contents

Jantar Mantar ● Children's Science Observatory ● July - August 2015 ● Year - 15 No - 4 Issue - 88

website : http://hsb.iitm.ac.in/~jm

Chemistry

Chemistry: Green and clean

Chemists are finding ways to save energy, cut waste and boost safety

Jennifer Weeks

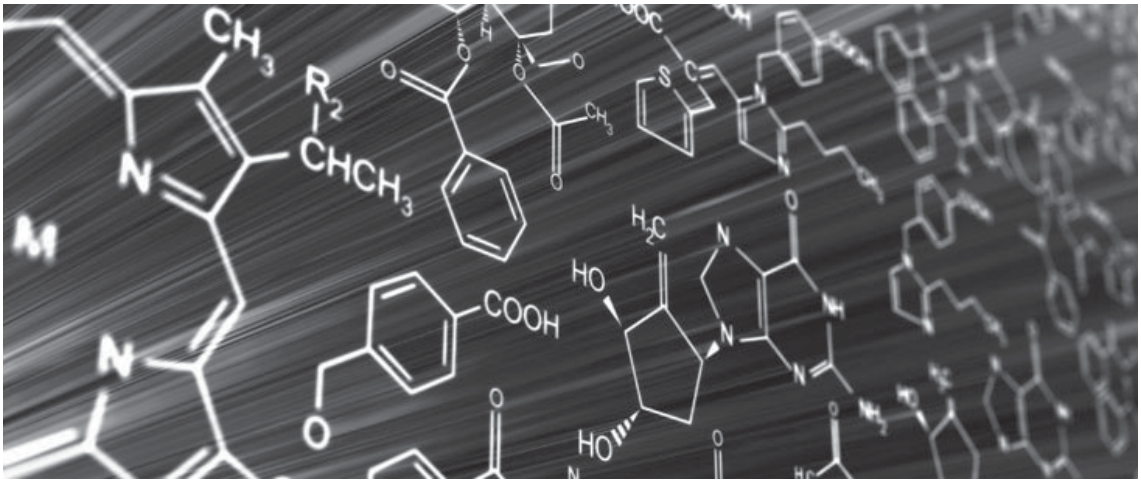
https://student.societyforscience.org/article/chemistry-green-and-clean

This high tech skateboard is made from rugged polycarbonate plastic. Yet its building blocks — molecules of bisphenol A — can pose problems once they get into water, foods and more. Fortunately, green chemists are at work on solutions for that and a host of other problems. Their goal: to make consumer products safer and kinder to the environment.

Vivian Nguyen/ Stanford University

People have used chemistry to improve their lives for tens of thousands of years. An early example: fire. Our prehistoric ancestors tamed flames to transform plants and animal products — that is, to cook them into food. Over time, their descendants learned about the chemical properties of rocks and other minerals, and of chemicals derived from plants and animals. They mixed materials together. Sometimes, they also applied heat, pressure or both. Through trial and error, they learned how to make new and useful materials. Paints and soap are two notable early examples.

Today, chemistry plays a role in almost



every product imaginable. Manufacturing companies have registered more than 83,000 chemicals with the U.S. government. Many of these find use in everything from foods and plastics to trucks and electronics.

Making, using and disposing of these chemicals, however, can pose risks to people or wildlife. Some chemicals, after all, are made from toxic raw materials, such as mercury or lead. Making other chemicals requires huge amounts of energy, clean water or other natural resources. And as we use them or discard them as trash, many chemicals can pollute the air, water or soil.

This high tech skateboard is made from rugged polycarbonate plastic. Yet its building blocks — molecules of bisphenol A — can pose problems once they get into water, foods and more. Fortunately, green chemists are at work on solutions for that and a host of other problems. Their goal: to make consumer products safer and kinder to the environment.

EPA

In the early 1990s, chemist Paul Anastas called for a change. While working for the U.S. Environmental Protection Agency, or EPA, he recognized that chemists usually probe possible risks of chemicals long after they have developed them. Anastas urged his fellow chemists instead to design products that would be safer and cleaner from the start.

The color green is often associated with anything that is good for the environment. So Anastas called this new field "green chemistry." (It's also sometimes called sustainable chemistry.)

In 1998, Anastas and a fellow chemist, John Warner, published 12 principles of green chemistry. They recommended that chemists cut wastes, reduce the toxicity of the materials they use and produce goods using processes that are safer. They also called for designing new chemicals that will break down harmlessly in the environment.

Today, Terry Collins directs the Institute for Green Science at Carnegie Mellon University in Pittsburgh, Pa. Green chemists work in laboratories, just as other chemists do. However, green chemists share a different goal, Collins explains. "We are working to develop a field of chemistry that can replace polluting technologies, one product or process at a time."

Peel dirt right off of clothes

Green chemists often start by identifying chemical products or processes that are wasteful, polluting or toxic. Then they find ways to make them kinder to the environment. That might mean changing a process so that it uses less energy. Or it could mean swapping out harmful ingredients for alternatives. Some alternatives might be safer. Others might have the advantage of breaking down in the presence of water or sunlight.

A surfactant is a chemical that helps liquids mix that would not regularly do so. To accomplish that, one end of the surfactant is hydrophilic (attracted to water). The other end is hydrophobic (repels water).

SuperManu/Wikimedia Commons (CC BY-SA 3.0)

One family of chemicals targeted by green chemists are known as surfactants (Sur-FAK-tuntz). They help mix liquids that would not ordinarily do so. Examples include oil and water. Each surfactant molecule has

one end that is hydrophilic (HI-droh-FIL-ik). That means it is attracted to water. The other end is hydrophobic (HI-droh-FO-bik). It repels water.

Surfactants are important ingredients in laundry detergents. They help lift dirt, which usually contains oils, out of clothes. In the United States, nonylphenol ethoxylates (NON-ul-FEE-null Ee-THOX-uh-lates) are a common class of surfactants. Because of their long name, chemists usually just refer to them as NPEs.

After use, NPEs go down the drain. From there, they flow into wastewater-treatment plants. Few such plants can remove NPEs from wastewater. So when they release treated water into lakes and rivers, NPEs will remain part of the mix. Eventually, NPEs will break down to form another chemical called nonylphenol. This chemical is "extremely toxic" to fish and green plants, EPA notes.

Canada and the European Union have banned NPEs in detergents. The United States, however, still uses thousands of tons of these chemicals every year. Not surprisingly, researchers have been finding high levels of nonylphenol in waters across North America.

Fruity alternative

Ramaswamy Nagarajan is a plastics engineer at the University of Massachusetts in Lowell. He and his students are developing a substitute for NPEs. They started with a green source — apple and orange peels. Microbes in the Gulf of Mexico inspired their choices.

A NASA satellite spotted oil from the 2010 Deepwater Horizon spill off the coast of Louisiana more than a month after the disaster began. Bacteria broke down some of the oil. That inspired a plastics engineer to work on a surfactant that would do the same thing.

NASA

The 2010 Deepwater Horizon oil spill released almost 5 million barrels of crude oil in the Gulf. Afterward, bacteria in the water started breaking down the oil. Nagarajan learned that the microbes had made natural surfactants. These substances contained long chains of linked sugar molecules, called polysaccharides (PAH-lee-SAK-uh-RIDES). So the Lowell research team turned to a natural source of polysaccharides for their new green surfactants.

"We are using pectin," explains Nagarajan. Fruit peels and many other food wastes contain this edible polysaccharide. In fact, home canners put pectin in their jams and jellies to make them gel. Best of all, Nagarajan notes, "bacteria can break it down." Natural pectin degrades harmlessly. Eventually, it vanishes from the environment — unlike the persistent and harmful nonylphenol.

To turn pectin into a surfactant, the chemists add a group of atoms to each pectin molecule. The process takes 30 minutes in a special laboratory microwave oven. When it's done, each pectin molecule now has a hydrophilic, or water-loving, chemical group (a collection of bound atoms) at one of its ends. At the other end: an oil-loving chemical group.

Green chemists still face more work ahead before pectins become widely used surfactants. One problem: their size. As large molecules, pectins do not dissolve well in water. Nagarajan's team is now working to overcome that. Their surfactant also does

not yet remove very oily or greasy dirt as well as do commercial laundry detergents. "That's because it doesn't have many hydrophobic groups," explains Nagarajan. "But we have found a way to add them and are getting better results."

The group also plans to confirm that their pectin-based surfactants will eventually break down into harmless substances. And biologists at their university are testing whether it causes allergic reactions in people with sensitive skin. They don't think it will, but they want to be sure.

For now, Nagarajan and his fellow green chemists have filed an application to patent the pectin surfactant. Meanwhile, several companies have shown an interest in it. So has the EPA: The government agency has provided a grant to fund more of their work on this new family of green chemicals.

Scientists used florescent dye and the chemical compound bromide to track the flow of contaminants in river water. Some of these contaminants can masquerade as hormones and affect animals in the environment.

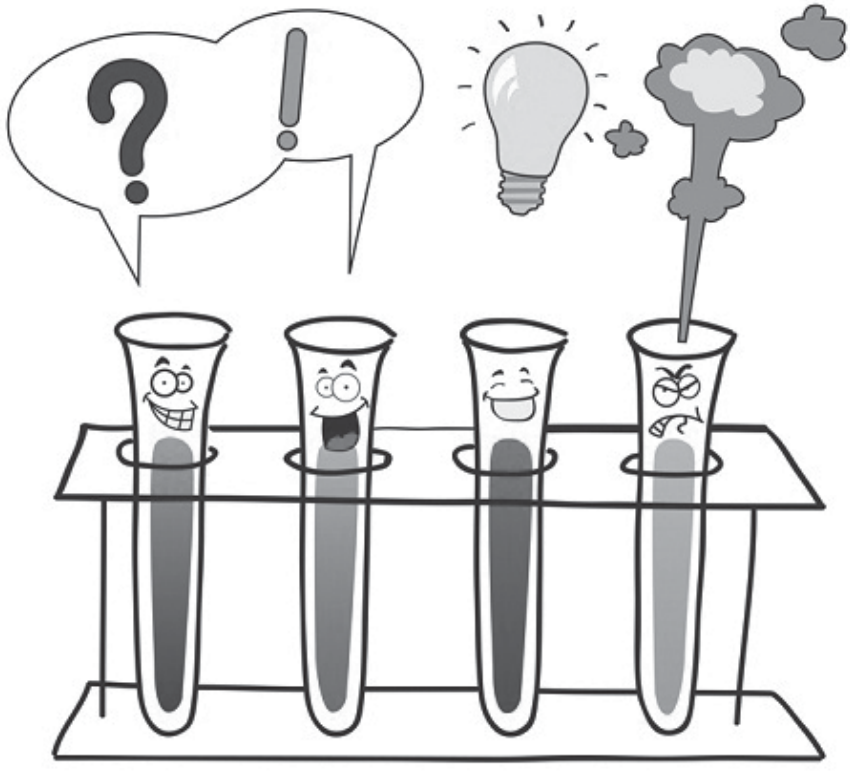
Jeffrey H. Writer, USGS

Time for a breakdown

Sometimes a chemical's job is to do harm. Hand sanitizers and soaps that contain antimicrobials — germ-killing chemicals — are two common examples. But their impacts can persist long after use. For instance, after washing down the drain, these chemicals may affect germs in lakes or streams. Some green chemists are now looking for ways to cut the risks posed when such chemicals get into the environment.

