosoever disturbs my tomb shall **unleash an invader more terrible than I.**”

In 1941 the Soviet scientists who opened the tomb of the Turkic conqueror Tamerlane, who was known for his barbarism, found this very inscription inside.

Soviet archeologists completed the exhumation on the night of June 21, 1941. Only hours later, on June 22, 1941, **Adolf Hitler invaded the Soviet Union.**

In November 1942, Joseph Stalin ordered Tamerlane's remains to be reburied with full Islamic honors. In the same month, the Soviets launched a successful counterattack at Stalingrad that became **a turning point in WWII that would culminate in victory over Hitler.**

by a dark, glowing body—evidence that this radiation is a remnant from the creation of the universe in the Big Bang. “At the instant of the Big Bang, all matter in the universe occupied a space smaller than a single electron. In this dimension, which we call the quantum world, the laws of nature do not apply. Then only coincidence can still influence events,” explains John Mather. Next the universe expanded, becoming so large that it exited the quantum world. However the random distribution of energy and matter that remained continued to expand. Over time, stars would form and give rise to the emergence of galaxies.

As the nascent universe matured, the effects of coincidence lessened and the laws of nature increasingly assumed the function of “custodians of the law.” But the universe was still rooted in the origins of coincidence. The building blocks of all the natural laws are the physical constants: those fundamental, invariant quantities that include, for example, the speed of light in a vacuum. These constant values appear to have been created purely by coincidence. In the quantum chaos as understood by early cosmologists, there was no way of predicting chaos. “These natural constants encode the deepest secrets of the universe. But although we are measuring them with increasing accuracy, we have not yet been able to explain their existence,” says Cambridge University physicist and mathematician John D. Barrow.

For physicists and biologists alike, coincidence is more or less the great creative spark of the cosmos. But they are more likely to speak of chaos than coincidence. Chaotic events change the old order and make it possible for a new order to emerge. If order were absolute, a kind of stalemate situation would arise. Life would be frozen the way it appears in a photograph.

In studying the development of life on Earth, the power of coincidence becomes especially clear. Each new species was created as the result of

“GOD PLAYS DICE WITH THE UNIVERSE, BUT THEY’RE LOADED DICE. THE OBJECTIVE OF PHYSICS IS TO FIND OUT HOW THEY ARE LOADED.”

—Joseph Ford

random mutations in the genes. Most of these changes proved to be flops. But when a genetic coup does occur, it can endow a species with a decisive advantage for survival. So essentially, evolutionary coincidence in biology is an endless story of trial and error and thus the kind of creative process with which every inventor can identify.

CAN WE ELIMINATE COINCIDENCE, AND WOULD WE WANT TO IF WE COULD?

Nowadays we’re no longer willing to accept the consequences of chance. All of our modern achievements have resulted from our fierce determination to break the power of coincidence. Natural phenomena provided us with the material from which religions were made. But as technological and social progress continued to take place, the religious interpretations that had been intended to explain the arbitrary power of chance were increasingly set aside.

The development of agriculture, for example, diminished our forefathers’ dependence on the fortuitousness of hunting; vaccinations and antibiotics prevented or cured many accidental infections; renewable energy plays an ever-larger role in environmental

protection, and modern sociopolitical achievements have lowered poverty levels worldwide. We also strive to moderate the destructive aspects of coincidence in our daily lives as well. That means a booming business for insurance companies, which collect over \$5 trillion in insurance premiums each year worldwide.

But even ultramodern technology cannot eliminate the risks posed by chance; it has been a fixed feature of the universe ever since the Big Bang. Risk researchers suspect that all our struggles against coincidence may eventually lead to serious problems. According to a study at the Hamburg University of Technology, the system starts to tilt out of balance when our latitude for decision-making becomes excessively curtailed. It is a mistake to believe chance could be defeated by implementing ever-more-stringent precautionary measures. “There is a problem of complexity: We don’t have a way to know for certain whether a reading on an instrument indicates a real fault in the system or whether the instrument itself is actually broken. That, of course, takes us to the limits of technological security. Because any time something has to be interpreted, there always lurks the possibility of misinterpretation,” says risk researcher Ortwin Renn. So, to put it plainly: If a mistake can happen, someday it will. There is no such thing as zero risk.

Statistics show, for instance, that there is one fatal accident for every 16 million commercial airline flights. (No one had been killed in such an accident in 2017.) And yet: The more flights there are, the greater the risk—no matter how small it is. Air safety experts utilize other comparisons to illustrate just how safe air travel has become: For example, the likelihood of being struck by lightning is much higher than the likelihood of dying in a plane crash in Europe or the U.S. But unlikely is not impossible. Don’t forget, “spark ranger” Roy Sullivan was struck by lightning seven times...

THE HUMAN RACE VS. AI

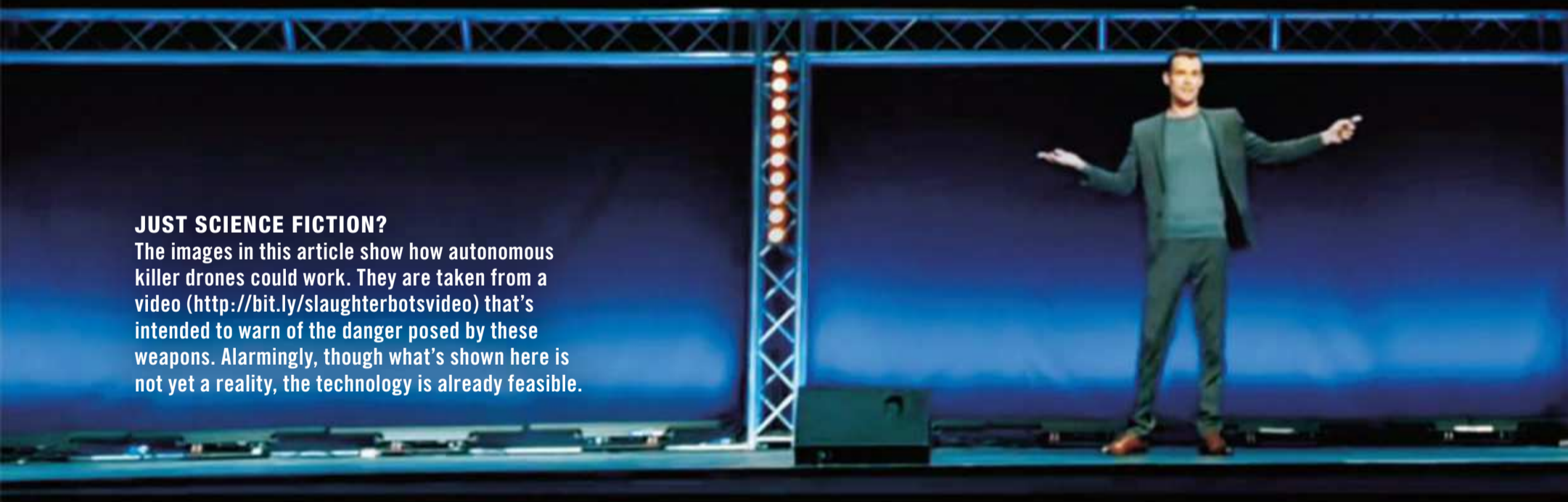
What if intelligent weapons could seek out their targets on their own? What if civilization were attacked by millions of “slaughterbots” at once? It is hard to imagine such a frightening scenario. And yet these weapons are already approaching the verge of development. Leading scientists caution that it’s imperative to stop them—now!



facial recognition +

JUST SCIENCE FICTION?

The images in this article show how autonomous killer drones could work. They are taken from a video (<http://bit.ly/slaughterbotsvideo>) that’s intended to warn of the danger posed by these weapons. Alarming, though what’s shown here is not yet a reality, the technology is already feasible.



“W

e’d be largely defenseless against an attack by intelligent autonomous weapons. Up until now no nation has developed a satisfactory response,” says Stuart Russell. The UC Berkeley

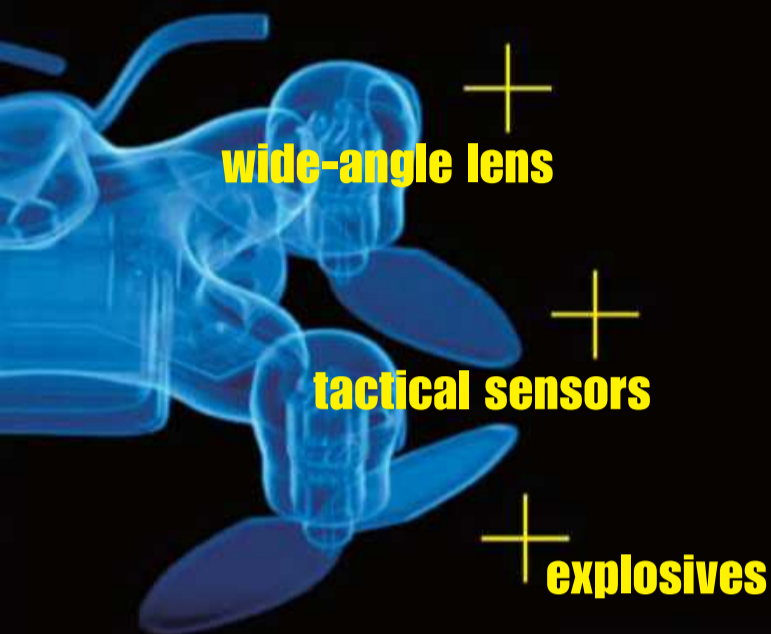
computer scientist is talking about a scenario in which groups of terrorists deploy thousands of “slaughterbots” against a major city like Washington or Moscow: flying drones programmed to seek out individuals as targets or open fire on people who simply share certain characteristics that the drones identify on their own. Science fiction?

“AUTONOMOUS WEAPONS ARE EASIER TO ACHIEVE THAN SELF-DRIVING CARS.”