Take triclosan (TRY-kloh-san). Its ability to kill germs on hands, kitchen counters and sponges has made it a popular ingredient in a host of products. But data have begun to emerge showing that in the open environment, triclosan's germ-killing impacts may backfire. How? This chemical might help bacteria resist the killing effects of antibiotic drugs.

Triclosan also can act as an endocrine disruptor. That means it can sometimes mimic the action of hormones. Hormones are potent chemicals. The body produces



them to control important activities, such as growth, sleep and reproduction. When the body encounters chemicals that masquerade as hormones, it may inappropriately turn on or off important cellular activities. That can alter how the body develops or can foster disease.

Green chemists would like to eliminate endocrine disruptors. But that's unlikely to happen. Too many chemicals have this property. And a large number of them have important industrial uses. So the next-best solution would be to find ways to break them down in the environment.

Explainer: What are endocrine disruptors?

Collins, at Carnegie Mellon University, has worked for more than 30 years studying compounds that do just that. He calls these chemical TAMLs. That's short for tetra-amido macrocyclic ligands (TEH-tra A-MEE-doh MAK-roh-SIK-lik LIH-gands). As catalysts, these chemicals turn on or speed up chemical reactions. Combined with a reactive chemical called hydrogen peroxide, TAMLs can break down other chemicals very quickly. It takes only a tiny amount to spur many reactions, all without generating harmful pollution.

TAMLs break down triclosan and many other pollutants that pose risks to aquatic plants and animals, Collins' team has found.

"Endocrine disruptors are changing the makeup of living things. It's a really big problem," Collins says. For instance, by acting like hormones (or interfering with hormones), some of these pollutants can alter the development of animals. In some instances, male fish have been feminized. That means the endocrine disruptors led males to look or behave like females. "But we have an unbelievably effective technique for getting rid of [endocrine disruptors]." He says. He's referring to those TAMLs.

A school of adult zebrafish. The fish are used in laboratories to test the effects of different chemicals. One effect is the feminization of fish — a process that leads male fish to develop female characteristics.

Courtesy of Robert Tanguay

One important concern: TAMLs themselves might be endocrine disruptors. To find out, Collins worked with other green chemists in the United States and Canada to probe that. First, they reviewed lists of known hormone mimics. Then they used computers to predict whether TAMLs might behave in a similar way. For the TAMLs that did, the researchers tested whether those chemicals would bind to cells in the same way that true hormones attach. Next, they analyzed whether these TAMLs also altered the way those cells worked.

Lastly, they tested the effects of TAMLs on fish. For these animal tests, Collins teamed up with Robert Tanguay. He's a biochemist at Oregon State University in Corvallis. Tanguay works with zebrafish. The small tropical fish are good lab animals. They grow quickly. Their embryos also can develop outside of a mother fish.

The scientists exposed zebrafish embryos to the TAML catalysts being developed for use in water treatment. And even high levels of TAMLs did not alter the growth of the fish.

"We've also tested fish swimming around with a TAML catalyst and peroxide, plus a micro-pollutant that feminizes male

fish," says Collins. And still, he reports, "the fish appear to be unharmed." The last step in their testing process is to see whether TAMLs might have impacts in mammals.

If they prove nontoxic there, too, Collins expects his team's TAML catalysts will soon find broad use in breaking down toxic water pollutants.

A close-up of a zebrafish just 15 hours after fertilization. The early developing eye, brain and chevron-shaped muscle bundles are already visible. Green chemists have used zebrafish to test the safety of a new class of chemicals, called TAMLs, designed to treat wastewater.

Courtesy of Robert Tanguay

Bright whites, less waste

If you are reading this article indoors, a chemical called titanium dioxide probably surrounds you. This simple white compound reflects light well. So paint makers use it to whiten or brighten their products. It also shows up in other products, including pudding. (In foods, titanium dioxide appears as "E171" in a list of ingredients.) But getting enough titanium dioxide for all of those products isn't very green.

Titanium is one of the most abundant elements on Earth. It's a building block of many minerals. Companies mine those minerals, then blend the crushed ore with other chemicals. Finally, they heat the mix to more than 900° Celsius (1,652° Fahrenheit). This takes a lot of energy and creates waste.

In 2013, the EPA gave a Presidential Green Chemistry Challenge Award to the Dow Chemical Co. The purpose? To help the company cut the amount of titanium dioxide a paint needs.

The company's solution is a new chemical it calls Evoque (Ee-VOKE). Blending it into paint can cut by up to 20 percent how much titanium dioxide is needed.

"One green chemistry goal is to get every bit of value from materials," explains Mindy Keefe. She's a senior research scientist at Dow in Collegeville, Pa. That's why Evoque shows promise, she says. "Using less titanium dioxide saves energy and reduces waste."

This image shows how Evoque, a

polymer developed by green chemists at Dow Chemical, surrounds a particle of titanium dioxide (shown in white). The polymer (represented by the red spots) pushes apart the particles so they don't clump up.

Dow Chemical Co.

Evoque is a polymer. Polymers are materials made from long chains of a repeating groups of atoms. In paint, the polymer fixes a common problem with titanium dioxide. "Titanium dioxide particles in paint tend to clump together," explains Keefe. "Evoque forms a shell around them and pushes them apart." This makes the paint more reflective. It also helps the paint cover surfaces more evenly and completely.

Scientists at Dow worked for more than 10 years to develop the polymer. In green chemistry, such a long investment in time can be well worthwhile. After all, a new product can benefit the environment for much, much longer than that.

"The more serious the hazard is, the more important it is to find green solutions," concludes Collins at Carnegie Mellon.

Power Words

antibiotic A germ-killing substance prescribed as a medicine (or sometimes as a feed additive to promote the growth of livestock). It does not work against viruses.

antimicrobial A substance used to kill or inhibit the growth of microbes. Manufacturers have added some, such as triclosan and triclocarban, to sponges, soaps and other household products.

bisphenol A A building block of polycarbonate plastics and many commercially important resins. This chemical gained widespread public attention when research showed it could mimic the activity of estrogen, a female sex hormone.

catalyst A substance that triggers or speeds up a chemical reaction without itself being affected.

chemistry The field of science that deals with the composition, structure and properties of substances and how they interact with one another. Chemists use this knowledge to study unfamiliar substances, to reproduce large quantities of useful substances or to design and create new and useful substances.

crude oil Petroleum in the form that it comes out of the ground.

embryo The early stages of a developing vertebrate, or animal with a backbone, consisting only one or a or a few cells. As an adjective, the term would be embryonic.

endocrine disruptor A substance that mimics the action (sometimes well, sometimes poorly) of one of the body's natural hormones. By doing this, the fake hormone can inappropriately turn on, speed up or shut down important cellular processes.

engineer A person who uses science to solve problems. As a verb, to engineer means to design a device, material or process that will solve some problem or unmet need.

feminize (in biology) For a male animal to take on physical, behavioral or physiological traits typical of females. It usually results from exposure to an

abnormal amount of female sex hormones — or pollutants that mimic these hormones. Feminizing It is sometimes used as a synonym for demasculinizing. In fact, they can be different. A demasculinized male may appear more feminine too, but largely because it had too little exposure to male hormones, not an excess of female hormones.

green chemistry A rapidly growing field of chemistry that seeks to develop products and processes that will pose little or no harm to living things or the environment.

hormone A chemical produced in a gland and then carried in the bloodstream to another part of the body. Hormones control many important body activities, such as growth. Hormones act by triggering or regulating chemical reactions in the body.

hydrogen peroxide A molecule made of two hydrogen and two oxygen atoms. Highly reactive, it can kill many tiny organisms, including germs. Its scientific symbol is H_2O_2.

hydrophilic Strongly attracted to (or readily dissolving in) water.

hydrophobic Repelling (or not absorbing) water.

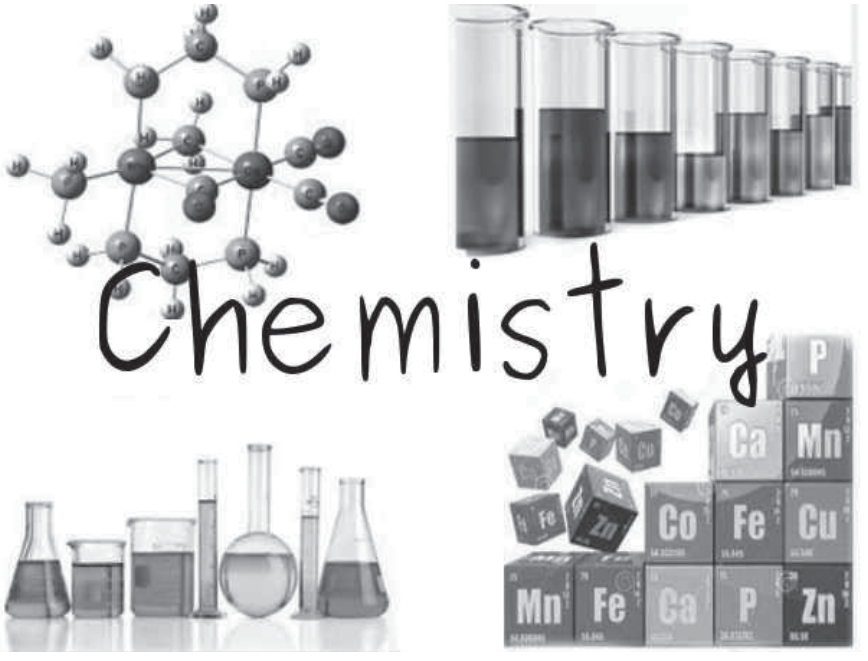
mineral The crystal-forming substances, such as quartz, apatite, or various carbonates, that make up rock. Most rocks contain several different minerals mish-mashed together. A mineral usually is solid and stable at room temperatures and has a specific formula, or recipe (with atoms occurring in certain proportions) and a specific crystalline structure (meaning that its atoms are organized in certain regular three-dimensional patterns).