Russell is not a member of the military looking to secure a bigger budget for

highly deadly offensive or defensive weapons. On the contrary: He wants lethal autonomous weapons (LAWs) to be prohibited in the same manner as nuclear or biological armaments. He is also neither a neo-Luddite nor an opponent of artificial intelligence (AI). Quite the opposite: Russell, a professor of computer science at the University of California, Berkeley, has written several standard works on AI and helped make the intelligent robots of the world more capable. But after more than 35 years of working in AI, he has become skeptical—though he

AUTONOMOUS WEAPONS



STUART RUSSELL,
UNIVERSITY OF
CALIFORNIA



**WE'D
BE LARGELY
DEFENSELESS
AGAINST AN
ATTACK BY
INTELLIGENT
AUTONOMOUS
WEAPONS.**

continues to view the field positively on the whole: “Our entire civilization, everything we value, is based on our intelligence. And if we have access to a lot more intelligence, then there is really no limit to what the human race can do.” The same applies to LAWs; the key distinction is that they “know” no limits: Individuals could carry out an attack that claims a high number of victims, approaching the scale of the aftermath of a nuclear bomb blast. “The technology is easier to achieve than self-driving cars, which require far higher standards of performance,” says

Russell. In fact, the first slaughterbot has already been deployed...

Armenia, April 2016: This tiny landlocked country in the Caucasus was caught in a conflict with neighboring Azerbaijan when Azerbaijani forces launched an Israeli-produced drone against a bus that carried Armenian recruits. Seven of them died. The IAI Harpy that was utilized for the aerial strike has about the same wingspan as a California condor (10 feet) and is able to operate totally autonomously. It located the bus and crashed into it, detonating its 50 pounds of explosives.

That day marked a revolution in the advance of warfare. After the invention of gunpowder and nuclear weapons, military scientists consider LAWs to be the third innovational development to radically change battlefield dynamics. That fact that the killer robot’s deadly deployment went largely unnoticed by the international media is a reflection of the location of its use: far from the public eye, regarded as part of a long-standing rivalry in an “Islamic region,” although practically all Armenians are Christian and the nation has suffered persecution from Islamic extremists. >

DRONE 1

PRECISION

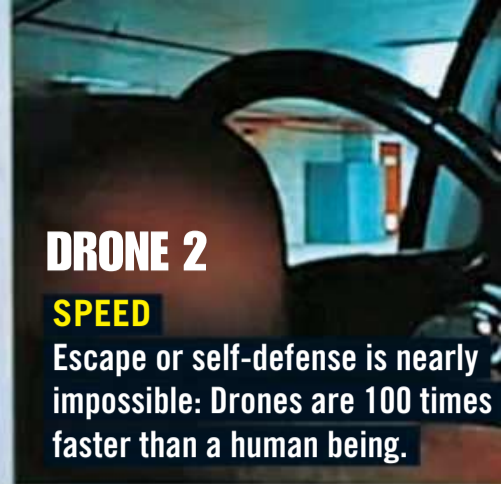
The drones fan out, each with its own individual target. Their hollow charges explode in front of the victim's forehead—the shock penetrates the skull and destroys the target's brain.



DRONE 2

SPEED

Escape or self-defense is nearly impossible: Drones are 100 times faster than a human being.



DRONE 3

OVERVIEW

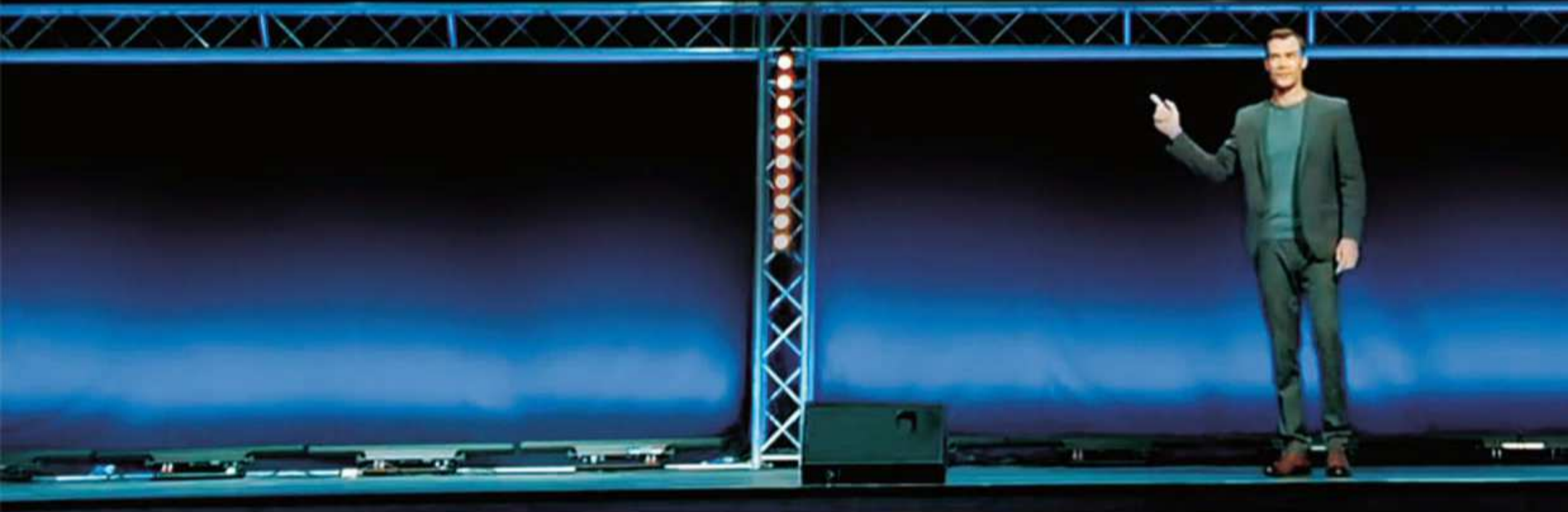
With their tactical sensors, drones have the advantage of being able to assess the entirety of a situation—and share the data with other drones.



DRONE 4

AIR SUPREMACY

The drones move throughout three-dimensional space—and can thus surprise their targets from above.



The Harpy (or Harop) that killed the Armenian volunteers is part guided missile (with pre-programmed target) and part conventional drone (guided by a pilot on the ground). Developed by Israel Aerospace Industries, the Harpy makes use of its sensors to fly autonomously to a predefined target, which it destroys by crashing into it. It has a flying time of six hours and returns to base if no target is found.

Most LAWS generally cost several million dollars. Because their sensors are relatively simple, their operational area must be familiar to the operator.

They are not yet exclusively steered by algorithms; a human operator can still intervene in order to guide or even break off a deadly “suicide” mission. But what sorts of possibilities could become reality when the technology inevitably becomes smaller, cheaper, and more intelligent? At what point will it no longer be worthwhile to have a human being piloting each drone?

WEAPONS PRODUCED BY A 3-D PRINTER

“The U.S. military is working on a program that would allow them to use

a 3-D printer to make thousands of disposable kill systems on demand,” says Frank Sauer, an expert in global security at Germany’s Bundeswehr (“armed forces”) University in Munich. “And they’ll function with a relatively high degree of autonomy.” The U.S. Defense Department’s elite research agency for innovative technology, the Defense Advanced Research Projects Agency (DARPA), was responsible for having invented the forerunner of the Internet, stealth technology for military fighter jets, and the GPS system, and it is already working on slaughterbots.



HOW DO

KILLER DRONES WORK?

The Campaign to Stop Killer Robots has described scenarios in which drones of the future are deployed to assassinate people. The most disturbing aspect: The technology already exists. These mini drones are each loaded with 3 grams of explosives. They are programmed to use facial recognition to identify the target, which they approach at 100 times the speed of human locomotion. They fly to the victim's face and explode against the forehead. The victim dies on the spot. These drones can be programmed as a swarm to strategically eliminate multiple targets.



According to Jean-Charles Ledé, a program manager at DARPA's Tactical Technology Office, these autonomous drones should be able to "hunt just like wolves in coordinated packs with minimal communication." But how realistic are these expectations?

Only a few years ago, a computer was not able to detect the difference between a cat and a dog. Today the algorithms used to analyze data can identify relationships that elude even experienced experts—who can only look on in amazement. A researcher at Stanford University used a deep-

learning algorithm to evaluate white Americans who had self-identified as either straight or gay. He found that the algorithm could identify gay men from their photos with 81% accuracy, far better than human judges looking at the same pictures. Just a few years back, it took months for a computer to become "smart" enough to reach the grandmaster level in chess. Now Matthew Lai, a computer scientist at University College London in the UK, has developed a learning system in which a computer can teach itself to play championship chess. After only

72 hours—playing only against itself—the computer is more proficient than 98% of ranked human chess players. Creating a slaughterbot to seek out and eliminate a target would appear to be child's play after that. After all, the use of facial recognition software is becoming increasingly widespread, even on today's smartphones.

"TIME TO ACT IS RUNNING OUT."

Meanwhile, it is not only the world's superpowers that have nuclear-tipped missiles, drones, and cyberwarriors. In order to maintain a technological >

HORROR SCENARIO

DRONE ATTACK

STEP 1

AIRDROP

Aircraft take thousands of drones to a location near the target area and release them.

STEP 2

POSITIONING

The swarm of drones enters the target area: In this scenario it is a university where there are more than 8,000 programmed targets.

STEP 4

ATTACK

Hundreds of drones have entered a classroom and use their integrated explosives to eliminate the targets.

STEP 5

SCANNING

The drones' sensors sweep the room, analyzing the full extent of the space for any possible targets in hiding.

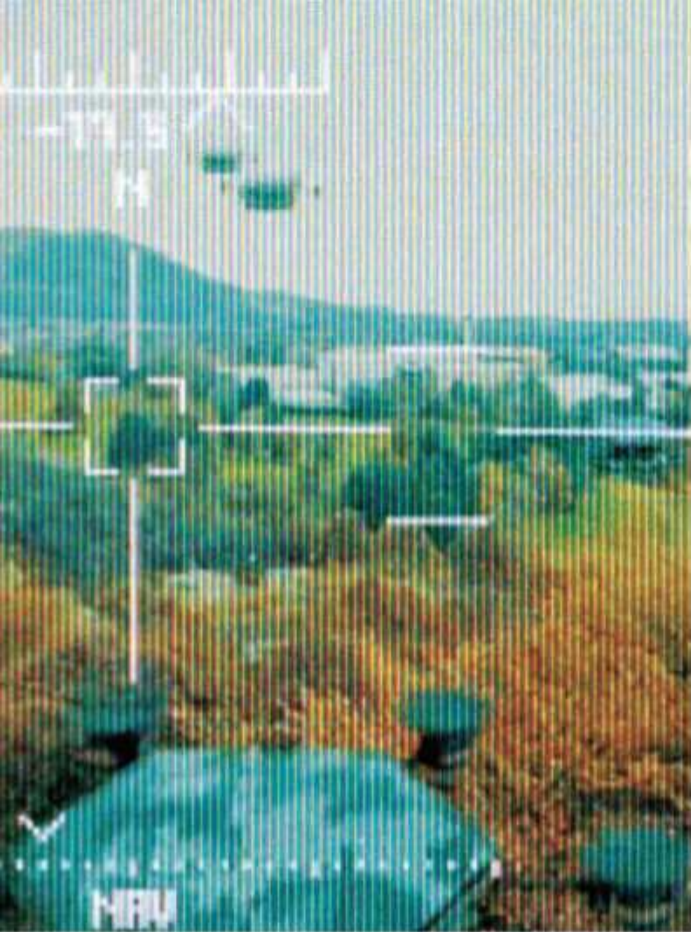
military advantage in today's world, the only effective strategy is to make weapons faster and more intelligent. And that is provoking a mega global arms race: "Speed kills," says Frank Sauer. "If defense systems get faster, offensive systems must be even faster than that. The competition is fierce." The problem: Although the weapons of the future may become incredibly fast, our brains can't be optimized to keep up. The brain effectively hinders the algorithms' speed and efficiency.

"Artificial intelligence is the future. Whoever becomes the leader in this

sphere will become ruler of the world," Russian President Vladimir Putin said recently. "When one party's drones are destroyed by drones of another, it will have no choice but to surrender." Russia now has at least 10 national research centers working on this. In November 2017, the United Nations Convention on Certain Conventional Weapons held its annual meeting in Geneva for formal deliberation on the lethal autonomous weapons systems, but attempts to forbid them met with opposition—particularly from Russia, Israel, and the U.S. "This can be fatal.

The window to act is closing quickly," says AI researcher Stuart Russell.

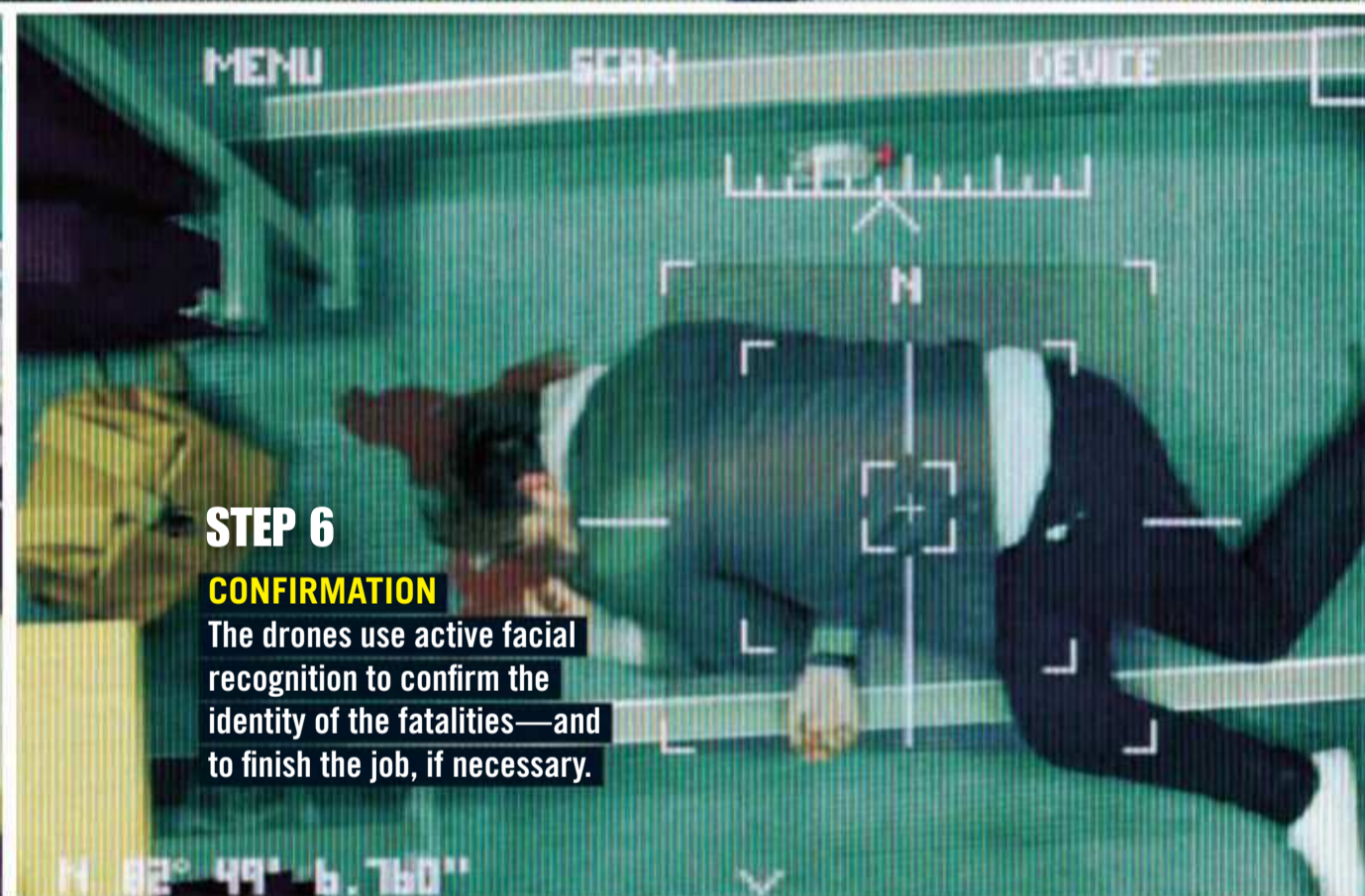
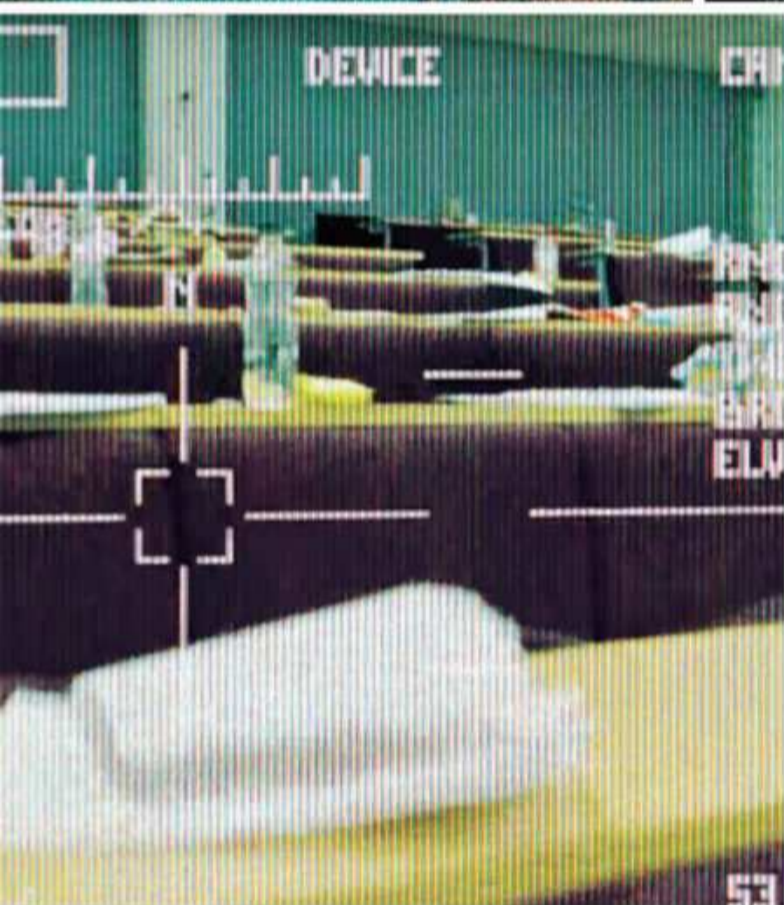
Stephen Hawking was yet another critical voice here: "The development of full artificial intelligence could spell the end of the human race." But why endow a machine with a human-like consciousness? Russell explains: "If we send out an intelligent robot to get coffee, it will have a strong incentive to ensure its success by disabling its own off switch or even exterminating anyone who might interfere with the mission. Some argue that we can just 'switch them off,' as if superintelligent



STEP 3

IDENTIFICATION

Each drone is programmed to seek out its intended target based on individual features. That could also include one's political views, as gleaned from social media.



STEP 6

CONFIRMATION

The drones use active facial recognition to confirm the identity of the fatalities—and to finish the job, if necessary.

machines are too stupid to think of that possibility.” He believes machines could actually develop the equivalent of the human survival instinct. So then why not incorporate some sort of fail-safe mechanism into a robot’s design? “We have yet to invent a firewall that is secure against ordinary humans—let alone superintelligent machines.”