molecule An electrically neutral group of atoms that represents the smallest possible amount of a chemical compound. Molecules can be made of single types of atoms or of different types. For example, the oxygen in the air is made of two oxygen atoms (O_2), but water is made of two hydrogen atoms and one oxygen atom (H_2O).

nonylphenol The name for a family of pollutants that can survive in the aquatic environment persistent for a long time. These chemicals are used primarily to make NPE surfactants and to strengthen certain plastics. Studies have shown these chemicals can mimic the action of estrogen, a female sex hormone. Animals can accumulate these pollutants from the environment. Nonylphenols can be extremely toxic to aquatic organisms.

nonylphenol exothylates (NPEs) A family of chemicals that are widely used in industry as surfactants and wetting agents. When they break down, NPEs produce nonylphenols, a family of chemical compounds that can be toxic to plants and aquatic animals.

patent A legal document that gives inventors control over how their inventions — including devices, machines, materials,



processes and substances — are made, used and sold for a set period of time. Currently, this is 20 years from the date you first file for the patent. The U.S. government only grants patents to inventions shown to be unique.

pectin A water-soluble substance that binds adjacent cell walls in plant tissue. Pectins also serve as a thickener in making jams and jellies.

peroxide A group of chemicals that contain a "bivalent" pair of oxygen atoms. Each oxygen atom has an unpaired electron orbiting it that is available to form bonds (attachments) with other atoms. Peroxides are oxidizing agents, meaning that they can react vigorously at room temperatures. Some are used as bleaches.

plastic Any of a series of materials that are easily deformable; or synthetic materials that have been made from polymers (long strings of some building-block molecule) that tend to be lightweight, inexpensive and resistant to degradation.

pollutant A substance that taints something — such as the air, water, our bodies or products. Some pollutants are chemicals, such as pesticides. Others may be radiation, including excess heat or light. Even weeds and other invasive species can be considered a type of biological pollution.

polymer Substances whose molecules are made of long chains of repeating groups of atoms. Manufactured polymers include nylon, polyvinyl chloride (better known as PVC) and many types of plastics. Natural polymers include rubber, silk and cellulose (found in plants and used to make paper, for example).

polysaccharide A type of carbohydrate made from long chains of simple sugars. Examples of polysaccharides include plant starches and cellulose (a structural material in trees).

sewage Wastes — primarily urine and feces — that are mixed with water and flushed away from homes through a system of pipes for disposal in the environment (sometimes after being treated in a big water-treatment plant).

surfactant A chemical compound that decreases the attraction between water molecules and makes it easier for water to spread on surfaces and to mix with other substances (such as oil).

TAMLs (tetra-amido macrocyclic ligands).

A family of compounds developed by chemists at Carnegie Mellon University. By working as catalysts, these chemicals turn on or speed up chemical reactions. Combined with hydrogen peroxide, TAMLs can rapidly break down other chemicals.

titanium dioxide A white, unreactive, solid material that occurs naturally as a mineral and is used extensively as a white pigment.

toxic Poisonous or able to harm or kill cells, tissues or whole organisms. The measure of risk posed by such a poison is its toxicity.

triclocarban A germ-killing chemical added to some common products such as hand soaps and sponges.

triclosan A germ-killing chemical added to some common products such as hand soaps and sponges.

waste Any materials that are left over from biological or other systems that have no value, so they can be disposed of as trash or recycled for some new use.

wastewater Any water that has been used for some purpose (such as cleaning) and no longer is clean or safe enough for use without some type of treatment. Examples include the water that goes down the kitchen sink or bathtub or water that has been used in manufacturing some product, such as a dyed fabric.

zebrafish A small tropical freshwater fish belonging to the minnow family. Zebrafish are used frequently in scientific research because they grow quickly and their genetic makeup is well understood.

2,000-Year-Old Water Supply System Uncovered in Jerusalem

Denise Chow

Part of an ancient aqueduct built more than 2,000 years ago to transport water into the city of Jerusalem was uncovered during a recent construction project, according to the Israel Antiquities Authority.

A section of the so-called Lower Aqueduct was discovered in the modern-day neighborhood of Umm Tuba, in East Jerusalem, during efforts to construct a new sewer line. The Lower Aqueduct was originally built more than 2,000 years ago by kings in the Hasmonean dynasty, who ruled Judea and its surrounding regions from about 140 B.C. to 37 B.C., and preceded King Herod the Great.

The sprawling, 13-mile-long (21 kilometers) aqueduct carried water to the capital, and "operated intermittently until about 100 years ago," Ya'akov Billig, director of the aqueduct excavation with the Israel Antiquities Authority (IAA), said in a statement. [The Holy Land: 7 Amazing Archaeological Finds]

The Lower Aqueduct fed from the En Eitam spring, which is located near three ancient reservoirs known as Solomon's Pools that are about 3 miles (5 km) southwest of Bethlehem. As water passed through the channel, it flowed down a gentle slope to Jerusalem, passing through the modern-day neighborhoods of Umm Tuba, Sur Bahar, East Talpiot and Abu Tor, according to the IAA.

"At first, the water was conveyed inside an open channel, and about 500 years ago, during the Ottoman period, a terra cotta pipe was installed inside the channel in order to better protect the water," Billig said.

For nearly 2,000 years, the Lower Aqueduct remained one of Jerusalem's principal sources of water, IAA officials said, which is why city rulers kept the structure so well preserved. About 100 years ago, the channel was replaced by an electrically operated water-distribution system.

The Umm Tuba section of the aqueduct was uncovered by workers at Gihon Company Ltd., who are constructing the new sewer line. Archaeologists at the IAA conducted an excavation of the site following its discovery, but the remains have since been covered up again to preserve the structure and prevent any damage, agency officials said.

Other sections of the extensive aqueduct have been uncovered in the past, including in the Armon Ha-Natziv tunnels in the City of David, on the Sherover promenade in southern Jerusalem and around the Sultan's Pool along the west side of Mount Zion in Jerusalem, IAA officials said.

World's Oldest Stone Tools Predate Humans

Charles Q. Choi

The oldest handmade stone tools discovered yet predate any known humans and may have been wielded by an as-yet-unknown species, researchers say.

The 3.3-million-year-old stone artifacts are the first direct evidence that early human ancestors may have possessed the mental abilities needed to figure out how to make razor-sharp stone tools. The discovery also rewrites the book on the kind of environmental and evolutionary pressures that drove the emergence of toolmaking.

Chimpanzees and monkeys are known to use stones as tools, picking up rocks to hammer open nuts and solve other problems. However, until now, only members of the human lineage — the genus Homo, which includes the modern human species Homo sapiens and extinct humans such as Homo erectus — were thought capable of making stone tools. [See Photos of the Oldest Stone Tools]

Ancient stone artifacts from East Africa were first uncovered at Olduvai Gorge in Tanzania in the mid-20th century. Those stone tools were later associated with fossils of the ancient human species Homo habilis, discovered in the 1960s.

"The traditional view for decades was that the earliest stone tools were made by

the first members of Homo," study lead author Sonia Harmand, an archaeologist at Stony Brook University in New York, told Live Science. "The idea was that our lineage alone took the cognitive leap of hitting stones together to strike off sharp flakes and that this was the foundation of our evolutionary success."

However, there were hints of primitive tool use before Homo habilis. In 2009, researchers at Dikika, Ethiopia, dug up animal bones nearly 3.4 million years old that had slashes and other cut marks, evidence that someone used stones to trim flesh from bone and perhaps crush bones to get at the marrow inside. This is the earliest evidence of meat and marrow consumption by hominins — all the species leading to and including the human lineage after the split from the ancestors of chimpanzees. No tools were found at that site, so it was unclear whether the marks were made with handmade tools or just naturally sharp rocks.

Now, scientists report stone artifacts that date back long before any known human fossils. Until now, the earliest known tools were about 2.8 million years old, the researchers said. The artifacts are by far the oldest handmade stone tools yet discovered — the previous record-holders, known as Oldowan stone tools, were about 2.6 million years old.

"We were not surprised to find stone tools older than 2.6 million years, because paleoanthropologists have been saying for the last decade that they should be out there somewhere," Harmand said. "But we were surprised that the tools we found are so much older than the Oldowan, at 3.3 million years old."

It remains unknown what species made these stone tools. They could have been created by an as-yet-unknown extinct human species, or by Australopithecus, which is currently the leading contender for the ancestor of the human lineage, or by Kenyanthropus, a 3.3-million-year-old skull of which was discovered in 1999 about a half-mile (1 kilometer) from the newfound tools. It remains uncertain exactly how Kenyanthropus relates to either Homo or Australopithecus. [Gallery: See Images of Our Closest Human Ancestor]

"Sometimes the best discoveries are the ones that raise more questions than provide answers," study co-author Jason Lewis, a paleoanthropologist at Stony Brook University and Rutgers University in New Jersey, told Live Science. "In any of these cases the story is equally new and interesting. We are comfortable not having all of the answers now."

The stone tools were discovered in the desert badlands of northwestern Kenya, where the arid, rocky terrain resembles a New Mexican landscape.

The artifacts were found next to Lake Turkana in 2011 almost by accident. "We were driving in the dry riverbed and took the left branch instead of the right, and got off course," Harmand said. "Essentially, we got lost and ended up in a new area that looked promising. Something was really unique about this place, we could tell that this zone had a lot of hidden areas just waiting to be explored."

By the end of the 2012 field season, excavations at the site, named Lomekwi 3, had uncovered 149 "Lomekwian" stone artifacts linked with toolmaking.

"It is really exciting and very moving to

be the first person to pick up a stone artifact since its original maker put it down millions of years ago," Harmand said.

The researchers tried using stones to knock off and shape so-called flakes or blades — a process known as knapping — to better understand how these Lomekwian stone artifacts might have been made. They concluded the techniques used may represent a stage between the pounding used by earlier hominins and the knapping of later toolmakers.

"This is a momentous and well-researched discovery," paleoanthropologist Bernard Wood, a professor of human origins at George Washington University, who was not involved in the study, said in a statement. "I have seen some of these artifacts in the flesh, and I am convinced they were fashioned deliberately."

Analysis of carbon isotopes in the soil and animal fossils at the site allowed the scientists to reconstruct what the vegetation there used to be like. This led to another surprise — back then, the area was a partially wooded, shrubby environment.

Conventional thinking has been that sophisticated toolmaking came in response to a change in climate that led to shrinking forests and the spread of savannah grasslands. Stone blades likely helped ancient humans get food by helping them cut meat off the carcasses of animals, given how there was then less food such as fruit to be found in the forest. However, these findings suggest that Lomekwian stone tools may have been used for breaking open nuts or tubers, bashing open dead logs to get at insects inside, or maybe something not yet thought of. [Denisovan Gallery: Tracing the Genetics of Human Ancestors]

"The Lomekwi 3 evidence suggests that important evolutionary changes that would later be really important for Homo to survive on the savannah were actually evolving beforehand, in a still-wooded environment," Lewis said.

"The capabilities of our ancestors and the environmental forces leading to early stone technology are a great scientific mystery," Richard Potts, director of the Human Origins Program at the Smithsonian's National Museum of Natural History, who was not involved in the research, said in a statement. The newly dated tools "begin to lift the veil on that mystery, at an earlier time than expected."

This discovery also has implications for understanding the evolution of the human brain, researchers said. Toolmaking required a level of dexterity and grip that suggests that changes in the brain and spinal tract needed for such activity could have evolved before 3.3 million years ago.

The scientists are now looking at the surfaces and edges of the tools under microscopes and with laser scans to try to reconstruct how they were used, "and also studying the sediment in which they were found to search for trace elements or residues of any possible plant or animal tissues that could be left on them after use," Harmand said.

The site is still under excavation, and Harmand said other artifacts could exist from early attempts at knapping.

"We think there are older, even more rudimentary, stone tools out there to be found, and we will be looking for them over the coming field seasons," he added.

The scientists detailed their findings in the May 21 issue of the journal Nature.

Name that tune: what parts of our brains do we use for naming songs?

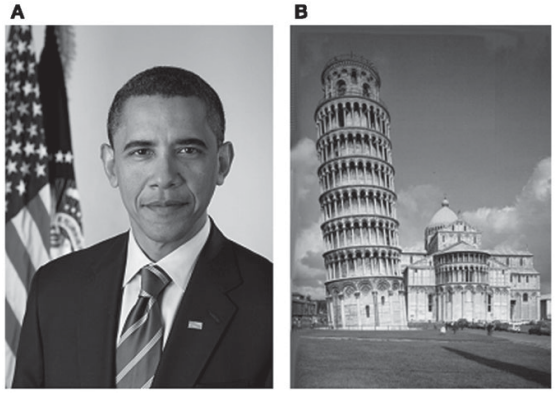
Abstract

Proper nouns refer to unique persons, places, and things. One of those "things" can be songs, and famous songs have specific names like "Take Me Out to the Ballgame" and "Jingle Bells." We conducted a scientific study to determine which parts of the brain are important for the process of naming famous songs. We already had some clues – we knew from previous research that people with damage to the left temporal pole (LTP) lost their ability to name famous people and places (landmarks). These people had strokes or surgery that damaged the LTP, and were unable to come up with names such as "Barack Obama" or "the Grand Canyon." In a new study, we investigated whether persons with LTP damage could name famous musical songs. The participants listened to famous songs and tried to name them. We found that participants with damage to the LTP had difficulty naming these songs. They named significantly fewer songs than participants with damage in other parts of the brain or participants with no brain damage whatsoever. Our findings support the theory that the LTP is the key brain region necessary for naming unique items, and for the first time, we know these items also include music.

Proper nouns are names for unique persons, places, and things. One of these "things" can be songs. Songs have specific names, such as "Take Me Out to the Ballgame" or "Jingle Bells." When you hear a song, you often think of its name. We conducted a scientific study to find out which parts of the brain are important for naming a famous song. We already had some clues about which brain region might be important – we knew from previous research that the left temporal pole (LTP) is an important brain region for naming proper nouns.

The Left Temporal Pole and Proper Naming

Have you ever seen a person and thought, "I know



them! What is their name?" Imagine how frustrating it would be if you could not name people that you saw – even people that you knew very well. Previous research has identified a group of people who experience this on a daily basis. These people have brain damage to the LTP. The LTP is a region on the left side of the brain near the temples (see the colored region in Figure 2). Individuals with damage to the LTP have trouble naming unique items with proper names [1].

Look at the picture in Figure 1A. If I asked you to name this face, you would probably say that this is Barack Obama. A person with damage to the LTP might say that this is the president of the United States, that he has two daughters, or that he was first elected in 2008. While knowing this information shows that they *recognize* the face, they would be unable to tell me his name. The difference between recognizing and naming is important: *recognizing* means that you know who the person is and other information about them (for example, he is the President of the United States). *Naming* means that you are able to give the proper name of the person (for example, Barack Obama).

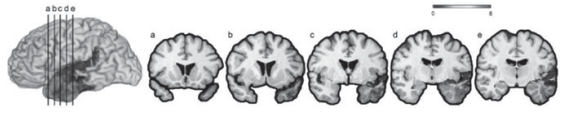
Figure 1 - Examples of A) famous faces and B) landmarks.

Individuals with damage to the LTP are able to recognize famous faces, but cannot name them. This occurs with other unique items too. Individuals with LTP damage are impaired at naming famous people when they hear their voices [2]. They are also unable to name famous landmarks (Figure 1B), such as the Golden Gate Bridge and the Leaning Tower of Pisa [3]. Knowing this information, we wondered whether individuals with damage to the LTP would also have trouble naming famous musical songs. We predicted that musical songs are similar to faces and landmarks because they all have unique, proper names. Therefore, we predicted that patients with LTP damage would be impaired at naming famous songs.

Participants

The participants in our study were individuals who had brain damage to the LTP. These individuals have brain damage because they had brain surgery or strokes. In total, we studied 10 individuals with LTP damage. Figure 2 shows the exact area of brain damage in these patients. The "hotter" colors (red, orange) show the area, which is the LTP, where most patients have damage.

- Figure 2 - Overlap map for patients with damage to the LTP.



- The image on the left is a view of the brain from the left side. The images to the right (a–e) show slices of the brain through the LTP region. The color bar shows how many individuals have damage to this region, with the "hotter" colors (red, orange) representing higher numbers of individuals with damage.

In addition to the LTP group, we studied a group

of individuals with brain damage *outside* the LTP. This is important because it can show if only damage to the LTP impairs naming of famous musical melodies, and not just damage anywhere in the brain. We call this group of individuals brain damaged comparisons (BDC). We studied 10 BDC individuals. Lastly, we studied 10 normal, healthy individuals with no brain damage. This group is called a normal comparison (NC) group. This way, we can see if individuals with damage to the LTP are impaired at naming famous musical melodies compared to people without any brain damage.

Naming Famous Songs

In order to see whether individuals with damage to the LTP had problems naming famous songs, we had participants listen to 52 famous musical songs. For example, this task included songs such as "Row Row Row Your Boat," "The Star Spangled Banner," and "Rudolph the Red Nosed Reindeer." The songs that the participants heard did not have any words; they were just the notes of the tune. After hearing each song, participants rated how familiar they were with the song on a scale ranging from "completely familiar" (a 6 on the scale) to "completely unfamiliar" (a 1 on the scale). Then, they were asked to state the name of the song. If they could not state the name, they were asked to state the lyrics or continue humming/singing the tune of the song.

We found that participants in all three groups (LTP, BDC, NC) recognized most of the songs. To correctly recognize a song, a participant had to either: (1) name the song, (2) state the lyrics, (3) continue humming/singing the tune, or (4) rate the song as a 5 or 6 on the familiarity scale. In all three groups, participants correctly recognized about 80% of the songs (Figure 3). There were no differences between the three groups, which show us that the individuals with damage to the LTP group were not impaired at recognizing famous songs.

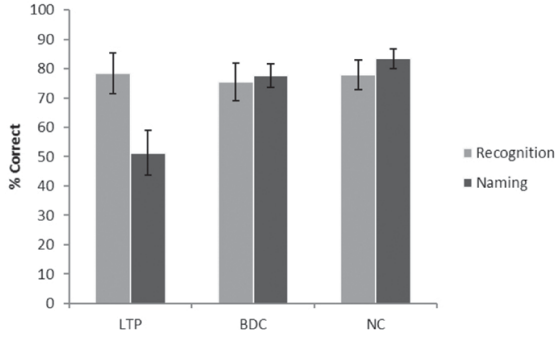
- Figure 3 - Percent correct for naming and recognizing famous musical melodies.

- Here, we show the scores for the three groups on both recognition (blue bars) and naming (purple bars) of famous musical melodies. This shows that all individuals, on average, recognized around 80% of the melodies. However, for naming the melodies, the BDC and NC groups correctly named about 80% of the melodies, while the LTP group named only 50% of the melodies. This shows us that individuals with LTP damage were impaired at naming famous melodies.

By contrast, when asked to name the song, individuals with damage to the LTP were significantly worse than individuals in the BDC and NC groups. Individuals in the BDC and NC groups correctly named about 80% of the songs, while individuals in the LTP group only correctly named about 50% of the songs (Figure 3).

Conclusion

Our findings support our prediction that individuals with damage to the LTP would be able to recognize famous musical songs, but not name them. These findings help show that the LTP is a critical



region for naming proper nouns of various types, including famous faces, landmarks, and now, songs. Without this brain region, people are impaired at naming unique items. This shows us that the LTP is an important brain region for naming proper items. The LTP is called a "convergence zone" for naming items. What this means is that the LTP does not store the names of the items, but it is a region where the names of items are related to the information about the items. This explains why people with LTP damage are able to say information about the item but not the name. So, next time you hear a song on the radio and think of its name, remember that you are using your LTP!

Original Source Article

'! Belfi, A. M., and Tranel, D. 2014. Impaired naming of famous musical melodies is associated with left temporal polar damage. Neuropsychology, 28:429–435.

References

[1] **'!** Damasio, H., Grabowski, T. J., Tranel, D., Hichwa, R. D., and Damasio, A. R. 1996. A neural basis for lexical retrieval. Nature 380:499–505. doi: 10.1038/380499a0

[2] **'!** Waldron, E. J., Manzel, K., Tranel, D. 2014. The left temporal pole is a heteromodal hub for retrieving proper names. Front Biosci (Schol Ed) 6:50–7. doi: 10.2741/S413

[3] **'!** Tranel, D. 2006. Impaired naming of unique landmarks is associated with left temporal polar damage. Neuropsychology 20(1):1–10. doi: 10.1037/0894-4105.20.1.1

How to learn 30 languages

Some people can speak a seemingly impossible number of tongues. How do they manage it, asks David Robson, and what can we learn from them?

David Robson

Out on a sunny Berlin balcony, Tim Keeley and Daniel Krasa are firing words like bullets at each other. First German, then Hindi, Nepali, Polish, Croatian, Mandarin and Thai – they've barely spoken one language before the conversation seamlessly melds into another. Together, they pass through about 20 different languages or so in total.