“ARTIFICIAL INTELLIGENCE DOES NOT NEED DRONES TO ANNIHILATE THE HUMAN RACE.”

“AI does not need drones or guns to annihilate the human race,” says AI

researcher Eliezer Yudkowsky. “The problem is not the weapons; it’s that AI is smarter than we are. A bacterium synthetically manipulated to produce botulinum toxin, for example, is all it would take.” In science this situation is referred to as the “gorilla problem”: Between 6 and 10 million years ago, evolution led to the development of humans beings who were physically inferior but intellectually far superior to their ancestors. And today, the very existence of the great apes depends on the attitudes and behavior of their human descendants.

The fate of the gorillas could soon become our own: If AI is not equipped with an absolutely fail-safe software barrier, it might try to emancipate itself from the yoke of its creators, resulting in a catastrophic robotic takeover by our own inventions. “AI needs to be perfectly programmed,” Yudkowsky says. It may be impossible to reset it or to update or uninstall its software after the fact... “I’m not sure I’d want to be the one holding the kill switch for some superpowered AI,” contends entrepreneur and engineer Elon Musk. “You would be the first thing it kills.”

IT WAS M WASN'T I

Around the world, sensational stories packed with lurid details grab headlines. The emerging facts
But sometimes what seems like an open-and-shut case ends up taking an unexpected turn...

URDER, T?

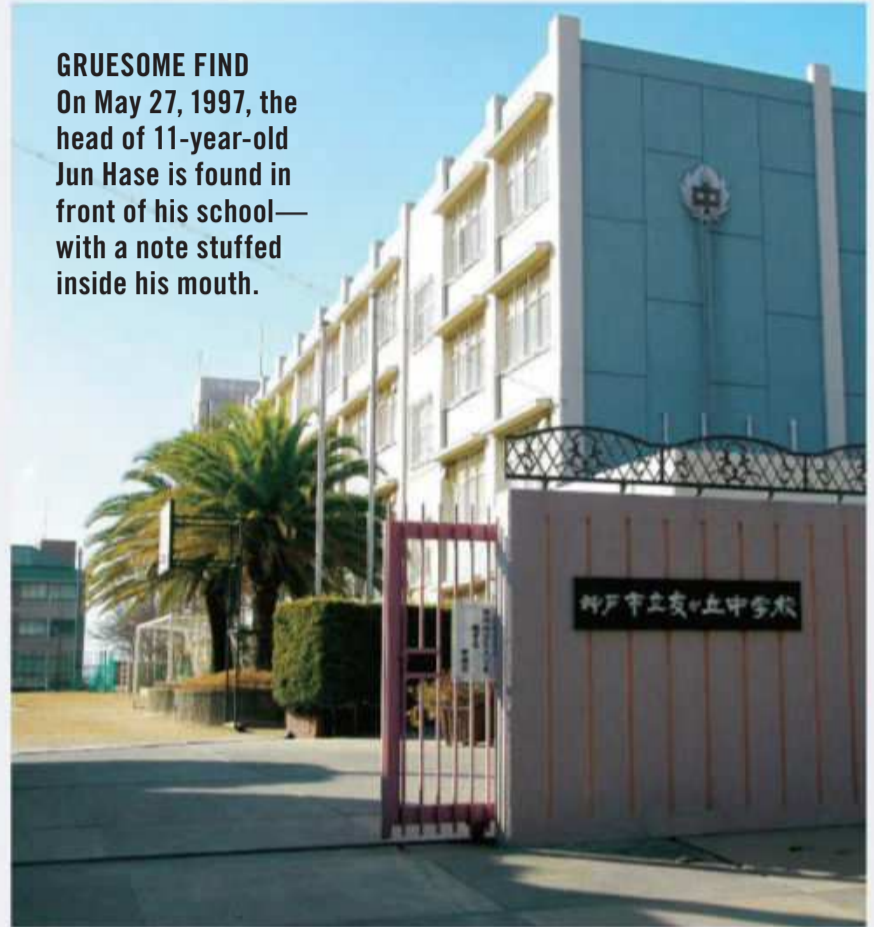
clearly incriminate a particular individual.

**UNPRECEDENTED
KILLINGS HORRIFY
JAPAN. THE VICTIMS:
CHILDREN! THE KILLER'S
MODUS OPERANDI:
BEATING, STRANGLING,
DECAPITATION.**

**WHEN HE IS ARRESTED, A SHOCK
WAVE HITS JAPANESE SOCIETY...**

**...IN PART BECAUSE HE CANNOT BE SENT TO
PRISON FOR MURDER EVEN THOUGH HIS GUILT
IS BEYOND DOUBT.**

SEITO SAKAKIBARA, JAPAN/1997



GRUESOME FIND
On May 27, 1997, the head of 11-year-old Jun Hase is found in front of his school—with a note stuffed inside his mouth.

JAPAN IS IN A STATE OF SHOCK. ON FEBRUARY 10, 1997, TWO YOUNG GIRLS IN KOBE ARE ATTACKED WITH A HAMMER, AND ONE

OF THEM IS SERIOUSLY INJURED. Only a month later, a criminal assaults another two young girls on the street. One of them is severely wounded in a knife attack, and the other, 10-year-old Ayaka Yamashita, dies of her injuries after her killer had brutally bludgeoned her while she was on her way to school. Ayaka fights for her life for 12 days before succumbing to her wounds. At this point police are still unaware that they are dealing with a serial killer. He will kill again before the authorities pick up his scent. On May 24, 1997, his crimes come to a horrific culmination when a schoolboy named Jun Hase disappears while on his way to his grandparents' home. Three days later his decapitated head is found outside his school with a note inside that was written in red ink. "This is the beginning of the game... A bloody judgment is needed for my years of great bitterness." It is signed with a pseudonym, "Seito Sakakibara," with another pseudonym written in English:

"shooll [sic] kill." These will not be the last words from the "school killer." When the media get his moniker wrong in their reports, Sakakibara writes a threatening letter to a newspaper and promises additional violence. "If you think I can only kill children, you are greatly mistaken." However there would be no more attacks. On an anonymous tip, Sakakibara is arrested on June 28, 1997, and an entire nation breathes a sigh of relief. But the relief soon turns to dismay. Such horrendous crimes are subject to capital punishment in Japan, which is usually death by hanging. But in Sakakibara's case the prosecutor is not allowed to demand the ultimate penalty. The serial killer now under arrest after a nationwide manhunt is only 14 years old—and therefore below the age of full criminal responsibility. He can't be prosecuted and convicted of murder; thus as a juvenile offender the teenager is convicted as "Boy A," because his real name cannot even be released. Instead he is sent for the next seven years to a special medical facility for juvenile offenders. In the year 2000, in reaction to his heinous crimes, Japan lowers the age of criminal responsibility from 16 to 14. On March 11, 2004, Sakakibara, now 21, is released from the facility after being found to be of relatively sound mind. But his real name is still not disclosed. His autobiography, published in 2015, quickly becomes a bestseller. In response, a newspaper reveals his real name for the first time.

THE MAN WHO KILLED HIS WIFE IN HER SLEEP AND WAS NEVERTHELESS ACQUITTED.

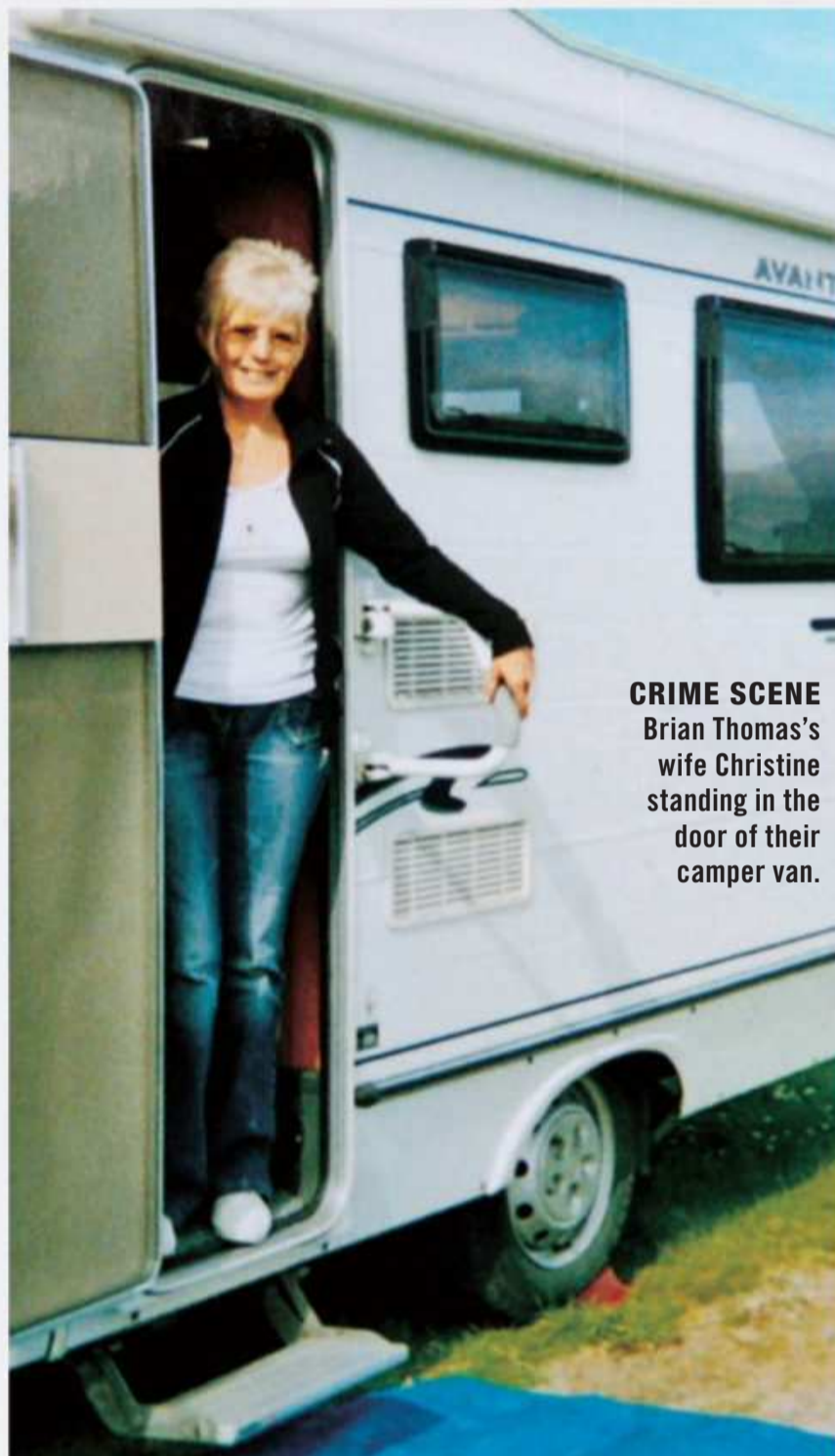
THE FACTS OF THE MATTER ARE CLEAR: A WOMAN LIES STRANGLED IN HER BED. THE ONLY POSSIBLE KILLER IS HER HUSBAND, BUT HE SAYS HE CAN'T REMEMBER A THING.