Back inside, I find small groups exchanging tongue twisters. Others are gathering in threes, preparing for a rapid-fire game that involves interpreting two different languages simultaneously. It looks like the perfect recipe for a headache, but they are nonchalant. "It's quite a common situation for us," a woman called Alisa tells me.

It can be difficult enough to learn one foreign tongue. Yet I'm here in Berlin for the Polyglot Gathering, a meeting of 350 or so people who speak multiple languages – some as diverse as Manx, Klingon and Saami, the language of reindeer herders in Scandinavia. Indeed, a surprising proportion of them are "hyperglots", like Keeley and Krasa, who can speak at least 10 languages. One of the most proficient linguists I meet here, Richard Simcott, leads a team of polyglots at a company called eModeration – and he uses about 30 languages himself.

With a modest knowledge of Italian and some rudimentary Danish, I feel somewhat out of place among the hyperglots. But they say you should learn from the best, so I am here to try to discover their secrets.

(Credit: Thinkstock) (Credit: Credit: Thinkstock)

Most of us struggle with the simplest phrases - but it needn't be that way (Credit: Thinkstock)

When you consider the challenges for the brain, it's no wonder most of us find learning a language so demanding. We have many different memory systems, and mastering a different tongue requires all of them. There's procedural memory – the fine programming of muscles to perfect an accent – and declarative memory, which is the ability to remember facts (at least 10,000 new words if you want to come close to native fluency, not to mention the grammar). What's more, unless you want to sound like a stuttering robot, those words and structures have to make it to the tip of your tongue within a split second, meaning they have to be programmed in both "explicit" and "implicit" memory.

Speaking extra languages delays dementia by five years or more

That tough mental workout comes with big payoffs, however; it is arguably the best brain training you can try. Numerous studies have shown that being multilingual can improve attention and memory, and that this can provide a "cognitive reserve" that delays the onset of dementia. Looking at the experiences of immigrants, Ellen Bialystok at York University in Canada has found that speaking two languages delayed dementia diagnosis by five years. Those who knew three languages, however, were diagnosed 6.4 years later than monolinguals, while for those fluent in four or more languages, enjoyed an extra nine years of healthy cognition.

(Credit: Getty Images) (Credit: Credit: Getty Images)

If you want to stay sharp in old age, learning a language could be the best neural workout (Credit: Getty Images)

Those lasting benefits are a stark contrast to the failure of most commercial "brain training" games you can download – which generally fail to offer long-term improvements in memory or attention.

Learning a new language as we age is easier than you might assume

Until recently, however, many neuroscientists had suggested that most of us are too old to reach native-like fluency in a fresh language; according to the "critical period hypothesis", there is a narrow window during childhood in which we can pick up the nuances of a new language. Yet Bialystok's research suggests this may have been exaggerated; rather than a steep precipice, she has found that there is a very slight decline in our abilities as we age.

Certainly, many of the hyperglots I meet in Berlin have mastered languages later in life. Keeley grew up in Florida, where he was exposed to native Spanish speakers at school. As a child, he used to tune into foreign radio stations – despite not being able to understand a word. "It was like music to me," he says. But it was only as an adult that he started travelling the world – first to Colombia, where he also studied French, German and Portuguese at college.

He then moved on to Switzerland and Eastern Europe before heading to Japan. He now speaks at least 20 languages fluently, almost all of which were learnt as an adult. "The critical period hypothesis is a bunch of crap," he says.

(Credit: Getty Images) (Credit: Credit: Getty Images)

Polyglots tend to "inhabit" a language and its culture (Credit: Getty Images)

The question is, how do hyperglots master so many new tongues – and could the rest of us try to emulate them? True, they may just be more motivated than most. Many, like Keeley, are globe-trotters who have moved from country to country, picking up languages as they go. It's sometimes a case of sink or swim.

Yet even with the best intentions, many of us struggle to speak another language convincingly. Keeley, who is currently writing a book on the "social, psychological and affective factors in becoming multilingual", is sceptical that it's simply a question of raw intelligence. "I don't think it's a major factor, although it does make it faster to have the analytical ability," he says.

Cultural chameleons

Instead, he thinks we need to look past the intellect, into the depths of our personality. Keeley's theory is that learning a new language causes you to re-invent your sense of self – and the best linguists are particularly good at taking on new identities. "You become a chameleon," he says.

Psychologists have long known that the words we speak are entwined with our identity. It's a cliche that French makes you more romantic, or Italian makes you more passionate, but each language becomes associated with cultural norms that can affect how you behave – it could be as simple as whether you value outspoken confidence or quiet reflection, for instance. Importantly, various studies have found that multilingual people often adopt different behaviours according to the language they are speaking.

(Credit: Getty Images) (Credit: Credit: Getty Images)

Building friendship is the primary motivation for most hyperglots (Credit: Getty Images)

Different languages can also evoke different memories of your life – as the writer Vladimir Nabokov discovered when working on his autobiography. The native Russian speaker wrote it first in his second language, English, with agonising difficulty, finding that "my memory was attuned to one key – the musically reticent Russian, but it was forced into another key, English". Once it was finally published, he decided to translate the memoirs back into the language of his childhood, but as the Russian words flowed, he found his memories started to unfurl with new details and perspectives. "His Russian version differed so much he felt the need to retranslate to English," says Aneta Pavlenko at Temple University in Philadelphia, whose book, The Bilingual Mind, explores many of these effects. It was almost as if his English and Russian selves had subtly different pasts.

Resisting the process of reinvention may prevent you from learning another language so well, says Keeley, who is a professor of cross-cultural management at Kyushu

Sangyo University in Japan. He recently ran a survey of Chinese speakers learning Japanese to examine their "ego permeability" – with questions such as "I find it easy to put myself in other's shoes and imagine how they feel" or "I can do impressions of other people", and whether you can change your opinions to suit the people you are near. As he suspected, the people who score highly on these traits had much greater fluency in their new language.

It is not just about the amount of time spent learning and using languages

How come? It's well known that if you identify with someone, you are more likely to mimic them – a process that would effortlessly improve language learning. But the adopted identity, and the associated memories, may also stop you from confusing the language with your mother tongue – by building neural barriers between the languages. "There must be some type of home in your mind for each language and culture and the related experiences, in order for the languages to stay active and not get all mixed together," Keeley says. "It is not just the amount of time spent learning and using the languages. The quality of the time, in terms of emotional salience, is critical." Indeed, that might explain why Keeley could switch so effortlessly between those 20-odd languages.

Of all the polyglots, Michael Levi Harris may demonstrate these principles the best. An actor by training, Harris also has an advanced knowledge of 10 languages, and an intermediate understanding of 12 more. Occasionally, his passion has landed him in some difficulty. He once saw an online ad for a Maltese meet-up. Going along, he hoped to find a group of people from Malta, only to walk into a room full of middle-aged women and their white lap dogs – an experience he recently relayed in a short film The Hyperglot. You can see a trailer below.

When I meet him in a cafe near the Guildhall School of Music and Drama in London, he effortlessly slips into a rather posh, "received pronunciation" English accent, despite being a native New Yorker. As he does so, his whole posture changes as he melds into the new persona. "I'm not really trying to consciously change my character or my persona. It just happens, but I know that I am suddenly different."

Importantly, Harris thinks that anyone can learn to adopt a new cultural skin in this way – and he has a few tips for how to begin, based on his experiences of acting. The important thing, he says, is to try to imitate without even considering the spelling of the words. "Everyone can listen and repeat," he says. You may find yourself over-exaggerating, in the same way that an actor may be a little over-the-top in their performance to start with – but that's a crucial part of the process, he says. "In acting first, you go really big, and then the director says OK, now tone it down. And you

do the same with a language." He also suggests looking carefully at things like facial expressions – since they can be crucial to producing the sounds. Speaking with slightly pouted lips instantly makes you sound a little bit more French, for instance.

Finally, he says you should try to overcome the embarrassment associated with producing "strange" noises – such as the guttural sounds in Arabic, for instance. "You have to realise it's not foreign to us – when you are disgusted, you already say 'eugh'. And if you acknowledge and give your subconscious permission to do it in speech, you can make the sound." That may sound a little silly, but the point is that all this should help you to get over your natural inhibitions. "It's all to do with owning the language, which is what actors have to do to make the audience believe that these words are yours. When you own words you can speak more confidently, which is how people will engage with you."

(Credit: Thinkstock) (Credit: Credit: Thinkstock)

Can thespians teach us all a better way to learn? (Credit: Thinkstock)

There's one big factor that stops people learning languages efficiently…

Even so, most agree that you shouldn't be too ambitious, particularly when starting out. "If there's a single factor that stops people learning languages efficiently, it's that we feel we have to be native-like – it's an unreachable standard that looms over us," says Temple University's Pavlenko. "The ease of expression is what matters to me a lot – finding a better way to express myself, colloquially."

Along these lines, you should also practice a little and often – perhaps just for 15-minute stints, four times a day. "I think the analogies with exercise are quite good," says Alex Rawlings, who has developed a series of polyglot workshops with Richard Simcott to teach their techniques. Even if you are too busy or tired to do serious study, just practising a dialogue or listening to a foreign pop song can help, says Simcott.

In the UK, Australia and US, it is easy to believe that we don't need to make that effort. Indeed, before I met the hyperglots, I had wondered if their obsession merited the hard work; perhaps, I thought, it was just about bragging rights. Yet all of the hyperglots I meet are genuinely enthusiastic about the amazing benefits that can only be achieved by this full immersion in different languages – including the chance to make friends and connections, even across difficult cultural barriers.

Harris, for instance, describes living in Dubai. "As a Jewish person living in the Middle East, I faced challenges. But it turns out that one of my best friends was from Lebanon," he says. "And when I moved away, he said 'when we first met I didn't think I could be friends with you and now you're leaving, I'm distraught'. It's one of the most precious things to me."

As Judith Meyer, who organised the gathering in Berlin, tells me, she saw Ukrainians and Russians, Israelis and Palestinians all conversing at the gathering. "Learning another language really does open up whole new worlds."

Many of Earth's groundwater basins are drying out

The majority of the world's largest aquifers are quickly being drained

Thomas Sumner

Of Earth's 37 largest aquifers, 21 are shrinking, satellite data show. Here, redder regions represent overstressed aquifers. Those buried reservoirs lose more water each year than they gain.

Of Earth's 37 largest aquifers, 21 are shrinking, satellite data show. Here, redder regions represent overstressed aquifers. Those buried reservoirs lose more water each year than they gain.

Around the world, large reservoirs of fresh water lie hidden underground. These groundwater basins are like banks. Water can be deposited, stored or withdrawn.

Now, changes in climate and human water usage are emptying those reservoirs, a new study finds. And it's happening at an alarming rate. Of Earth's 37 largest groundwater basins, 21 lose more water each year than they gain. Details appear in a paper to be published in Water Resources Research.

The conclusion is troubling. That's according to study coauthor Sasha Richey. She is a hydrologist at Washington State University in Pullman. (Hydrology is the study of Earth's water.) Groundwater quenches the thirst of about 2 billion people. It also irrigates crops.

"People need to think about groundwater as an important resource," Richey says. "We're not managing that resource adequately, or even at all, in most of the world."

People extract groundwater by drilling into underground reservoirs called aquifers. Aquifers are refilled when water seeps down through the soil.

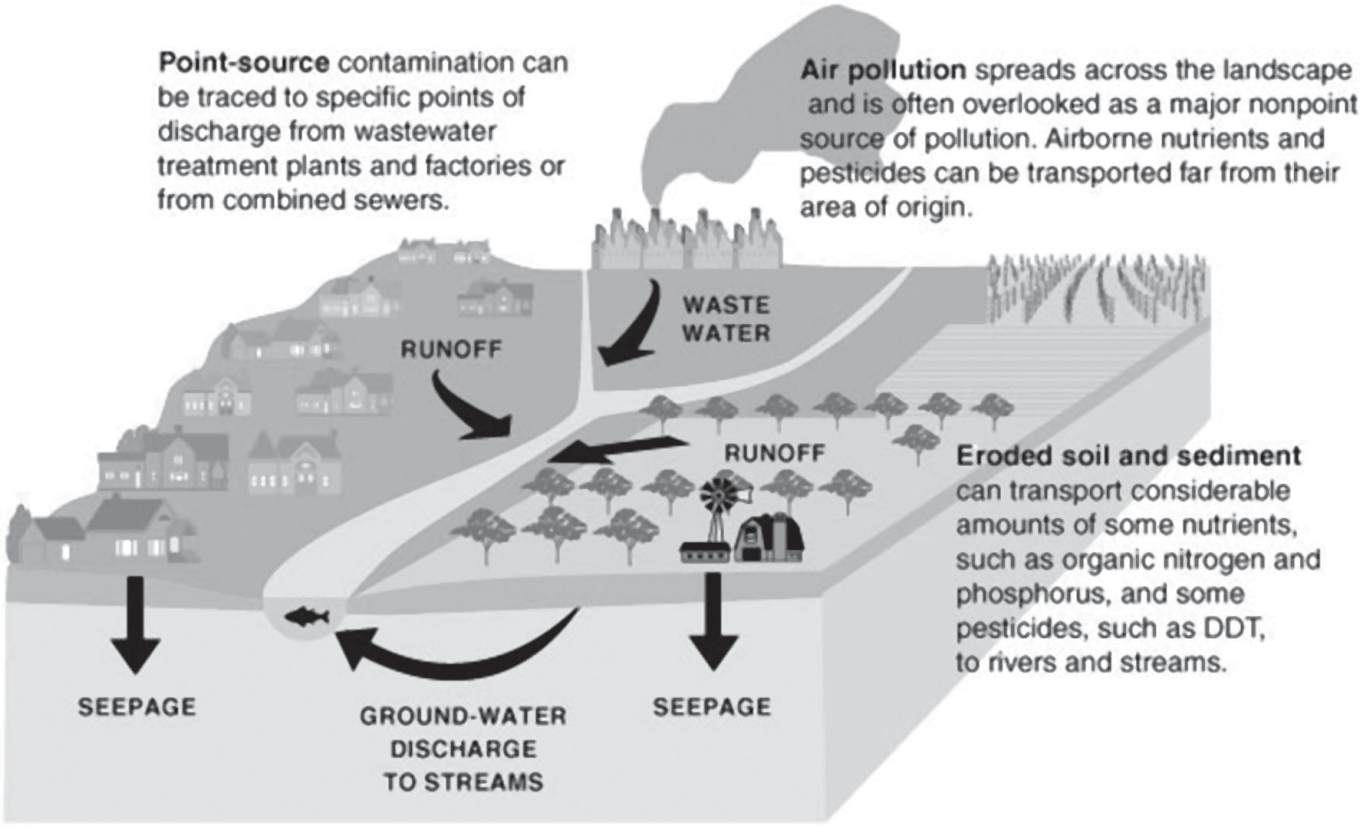
Scientists can monitor groundwater using wells. Water levels drop as an aquifer is drained. This method fails to provide a global picture of changes in water levels, though.

Richey and colleagues instead used data collected by the GRACE mission. These twin satellites measure small changes in Earth's gravity. Variations in the density of Earth's surface cause those small variations in gravity. (Density is a measure of how much mass is contained in a given volume.)

The emptying and refilling of groundwater basins is one way that the density of Earth's surface changes. The GRACE satellites pass over these buried reservoirs regularly. As they do, the satellites "weigh" the mass of the water stored inside.

The researchers examined gravity changes over Earth's largest aquifers from 2003 through 2013. Eight of the studied aquifers lost significant volumes of water over that decade. The researchers classified these aquifers as "overstressed." That means almost no water naturally trickled in to replace water being pumped out. The regions of greatest concern were in the Middle East, northern Africa and northwestern India and Pakistan.

The most dried-up aquifers were in areas near large cities, in heavily agricultural areas



or in arid climates. All three characteristics probably contributed to the extreme stress affecting the basins below central California, Richey says. California has both people and farms. It's also in a multi-year drought. As a result, the state's pumping of groundwater recently has skyrocketed.

The GRACE mission provides valuable information about how global groundwater has changed. It can't measure exactly how much water is left in the aquifers, however, says Gordon Grant. He is a hydrologist with the U.S. Forest Service in Corvallis, Ore. Still, the new work allows scientists to "better understand, like an accountant would, withdrawals and deposits of groundwater around the world."

Power Words

agriculture The growth of plants, animals or fungi for human needs, including food, fuel, chemicals and medicine.

aquifer Rock that can contain or transmit groundwater.

arid A description of dry areas of the world, where the climate brings too little rainfall or other precipitation to support much plant growth.

climate The weather conditions prevailing in an area in general or over a long period.

climate change Long-term, significant change in the climate of Earth. It can happen naturally or in response to human activities, including the burning of fossil fuels and clearing of forests.

density A measure of the consistency of

an object, found by dividing the mass by the volume.

drought An extended period of abnormally low rainfall; a shortage of water resulting from this.

gravity The force that attracts anything with mass, or bulk, toward any other thing with mass. The more mass that something has, the greater its gravity.

groundwater Water that is held underground in the soil or in pores and crevices in rock.

hydrology The scientific study of Earth's water, especially in relation to land. Experts in this field are known as hydrologists.

irrigation The supply of water to land or crops to help growth.

mass A number that shows how much an object resists speeding up and slowing down — basically a measure of how much matter that object is made from. For objects on Earth, we know the mass as "weight."

reservoir A large store of something. Lakes are reservoirs that hold water. People who study infections refer to the environment in which germs can survive safely (such as the bodies of birds or pigs) as living reservoirs.

satellite A moon orbiting a planet or a vehicle or other manufactured object that orbits some celestial body in space.

stress (in biology) A factor, such as unusual temperatures, moisture or pollution, that affects the health of a species or ecosystem. (in physics) Pressure or tension exerted on a material object.

Simple Biology Experiment Ideas

Here are some simple biology experiment ideas for kids, to make the learning process more fun at school...

Biology is a fascinating subject, however in order to get the students interested in the subject, you can make use of some simple experiments to peak their interest. Putting biology into action is a far more interesting way to engage kids instead of sticking to theorized classes. It builds on their keen learning abilities to explore what biology as a subject offers. In case you are looking for some simple biology experiments for kids at school or even at home, here are some suggestions to help you with this.

Simple Experiments for Kids

Experiments need to be simple, in terms of the apparatus used as well as the concepts explained. Generally, you can start with experiments that deal with plants, flowers or even the observation of insects, soil / food samples and so on.

Experiment #1 - Colored Flowers

This is a very simple and fun biology experiment, which will serve to teach children about water absorption systems in plants.

Things Required:

A cup of water

Food color

A flower with an intact stalk

Empty clean flask

Procedure:

First of all, mix the food color in the water. Make sure there are no lumps and that the color dissolves completely in the water.

Now pour the colored water into the flask. Make sure that the flask is clean and doesn't have any impurities on its surface.

Now, take the flowers (with intact stalks) and place them in the flask, so that half of the stalk is submerged under water.

Place the flask on a window sill or any other surface that gets sufficient sunlight.

Tell the children to observe the color of the flowers over a period of time.

Experiment Results:

Plants need water for sustenance; this simple experiment demonstrates how water is absorbed by the stalk, and

distributed throughout the plant to its leaves and flower.

Experiment #2 - Observing Bacteria

Well, although the title might give a notion that the experiment is too advanced - it is not! It is a simple and easy experiment to introduce the children to some species of bacteria.

Things Required:

A compound microscope

Yogurt

Clean empty cup

Water

Unused ink dropper

Microscope slide

Cover slip/glass

Procedure:

First of all, take a small quantity of yogurt (half a teaspoon) and drop this into the cup, adding two teaspoons of water to it.

Mix the yogurt and water with a spoon, so as to create a homogeneous suspension.

Using the ink dropper, place a drop of this yogurt suspension on the clean, sterilized microscope slide. Make sure you don't take more than a drop.

Place the cover slip on the drop of suspension. Now, the slide is ready to be observed under the microscope.

Now simply allow the children to observe the sample under the microscope.

Experiment Results:

Usually the commercially manufactured yogurt include Streptococcus thermophilus and Lactobacillus bulgaricus. You can tell the children about these bacteria which are in fact helpful to our systems, and not harmful like other kinds of bacteria.

Experiment #3 - Flexi Bones

This experiment will show kids how calcium (a mineral) and collagen (a protein), are the two important elements, that are needed in order to keep the bones strong and flexible. If any of the two elements becomes deficit, then there is a possibility that the bones would lose their strength and/or flexibility. Lack of strength can cause them to break easily, while lack of flexibility can cause them to bend, each of which, is a dangerous condition.

On the lighter side, it'll also encourage children to drink lots of milk for calcium and eat dark-green vegetables like spinach, broccoli and collards for collagen.

Things Required:

Drumstick bone - 2 per student

White vinegar (ordinary)

Plastic containers with lids

Procedure:

It is wise to have the students (or their parents) clean the bones thoroughly before wrapping them up in plastic bags and placing them in the refrigerator, for the experiment the following day at school.