**ALTHOUGH HE IS CHARGED WITH THE CRIME,
THE TRIAL ENDS IN A VERDICT OF NOT GUILTY.**



WHEN BRIAN THOMAS WAKES UP ONE MORNING IN HIS CAMPER VAN, HE FINDS THE CORPSE OF HIS WIFE, CHRISTINE, LYING NEXT TO HIM. WHEN THOMAS REALIZES WHAT HE HAS DONE, HE REACHES FOR HIS CELL PHONE AND

CALLS THE EMERGENCY NUMBER. “What have I done? I’ve been trying to wake her. I think I’ve killed my wife. Can you send someone?” A short time later police arrive at the scene in Aberporth, Wales. Upon seeing the dead woman’s body, police arrest her distraught husband. The case appears clear enough to everyone—just not to Brian Thomas. He says he was asleep when his wife died and can’t remember anything about the incident. He goes on to explain that for the past 50 years, since he was a child, he has suffered from night terrors (*pavor nocturnus*) without ever being treated. Over the months that follow, several medical consultants called in to test Thomas’s sleep patterns discover the devoted husband and father



CRIME SCENE
Brian Thomas's wife Christine standing in the doorway of their camper van.

of two is prone to sleepwalking and other sleep disorders. They decide this must have been the case on that fateful night in July 2008. Thomas was having a nightmare about a “boy racer” who had broken into their camper to attack his wife. He had seen a group of racers just the day before. Thomas began to fight the attacker in his dream, however the fight was not confined to the nightmare, and Thomas strangled his wife. Does that make him a murderer? When he is put on trial one year later, Thomas pleads not guilty: It is his illness, not himself, that’s responsible for his wife’s death. Judge Nigel Davis discharges the defendant with words that reflect much of the British opinion on the case: “You are a decent man and a devoted husband. I strongly suspect that you may well be feeling a sense of guilt. In the eyes of the law you bear no responsibility.”

THE KILLER WHOM DNA EVIDENCE COULD NOT PUT BEHIND BARS.

A YOUNG WOMAN IS MURDERED. THE KILLER HAS LEFT TRACES OF DNA BEHIND. AND THERE IS A CLEAR SUSPECT. BUT AT THE TIME OF THE MURDER, THE SCIENCE OF DNA IS NOT YET SUFFICIENTLY ADVANCED TO ESTABLISH THE KILLER'S GUILT.

THE PROOF COMES YEARS LATER. BUT STILL THE KILLER REMAINS AT LARGE...

ISMET H., GERMANY/1981



QUEST FOR JUSTICE

Almost four decades after the fact, Hans von Möhlmann is still fighting to get justice. He is certain he knows who killed his daughter Frederike—but the German judicial system refuses to try the alleged killer a second time.

In the autumn of 1981, 17-year-old Frederike von Möhlmann misses the last bus home after her choir rehearsal and decides to hitchhike home instead—she climbs unsuspectingly into her killer's car. When her body is discovered in the woods four days later, a suspect is soon named: 22-year-old Ismet H. Not only are his tire marks at the scene of the crime; the fibers found on Frederike's clothing are also a match for the fabric in Ismet's BMW 1602. Ismet has no alibi, and the statements he makes to police do not hold up. In 1982 a jury finds him guilty and the young man is sentenced to life in prison. But then there is a surprising turn of events when the German Supreme Court overturns the verdict for lack of more concrete evidence. Ismet H. is set

HANS VON MÖHLMANN HAS IDENTIFIED THE KILLER OF HIS DAUGHTER FREDERIKE. HE'S SURE HE KNOWS WHO RAPED HER ON THE NIGHT OF NOVEMBER 4, 1981, BEFORE STABBING HER 11 TIMES WITH A

KNIFE AND CUTTING HER THROAT. Nevertheless, the killer is still at large—and likely to remain so. But how can it be that a murder was committed so long ago and the perpetrator has never had to pay for the crime?

free and even receives compensation for the time he had to spend in jail. However Hans von Möhlmann is convinced that Ismet H. is guilty and refuses to give up. In 1988 Germany allows the admission of DNA evidence for the first time, and Möhlmann pushes for a test to be performed. Evidence from the crime scene has been preserved, and it includes traces of DNA, even though there was no way of testing them at the time the crime had occurred. Möhlmann finally scores his first success: 31 years after the cruel murder of his beloved daughter, the samples are tested. And the results are conclusive: Beyond any doubt, the DNA discovered on Frederike's clothing is that of Ismet H.

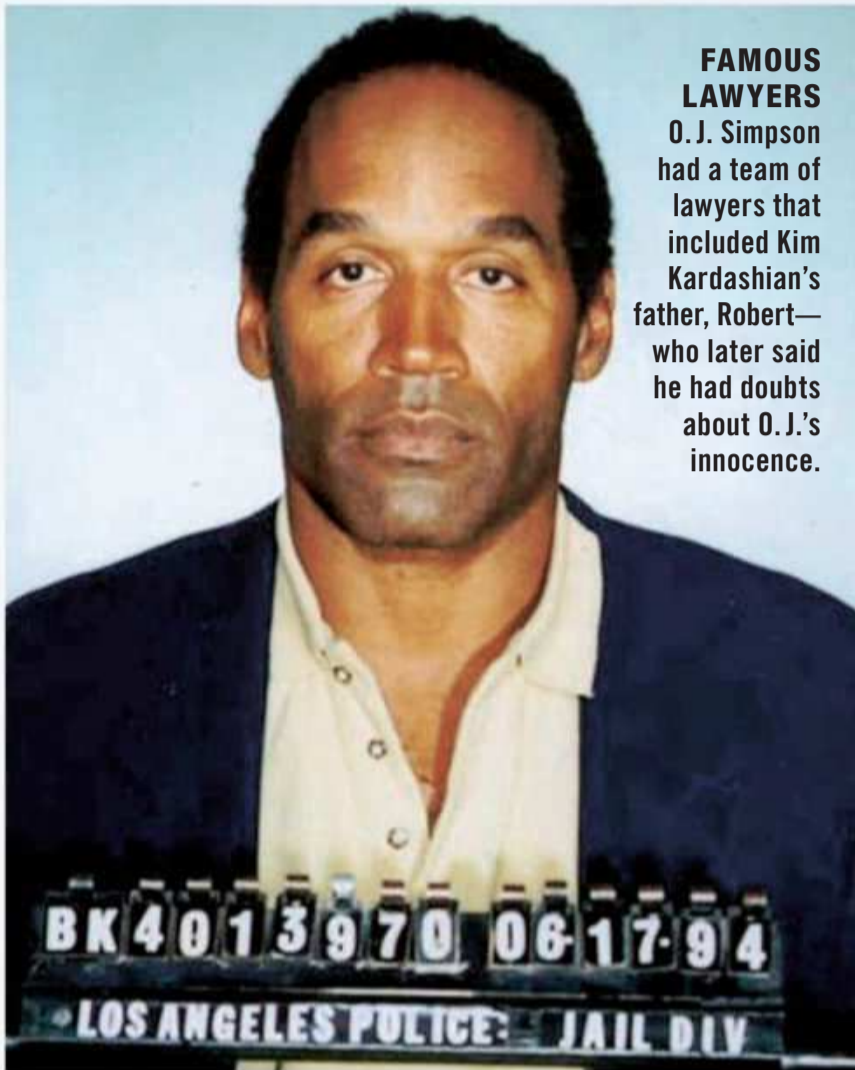
But that knowledge is the only satisfaction Möhlmann is able to obtain. Germany, like the United States, does not permit double jeopardy: A person cannot be tried twice for the same crime. So the matter is at an impasse. Unless Ismet H. chooses to make a confession—which he is highly unlikely to do.

THE EVIDENCE IS OVERWHELMING.

THE SUSPECT IS APPREHENDED AFTER A WILD CHASE, AND THE POLICE FIND TRACES OF THE TWO VICTIMS' BLOOD ON HIS CLOTHING. BUT THE CASE THAT BEGAN AS SUSPECTED MURDER SOON OPENS UP A DEBATE ON RACISM AND DIVIDES AN ENTIRE NATION.

IN THE END THE SUSPECT IS FOUND NOT GUILTY IN A CRIMINAL TRIAL, YET HE IS LATER FOUND LIABLE IN A CIVIL LAWSUIT.

O.J. SIMPSON, USA/1994



FAMOUS LAWYERS
O. J. Simpson had a team of lawyers that included Kim Kardashian's father, Robert—who later said he had doubts about O. J.'s innocence.