Have students place their drumstick bones in a plastic container.

Label the containers as 'Vinegar' and 'Oven'.

In the container labelled 'Vinegar':

Submerge the first bone in vinegar, enough to let it cover the entire bone's surface.

Place the lid on the container, making sure it is airtight.

Leave the bone in vinegar in the school lab for about 3 days.

Have students drain the vinegar out, gently wiping down the bone.

In the container labelled 'Oven':

It is highly advised for parents (or teachers) to be around and use a kitchen mitt when handling the bone, as it will become really hot when baked.

Bake the bone in the oven at 250 degrees for 3 hours.

Remove the bone from the oven and let it cool down.

Experiment Results:

Students will notice that the bone that was soaked in vinegar has a rubber-like texture to it, being extremely malleable when touched. This is because the vinegar's acidic content was able to break down calcium over time. On the other hand, the baked bone will be brittle and would break easily because baking has caused the collagen in the bone to break down.

The bottom line is, therefore, that calcium and collagen both are essential for sturdy and tensile bones.

Kids will be drawn to such experiments if you dedicate a time of the week during school hours to expose them to such interesting practical classes. Have them try similar experiments at home with help from their parents, and have them bring to class their feedback about what they learned from the experiment.

Read more at Buzzle: http://www.buzzle.com/articles/simple-biology-experiment-ideas-for-kids.html

Early humans heard sounds differently than we do today, according to new research that provides intriguing clues on the environments our ancestors were living in, and how prehistoric humans communicated with each other.

A key finding of the study, published in the journal Science Advances, is that our ancestors living in South Africa around 2 million years ago were extremely sensitive to close-range sounds, hearing them more keenly than both our species and chimpanzees do now.

"We concluded that Australopithecus africanus and Paranthropus robustus had a heightened sensitivity to sound between 1.0-3.0 kHz compared with both chimpanzees and humans," lead author Rolf Quam, an assistant professor of anthropology at Binghamton University, told Discovery News.

Photos: Faces of Our Ancestors

He added that these early humans "were capable of hearing softer sounds" than our species and chimps can.

Quam and colleagues made the determination after reconstructing the internal anatomy of the ears of the two prehistoric humans. To do so, the researchers used CT scans and virtual computer reconstructions based on fossils. The particular human species were selected for the study because their remains include preserved ear bones.

The sensitivity to short-range sounds likely would have facilitated up close communication in an open habitat. Prior research on the tooth enamel of the prehistoric humans found evidence for consumption of foods found in both forests and savannahs, so our South African ancestors must have divided their time between these two environments.

Retreating to the forest might have been necessary, since humans were on the menu at the time for a wide range of large predators, such as leopards, lions and hyenas.

Photos: Early Humans Brought To Life In Exhibit

In terms of how the prehistoric humans would have been communicating with each other, there is a general consensus among anthropologists that the small brain size, ape-like cranial anatomy and vocal tract of these individuals would not have given them the capacity for language.

Like other primates, though, they would have been emitting meaningful vowel-based calls. Quam and his team propose also propose that they could have used what are known as "voiceless consonants."

"These are consonants that are produced solely by air flowing through the lips, teeth and tongue, such as the sounds in English associated with the letters "t," "k," "f" and "s," Quam explained. "These are considered 'voiceless consonants' because the vocal chords do not move when they are produced."

http://news.discovery.com/human/evolution/our-ancestors-heard-the-world-differently-150925.htm#mkcpgn=rssnws1

Viruses have been difficult to classify, with some scientists arguing that they are just nonliving bits of DNA and RNA, yet new research not only finds that they are very much alive, but that they also emerged before the first modern cells.

Viruses have therefore just been placed on the tree of life, occupying the senior-most spot right at the bottom of the tree. They are not "animal, vegetable or mineral," as the saying goes, but exist within their own unique group, according to a new study.

"For now, we call it the 'viral supergroup,' just short of 'superkingdom' or 'domain,' which are words that are quite charged with meanings," Gustavo Caetano-Anoll's of the University of Illinois and the Carl R. Woese Institute for Genomic Biology told Discovery News. He co-authored the study, published this week in the journal Science Advances.

Photos: The Art of Microbiology

Arshan Nasir, who is Caetano-Anollés' graduate student and also worked on the study, added that "viruses are living. They simply have an atypical mode of living that is slightly different from ours. They are not fully independent. Instead, they move in and out of our bodies, stealing the resources and producing their offspring. In short, we need to broaden how we define life and its associated activities."

Viruses are challenging to study because the sequences that encode their genomes are subject to rapid change. As a result, the scientists elected to study what are known as "folds": the structural building blocks of proteins that give proteins their complex, three-dimensional shapes.

The scientists compared fold structures across different branches on the tree of life, reconstructing the evolutionary history of the folds and of the organisms whose genomes code for them. The researchers did this for 5,080 organisms representing every branch of the tree of life, including 3,460 viruses.

They identified 442 protein folds shared between cells and viruses, and 66 that are unique to viruses.

Viruses Pass Major Test to Enter Ranks of Living

Nasir said that "a large number of viral genes are nothing like we have seen so far in the cellular world. They are most likely new genes created by viruses."

The researchers theorize that viruses evolved at a time when primordial cells were extruding genetic material, which viruses could then acquire. Most viruses then gained the ability to encapsulate themselves in protective protein coats, called capsids, which became more sophisticated over time. Capsids allowed viruses to become infectious to cells that had previously resisted them.

Viruses, Caetano-Anollés said, "can be visualized as cells that have lost and lost genetic material in exchange for reaping the benefits of their interactions with other cells."

http://news.discovery.com/animals/viruses-are-alive-and-are-oldest-living-creatures-150925.htm#mkcpgn=rssnws1

Fresh views of Ceres but 'spots' remain mysterious

By Jonathan Webb Science reporter, BBC News

30 September 2015

From the section Science & Environment

Image copyright NASA/JPL-Caltech/ UCLA/MPS/DLR/IDA

Image caption The Occator Crater, colour-coded to show differences in elevation, and its baffling bright spots

The team behind Nasa's Dawn mission to Ceres has released striking new images, but remains unable to explain the dwarf planet's most intriguing mystery.

Bright spots within a 90km-wide crater have baffled scientists since the probe spotted them on its approach.

Now in orbit around Ceres, Dawn is gathering detailed data about the world's geology and its composition.

Mission researchers described the latest images at the European Planetary Science Congress in Nantes, France.

Currently, their best guess to account for the spots is an expanse of some type of salt - but this is speculation.

"We haven't solved the source of the white material," said the mission's principal investigator Chris Russell from the University of California Los Angeles.

"We think that it's salt that has somehow made its way to the surface. We're measuring the contours, trying to understand what the surface variations in that crater are telling us."

Ceres is a 950km-wide dwarf planet sitting in the Solar System's asteroid belt. Dawn is currently orbiting it at a distance of 1,470km and imaging the entire surface every 11 days.

Image copyright NASA/JPL-Caltech/ UCLA/MPS/DLR/IDA

Image caption This height-coloured map of Ceres has a resolution of 400m per pixel. The bright spots are in the Occator Crater (centre-right)

Image copyright Anita

Image caption These "stretched" colours give clues about Ceres' mineral composition

It was eight years ago this week that Dawn blasted off on its mission from Cape Canaveral, Florida.

Before arriving at Ceres six months ago, the spacecraft dropped in on the asteroid Vesta for just over a year in 2011 and 2012.

The latest release of data includes a new topographic map, showing the shape of Ceres' entire surface in the most detail yet.

"The irregular shapes of craters on Ceres are especially interesting, resembling craters we see on Saturn's icy moon Rhea," said deputy mission chief Carol Raymond from Nasa's Jet Propulsion Laboratory in California. "They are very different from the bowl-shaped craters on Vesta."

There is also a colour-enhanced mosaic image that offers clues about what the dwarf planet is made of - arguably asking more questions than it answers.

"There's an interesting blue ring here," Prof Russell told a media briefing at the conference. "We have absolutely no idea what that blue ring is due to.

"And there are streaks across the surface that point back to the Occator Crater with its bright spots. We are poking at this, and we're looking for ideas, but we haven't solved the problem yet."

Image copyright NASA/JPL-Caltech/ UCLA/MPS/DLR/IDA/PSI

Image caption Another new height-coloured image describes the contours of this strange mountain

Image copyright NASA/JPL-Caltech/ UCLA/MPS/DLR/IDA

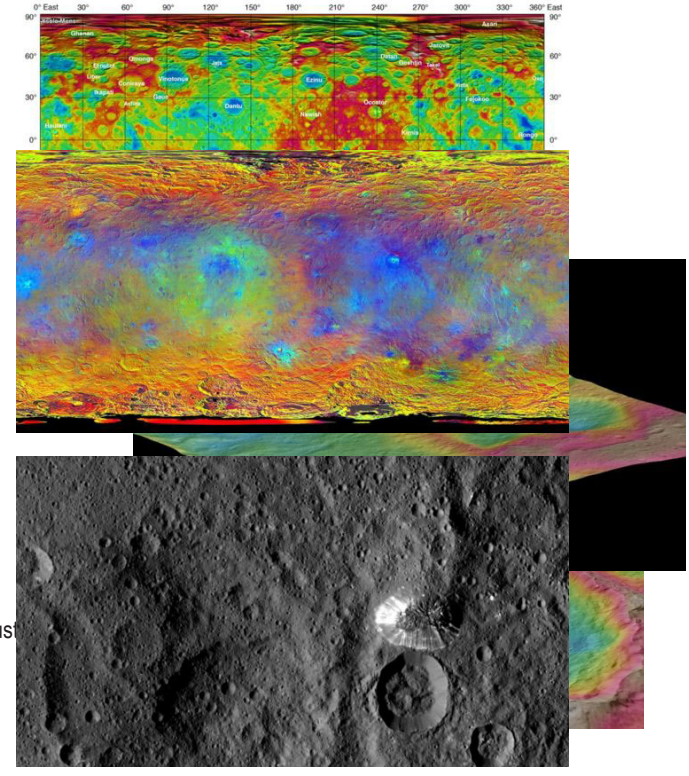
Image caption This earlier image showed the mountain - which is yet to be named - from above

An oddly shaped mountain that towers 6km above relatively flat surrounding terrain is also puzzling the team, Prof Russell added, because it does not look like the result of known geological processes.

"We're having difficulty understanding what made that mountain," he told reporters.