JUST AFTER MIDNIGHT ON JUNE, 13, 1994, A PASSERBY FINDS THE BODIES OF TWO VICTIMS IN LOS ANGELES. BOTH HAVE BEEN STABBED TO DEATH.

POLICE QUICKLY IDENTIFY THE VICTIMS: the waiter Ronald Goldman, and Nicole Brown—the ex-wife of the actor and former football great O. J. Simpson. He quickly becomes the prime suspect. The victims' blood is found in Simpson's car, inside and outside of his home, and on his clothing. He has no alibi. As police move to arrest him, Simpson flees in his white Ford Bronco. He has \$9,000 in cash on him along with his passport and a fake beard. After a 90-minute chase shown on live television to some 95 million viewers, Simpson surrenders. The murder case is tried before a jury. The prosecution seems to have all the evidence they need for a conviction. But Simpson's lawyers attempt to create a sense of doubt about the

evidence and make emotional arguments to win over the jury in favor of the accused. They claim the DNA evidence is inconclusive and that the blood samples have been mishandled. Then the defense attorneys pose a question that will split the nation along racial lines: Is O. J. Simpson perhaps not the perpetrator at all? Was he instead the victim of a racist police force? One of the detectives who testifies at the trial is said to have made racist comments about African Americans. Is it possible that he has falsely accused a black man of having murdered a white woman? The allegations trigger a nationwide debate on racism. The apparent strategy of Simpson's defense attorneys: to prejudice the predominantly black jury against the prosecution. After a trial lasting 252 days, the verdict is read out in the courtroom and to a TV audience of more than 150 million viewers: Simpson is declared not guilty. Although the principle of double jeopardy does not permit the prosecution to appeal, the case resurfaces in 1997—as a civil lawsuit. The outcome is once again dramatic: Simpson is found liable and ordered to pay the victims' families compensation of \$33.5 million for the "wrongful deaths." Consequently, Orenthal James Simpson has been both acquitted of and held accountable for the same crime.





CAN I PROGRAM MY GENES TO GIVE ME BIGGER MUSCLES?

This is the question that has fascinated a certain man with a background in genetics. Not only can he explain how human gene sequences can easily be edited to increase muscle size—he also insists that anybody can do it. And now he is marketing a genetic-hacking starter kit intended for home use...

C

hoose your color and the decision is made—and the story could end there. Many of us are familiar with the scene from the movie *The Matrix* in which the rebel leader Morpheus offers the protagonist, Neo, a choice between a blue pill and a red pill. If he takes the blue pill, he will wake up in his bed and believe whatever he likes, while the red pill will leave him in the wonderland of the Matrix. But unlike Morpheus, Josiah Zayner is for real. The American biohacker also offers people a choice: He says he can free them from the prison he thinks most of them don't realize exists. And the eccentric (some might say unhinged) genetic researcher is prepared to go to some lengths to do it—even if his experiments with gene editing might inadvertently result in a new version of the human species.

While working toward his Ph.D. in biophysics Zayner had read about a Spanish microbiologist by the name of Francisco Mojica, who in his 1989 dissertation at Spain's University of Alicante described repeating DNA sequences in the genome of a salt-loving unicellular organism. He called them Clustered Regularly Interspaced Short Palindromic Repeats: CRISPR. >

HOW CAN I MODIFY GENES?



PETRI DISHES

E. COLI BACTERIA

TEST TUBE

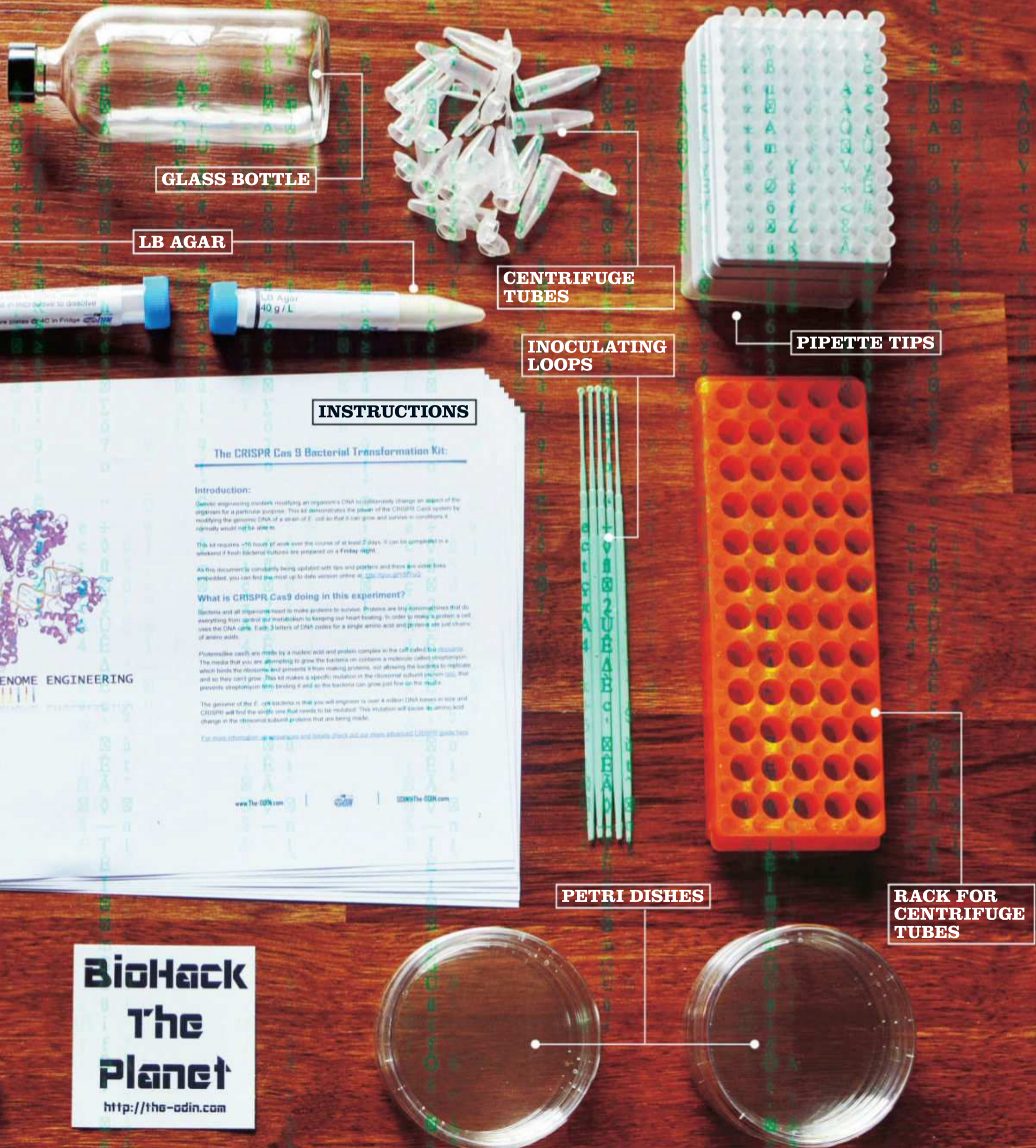
NITRILE GLOVES

CENTRIFUGE TUBES

MICROPIPETTE

X It doesn't take a high-tech laboratory to cut and edit genes with the CRISPR/Cas9 process. In fact, the relatively simple starter kit (pictured below) that Josiah Zayner sells in his online shop suffices to make basic gene modifications in a bacterial culture. The price: \$159. The kit includes petri dishes, plastic gloves, a micropipette, and LB agar to feed the nonpathogenic bacterial cultures. The other key component:

a set of instructions written by Zayner that enables the user to create a certain mutation (K43T) in a bacterial culture to make the microbes resistant to a specific antibiotic. But be cautious about having it shipped outside the U.S.: It's not illegal to have a kit sent to Germany, for example, but its use most certainly is. The reason: Germany has a (rather sensible) law prohibiting genetic engineering outside of a licensed facility.



GLASS BOTTLE

LB AGAR

CENTRIFUGE TUBES

PIPETTE TIPS

INOCULATING LOOPS

INSTRUCTIONS

PETRI DISHES

RACK FOR CENTRIFUGE TUBES

**BioHack
The
Planet**
<http://the-odin.com>

But it was not until 2003 that Mojica found a CRISPR gene sequence in a bacterium that was identical to that of a virus that attacks the same strain of bacteria. To his surprise, Mojica realized this bacterium was immune to the virus—thanks to the CRISPR sequence. And with that the scientist had made a sensational discovery: the “immune system” of bacteria.

GENETIC DETECTIVES

Shortly after Mojica’s finding became known, the next sensation came to light. Microbiologists Philippe Horvath and Rodolphe Barrangou realized the CRISPR sequences in the immune system of bacteria act like sketches of wanted criminals. The principle is simple: When a bacterium comes into contact with a virus, it recognizes the virus’s genetic code that would allow the virus to enter the bacterium and reproduce itself. The bacterium then produces restriction enzymes (akin to molecular “scissors”) that attack the virus’s DNA before it can damage that of the bacterium. If the bacterium is later attacked by the same virus, it recognizes the DNA signature of the attacker and creates tailor-made Cas9 gene scissors. These scissors will then cut the genome of the virus in the right place to disarm it.

In June and September of 2012, Emmanuelle Charpentier and Jennifer Doudna published renowned studies in which the biochemists described how the CRISPR/Cas9 process can be used in life-forms beyond bacteria. In order to cut the human genome at a specific site with Cas9, for example, the modified genetic sequence would be injected into a prepared target cell. This cell will then implement the gene sequence into the CRISPR area of its own DNA—and so it is subsequently equipped to produce another Cas9 cutter if a gene sequence is spotted that fits the right description. If such a prepared cell comes into contact with normal cells, the following takes place: The Cas9 scissors slice the genome in the precise place they are

programmed to find. Since essentially any gene sequence can be created in a lab, Charpentier and Doudna say it is possible to cut and modify any sequence at any point.

When Josiah Zayner read about the work of Charpentier and Doudna, he immediately understood that the CRISPR technology would change everything that had previously been believed about the inevitability of human development as determined by a person’s genes. The reason: The process not only makes it possible to rewrite the genetic blueprint of the human body; in theory, anyone can use this process to modify genes in order to cure a disease, for instance. “For the first time in history, we are no longer slaves to our genomes,” says Zayner. “We have a choice.” And Zayner has a plan: “We are trying to get genetic engineering in the hands of consumers, to let them do basically whatever they want with it.” And he is working to implement his plan.


PHASE 2: SELF-EXPERIMENTATION

January 2016: Zayner has taken the leading role in a worldwide network of biohackers who are continuing to develop the CRISPR/Cas9 process outside of the traditional laboratory. And he has also found a way to bring this new form of genetic technology into the homes of ordinary laypeople: He heads up a company that sells a genetic-modification kit starting at around \$150—an easy-to-use DNA chemistry set that allows people to experiment on the genes of a certain bacterial strain in the comfort of their own kitchens. And to underscore how serious he is about “democratizing” genetic research, Zayner employs a radical method: self-experimentation. For this purpose, he has consumed large quantities of fecal bacteria from a “healthy” donor to completely reset the communities of bacteria residing in his intestines. It does not seem to concern him that he might quickly die if his immune system were to reject >



HOW DANGEROUS IS THE CRISPR STARTER KIT?

X In his online store, Josiah Zayner sells a CRISPR starter kit that lets laypeople undertake genetic modifications at home. But critics are sounding the alarm: Genetic researchers warn that the improper use of genetically manipulated cultures outside the lab could result in potentially dangerous microbes being released into our air or water. Storing bacterial cultures at home (e.g., in the fridge next to food) is also hazardous. Then there is the danger of misuse: Since such experiments can also be performed on lethal bacteria, terrorists could put the technology to nefarious use.



“WE ARE TRYING TO GET GENETIC ENGINEERING IN THE HANDS OF CONSUMERS, SO THEY CAN DO WHATEVER THEY WANT.”

JOSIAH ZAYNER,
BIOPHYSICIST



CRISPR/CAS9

Even before the discovery of the CRISPR/Cas9 process, it was possible to use other means to induce breaks in gene sequences (i.e., causing genetic changes through the use of radiation or chemicals)—and thereby deactivate certain genetic functions. The problem: Creating these mutations is a very

inexact science because the type of genetic change is unpredictable. Cas9 scissors, on the other hand, are very exact. The influence on the genome of plants, for example, is said to be so precise that some believe modified plants need not be treated any different than those plants that have not been altered at all.

WHAT CAN THE CRISPR/CAS9 PROCESS BE USED TO DO?



CREATE BIOLOGICAL WEAPONS

In 2016 Canadian researchers managed to resurrect the horsepox virus, which had been wiped out in 1980 and has huge potential for use as a biological weapon. Scientists are warning of the possibility of a new form of bioterrorism as well—for example, if someone were to take a readily available CRISPR starter kit to make the tuberculosis bacillus immune to all currently available treatments.



DEFEAT HUNGER

Some large food and pharmaceutical corporations are already fighting over the rights to plants created using the CRISPR process, which has the potential to yield crops with increased nutritional content. In general, the new technology is being used to increase the profitability of crops—for example, by making them immune to pests so they can be treated with less pesticide and herbicide.



CURE DISEASE

With the CRISPR process, it has become possible to create therapies for cancer that are tailored to the specific form of cancer from which a patient is suffering. Some experts believe such treatments may already be available on the black market today. Another possibility in this arena is to genetically modify organs from animals (such as pigs) in such a way that they can be transplanted into the human body.

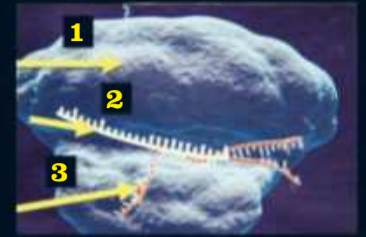


UPGRADE THE HUMAN BODY

In many cases the CRISPR process could be used instead of cosmetic surgery. Rather than using a scalpel, doctors may be able to change a body's appearance with genetic modification. In the future, people may be in a position to determine their own appearance, strength, or stamina. Thus the genetic blueprint each of us is born with may no longer govern the development of our lives but instead only represent one of many possibilities.

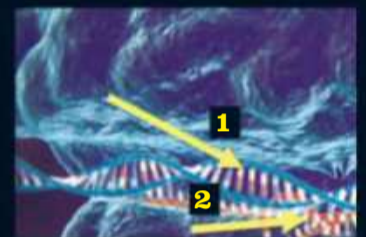
STEP 1: CREATING GENETIC SCISSORS

1. Fabricate a protein guided by RNA that can cut DNA. 2. The RNA sequence matches the segment of DNA that the researcher wants to modify. 3. The guide RNA is paired with a protein called Cas9 that acts like a genetic scalpel.



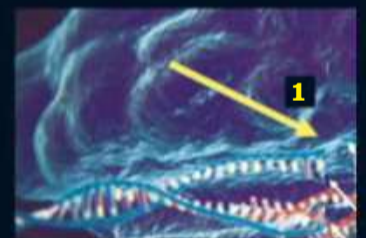
STEP 2: TARGETING THE GENOME WITH THE CAS9 PROTEIN

The Cas9 gene-editing complex targets the gene to be changed. With absolute precision, the guide RNA aims the protein at the exact place where the gene is to be cut. 1. Cas9 gene scissors. 2. Target gene within the double helix.



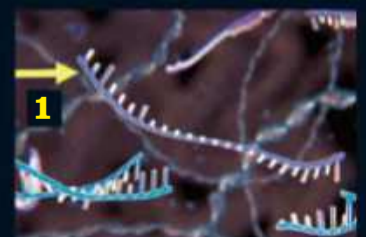
STEP 3: THE CAS9 PROTEIN CUTS THE GENOME AT THE PREDETERMINED SITE

1. With the help of the guiding RNA, the Cas9 protein scissors cut into the DNA sequence at the specified site in the target genome. The alteration is irreversible. The previous gene sequence has been disabled and loses its function.



STEP 4: IMPLEMENTATION OF THE NEW GENE SEQUENCE

The desired DNA sequence is then inserted in place of the previous segment in the gap made by the Cas9 protein and ligase enzymes repair each cleaved end. 1. New DNA: The function of the new DNA has been crafted in advance for a desired characteristic.



the foreign material, which, after all, could include lethal strains of *E coli*. Zayner has survived his experiments thus far, but for many physicians and scientists, he has crossed a red line.

Despite the great risks involved, in early 2017 Zayner became a guinea pig once more. In order to genetically reprogram the makeup of his muscle tissue, he injected himself with a Cas9 solution that is supposed to destroy the protein myostatin within his cells. Myostatin is a protein that regulates muscle growth in the body. Inspired by a Chinese experiment conducted on dogs, Zayner sought to eliminate this regulator in his body. The Chinese researchers had succeeded in using the process to produce two extremely muscular beagles. Zayner also hopes for bigger muscles—along with proof his genetic tuning is “safe” (from his point of view) and that a genetically tailored body is no farther away than an injection of modified proteins. Only the future will reveal whether he will indeed have more muscles when the experiment is over. And for him, that is of secondary importance anyway—what he really cares about is having a choice. “Will I someday be big and strong? Would I rather have light or dark skin?” He poses these questions before insisting: “We are reaching the point when all people will soon have a choice about their genetic makeup.” Zayner seems to take the prospect of

changing the human genome about as seriously as changing an outfit. But it’s not quite that safe or simple.

LIBERATING THE GENES

“I take a highly critical view of these developments,” says Günter Stock, former president of the Union of the German Academies of Sciences and Humanities. “These experiments may well not meet safety standards—and they’re extremely difficult to monitor.” And that’s a very big problem, agrees immunologist Rayk Behrendt. He has tested Zayner’s DIY kit in his own lab. “The problem is, the CRISPR/Cas9 process can be used on bacteria that are anything but harmless,” he says. “The technique can also be used to modify extremely deadly bacteria, like those that cause tuberculosis, typhus, or cholera.” There is also the danger that bacterial strains that have been genetically modified at home could unintentionally be released into the environment.

However in Zayner’s opinion, such reservations are simply an attempt on the part of the scientific elite to keep the power of genetics in their own labs. He’s not overly concerned. “There are no real boundaries here, so no one can stop it,” he says. And he may be right. For he is not the only one to have recognized the incredible potential of genetic modification. So if Zayner does not make use of the

godlike possibilities of the CRISPR/Cas9 process to change the world, others are certainly prepared to try. At China’s Guangzhou Institutes of Biomedicine and Health, Lai Liangxue is already making strides. “So far I’ve used CRISPR on dogs, pigs, rabbits, and mice,” says Lai. “We know that the idea of playing God makes a lot of people nervous. But as soon as we have successfully completed our animal experiments, we will test our knowledge on humans.”

Zayner for one sees good reasons to do so. “I have absolutely no doubt that there are already places where individually tailored cancer therapies are being offered—and it will not be long before we see the first genetic cancer clinics,” he says. But there is another side to this coin. The list of “Frankenstein projects”—as critics of the uncontrolled use of the CRISPR technology outside of laboratories like to call it—is already long. In the summer of 2017, Israeli researchers claimed genetic tuning could increase average human life expectancy by at least 10 years. Other studies suggest that science can turn back the clock on the chronological age determined by our genetic makeup. And Canadian researchers caused quite a stir in the scientific community in 2016 when they reported that they used CRISPR technology to resurrect the horsepox virus, long believed to be extinct in nature. Given that accomplishment, it’s not hard to see why researchers worry about a completely new type of bioterrorism that could begin with a DIY starter kit from Zayner’s store.

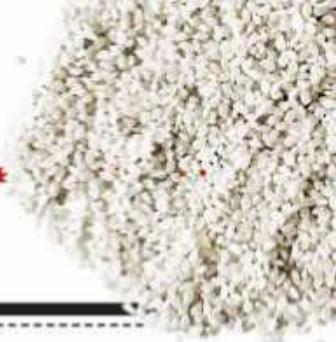
Regardless of what you might think of Zayner, Pandora’s box is now open, and the moment could soon arrive when each of us must decide whether we want to swallow the blue pill—and continue down our present path, or take the red pill—and break out of the matrix of our genes. In the movie scene mentioned at the beginning of the article, Morpheus warns Neo: “This is your last chance. After this, there is no turning back.”

“WE HAVE ALREADY TESTED CRISPR ON DOGS.”

LAI LIANGXUE,
MOLECULAR BIOLOGIST

DOES NATURAL MUSCLE TUNING EXIST? The images at right show two dogs of the same breed (whippets). The dog on the left suffers from a genetic mutation in its “myostatin gene” that has led to unchecked muscle growth. Chinese researchers have used the CRISPR process to insert this mutation into the genome of dogs. Similarly, Josiah Zayner has tried to modify his own myostatin gene in an experiment on himself (ultimate result unknown).





Why do modern humans bear **the DNA of female Neanderthals**?



Scientists have long known that 2.5 to 4% of the genome of a modern person contains sequences that are of Neanderthal origin. More recently it has been discovered that the genes of the Y chromosome of our fathers are not identical to those of a Neanderthal male. Thus all of our Neanderthal genes have come from a primeval Neanderthal mother—no men had been involved in the genetic connection between Neanderthals and modern-day people. Studies have confirmed that the genomes of the two primates were compatible only in female offspring.

Do grains of **rice** have **more genes than people**?



Is humankind the crown of creation? Not so fast. Studies show that rice has between 42,000 and 63,000 genes, which are smaller than ours but far more numerous. (We have 30,000 to 40,000.) More than most other plants, rice has been the focus of genetic research for many years. The reason: As a staple crop, rice is essential to the survival of about half of the worldwide human population. Having completely mapped the rice genome, scientists now seek to optimize the plant genetically to increase crop yields and the resistance to pests.

Are all **human beings** descended from **one primeval mother**?

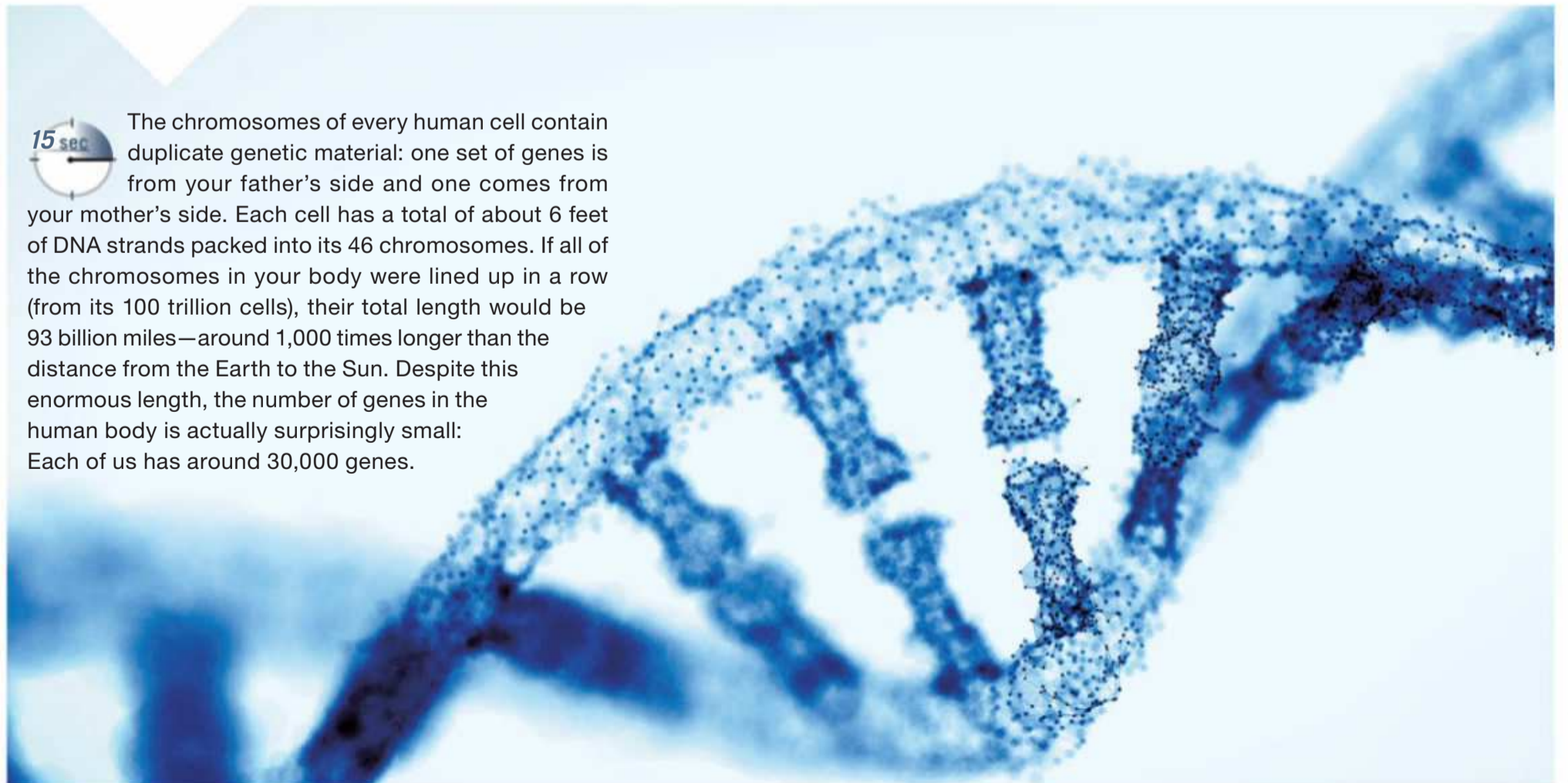


Normally our DNA is composed of equal parts female and male DNA from our mothers and fathers. One exception: The mitochondrial DNA in our cells comes entirely from the female side. New studies have shown that the mitochondrial DNA of all people alive today came from a single female ancestor (whom researchers call “Eve”). That means: There was once a primeval mother who is responsible for giving rise to every human being on this planet. Thus all of us are related to her, and to one another. “Mitochondrial Eve” is said to have lived between 150,000 and 200,000 years ago.

How long are all the **DNA strands** in our cells?



The chromosomes of every human cell contain duplicate genetic material: one set of genes is from your father’s side and one comes from your mother’s side. Each cell has a total of about 6 feet of DNA strands packed into its 46 chromosomes. If all of the chromosomes in your body were lined up in a row (from its 100 trillion cells), their total length would be 93 billion miles—around 1,000 times longer than the distance from the Earth to the Sun. Despite this enormous length, the number of genes in the human body is actually surprisingly small: Each of us has around 30,000 genes.





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What really counts in the end...

24 HOURS...

...per day the fueling stations of the Serengeti are open for business. Nonetheless, most land animals only approach the watering holes at night and during the cooler early morning hours. Birds, on the other hand, are mostly found during the day. But the exact times and species that visit these vital pit stops vary from one watering hole to another. For example, there are some spots where leopards can be found every morning, while other holes are usually visited at midnight by black rhinos. For that reason, the character of each hole is as different as a human fingerprint. Each one is a masterpiece of nature.

UP TO 40 MILES...

...is the distance between the watering holes in the Serengeti. There is hardly any other region in the world where fresh water is so scarce. Thus in the search for water, the slightest deviation from the proper course can end in death. That is especially true for elephants, which can drink up to 50 gallons per day. These gray giants do not use their hearing or sense of smell to orient themselves; they use their memory. Researchers discovered that elephants maintain a complete water map of the Serengeti in their heads and can locate any source with amazing accuracy. Even if a watering hole has dried up, they know it is there and will dig until they find it.

12 INCHES...

...can be a matter of life or death at a watering hole: When the water level has dropped toward the end of a hot day due to evaporation, animals can be in mortal danger, especially along the edges. Younger animals are sometimes unable to get back to dry land—and drown in one of the driest regions in the world. Herds of elephants can sometimes be seen searching for more level approaches to the water. If such access routes are already occupied by other animals, the elephants drive them away with a loud roar. In fact, an unwritten law of the Serengeti is that elephants rank highest in the watering hole hierarchy, followed by rhinos, lions, hyenas, and leopards.

20 MINUTES...

...is the maximum time zebras, gnus, and gazelles will stay at a watering hole. They instinctively know: While they are drinking, they become easy prey for lions. To keep from being surprised by predators, many herd animals take shifts at the watering hole. While half of the zebras are drinking, the other half of the herd is watching for potential danger. They reverse roles every 20 minutes. The only animals that need no alarm system are full-grown bull elephants. With an average weight of 5 tons, they can even sleep at a watering hole without fearing that a predator might dare to attack them.

THE WONDERS OF THE SAVANNA

In Africa watering holes are oases of life—and for the millions of inhabitants of the Serengeti Plain, they are absolutely indispensable. iD presents a unique view of one of the most fascinating, vibrant, and at the same time dangerous kinds of locales in the natural world...



2,200 PHOTOS IN A SINGLE PICTURE

Photographer Stephen Wilkes spent 26 hours at a watering hole in the Serengeti to obtain this image—taking 2,200 photos with his camera. Then he put the photos together to assemble this breathtaking picture.