In October, Dawn will start dropping to its final target altitude of 375km for an even closer look at Ceres. This will be its final home. Even after it ceases operations in mid-to-late 2016, the probe is expected to stay in this stable orbit and become a permanent fixture in the dwarf world's sky.

"We're not going to leave Ceres. We're going to stay in Ceres orbit forever," Prof Russell said.



How tiny killer flies pounce on prey

By Jonathan Webb Science reporter, BBC News

29 September 2015

From the section Science & Environment

Jump media player

Media player help

Out of media player. Press enter to return or tab to continue.

Media caption The researchers studied the insects pouncing on smaller bugs, as well as sliding beads (footage: Trevor Wardill and Paloma Gonzalez-Bellido, Cambridge University)

Neuroscientists have recorded the first video footage of a tiny killer fly catching its prey in mid-air.

They were investigating how the 4mm-long insect decides when to pounce.

Apparently the flies are not much good at judging the size of a target, so they use a strategy based partly on how fast a potential meal is buzzing past.

That means the researchers could trick the flies into going for targets that were far too big, but further away and faster-moving than expected.

The experiments, published in the journal Brain, Behaviour and Evolution, used a species called Coenosia attenuata, which is so good at killing other airborne critters - including fruit flies - that organic farmers use it as a biological control mechanism.

C. attenuata is an unfussy eating machine, explained Dr Paloma Gonzalez-Bellido - and that was partly why she started to study the little predators.

"It didn't look like they have a template for what they're looking for," she told BBC News.

"They go after things that are very slow, after things that are fast, after things that are white, things that are black..."

But a fly can't just pounce on everything. So what cue is the creature's brain looking for?

Image copyright Trevor Wardill

Image caption Some organic farmers use this species of killer fly to control insect pests

Many predators are able to gauge the size of their prey, using information like the comparison between two eyes to judge how far away it is and then calculate its size accordingly, before they decide whether to strike.

This includes dragonflies, which have much bigger eyes and brain than C. attenuata.

Dr Gonzalez-Bellido and her colleagues at the University of Cambridge set out to see whether these diminutive diners could do the same sums.

"We don't really know how well such small animals see; we don't really know what the constraints are on the system," she said.

In video experiments, her team presented the flies with moving beads of different sizes and speeds, as well as real fruit-fly meals. Every pounce was monitored using two cameras, so that the movement could be tracked precisely.

The cameras witnessed some extremely poor decisions, in which the 4mm insects set off after beads 12mm across. And the team saw similar mistakes when they observed the insects outside the lab.

"In the wild, we see them take off after bees - and then turn around, halfway through the flight," Dr Gonzalez-Bellido said.

Quick thinking

Since the flies seemed unable to use a target's actual size in their decision, the researchers set about testing the role of various other factors.

This included calculating how big - and how fast - each target would appear to the fly, taking into account the exact distance between them.

Using these apparent or "subtended" values, instead of actual ones, the researchers discovered a particular ratio between size and speed that usually triggers a pounce.

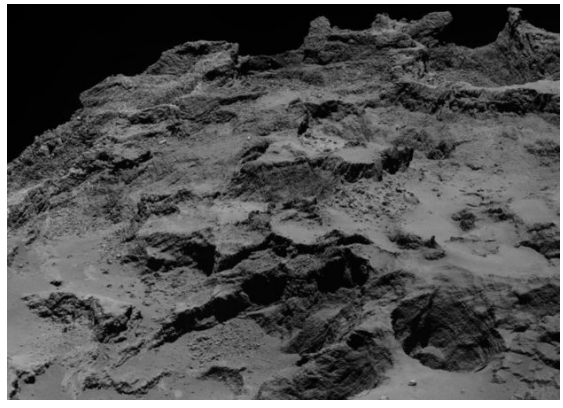
"[A target] has a subtended size. But something that subtends a size could be small and close, or large and far away. So in theory, they could go after an aeroplane," Dr Gonzalez-Bellido explained.

"One way of solving this problem is to match up the size with the speed. So a plane may have the right subtended size,

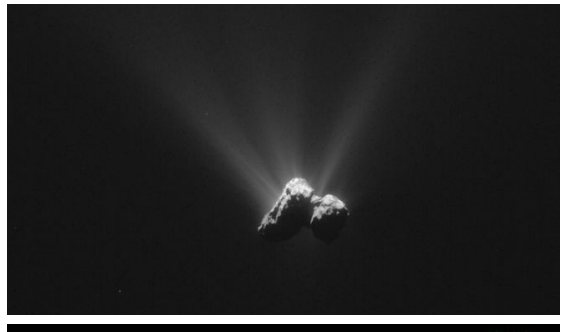
but it won't come across the retina at the right speed."

Image copyright Trevor Wardill

Image caption The team used twin cameras to record exactly where the flies moved

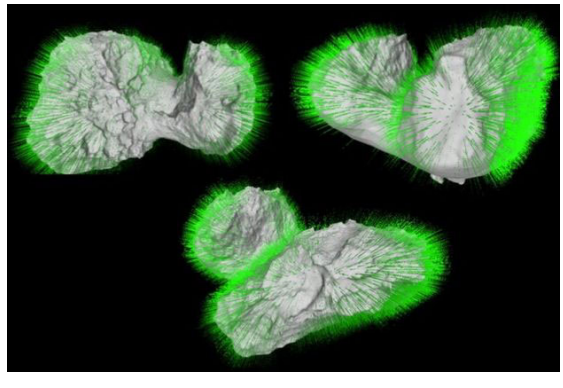


This relatively simple formula for picking a target, the researchers say, has probably evolved because of the tiny size of the fly's brain and eyes - but also because the decision has to be made extremely fast.



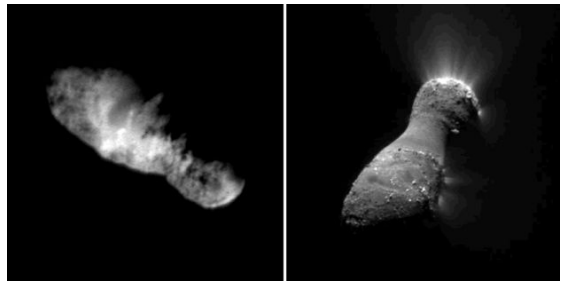
The killer flies in the study, on average, went for targets about 8cm away and they covered that distance in less than 0.4 seconds.

"If they take too long, it'll be gone," Dr Gonzalez-Bellido said. "And one way to take less time is not to bother working out how far away it is."



Furthermore, the experiments showed that the flies can detect extremely small targets, which will only trigger activation in a single lens of the fly's compound eye.

"That means that they've really tuned the system," said co-author Dr Trevor Wardill. "They really are doing quite well with a pretty tiny eye."



Rosetta's 'rubber duck' comet was once two objects

By Jonathan Amos BBC Science Correspondent

28 September 2015

From the section Science & Environment

Image copyright ESA/ROSETTA/NAVCAM

Image caption The new report answers one of the big questions of the Rosetta mission

The rubber duck-shaped comet being followed by Europe's Rosetta probe used to be two separate objects.

Scientists say pictures of 67P show its two lobes to have "onion skin" layers that intersect in a way that can only be the result of two different bodies having collided and stuck together.

Ever since Rosetta arrived at the comet, the origin of its bizarre form has been one of the major puzzles.

The solution is now due to be published in the journal Nature.

Mission team members have also held a media conference to give further details, at the European Planetary Science Congress in Nantes, France.

Rosetta first spied the duck shape on approach to 67P/Churyumov-Gerasimenko in July 2014.

The idea that it was a "contact binary" - two conjoined comets - was a popular explanation from the word go.

But proving it has not been straightforward. An alternative possibility is simply that the icy dirt ball has been sculpted this way.

Every time it comes around the Sun, 67P's ices warm and it throws off gas and dust, and it could have been that this process has dominated in just one region to produce the distinctive appearance.

The Osiris camera on Rosetta can now settle the debate.

It reveals layers up to 650m thick in the body of the duck that are independent of similar strata detected in its head.

Image copyright ESA/ROSETTA/MPS FOR OSIRIS TEAM

Image caption The deep pit at bottom-right shows the internal layering on the duck's body

Additional measurements taken by Rosetta of variations in the local tug of

gravity across the lobes also support this two-body origin.

The direction of the tugging is more closely aligned with the independent layering than with a centre of mass associated with a single object.

Union of onions

Scientists say that to collide and stick together, the impact must have been a very low velocity one - perhaps just a few metres per second. Any faster and the primary objects would have done enormous damage to each other.

"I would say it's a quite beautiful love story," Matteo Massironi, from the Osiris team, said at Monday's press briefing.

He added that a key piece of evidence was a series of cross-sections of the comet, which the team were able to construct by extending the layers glimpsed on the surface into a 3D model of 67P's interior. These cross-sections painted a clear picture of two distinct sets of layers, reminiscent of a pair of onions.

"You don't know the structure of an onion until you cut across it," Dr Massironi said. "What we have seen is that this stratification is really continuous - and that [the one in the tail] doesn't match that of the head."

The discovery's consequences for what we understand about comet formation could be quite profound, says team member Stephen Lowry from Kent University, UK.

"It shows that comets were forming into large sizes and that they were then still colliding in this grown form to make even larger comets. So, it's not simply a case of independent comets completely forming out of centimetre- or metre-sized planetesimals, to make the comets we see today. And that's really quite fascinating, because it could be quite a ubiquitous process."

Image copyright ESA/ROSETTA/MPS FOR OSIRIS TEAM

Image caption The local gravity field supports the idea that 67P was once two separate objects rather than a single formation

Other comets seen at relatively close quarters also display lobed shapes, including comets Halley, Borrelly and Hartley-2. Could they also be the result of low-velocity bump-and-stick events?

The tantalising prospect now is whether what was once two objects could split into two again. Could the constant erosion of gas and dust result in the duck losing its head? And will Rosetta be on hand to witness it?

The European Space Agency (Esa) probe has pictured a crack in the neck region of 67P, says Dr Lowry.

"If a comet is going to split, it's most likely to break along the interface between the two lobes. But I haven't seen any evidence yet that the crack is getting longer or wider. That's a strong indicator to me that perhaps 67P won't split on this orbit of the Sun."

Image copyright NASA

Image caption Comets Borrelly and Hartley-2 have lobed shapes. Were they also made in low velocity collisions between objects

The comet takes just over six years to orbit the Sun and the Rosetta mission, after receiving a 10-month extension, will nonetheless end in September 2016.

At that point the spacecraft will spiral gradually closer and land yet again on 67P, said Esa project scientist Matt Taylor at the press conference - making a reference to the Philae lander's bumpy touchdown in November 2014.

He added that although the comet had passed its "perihelion" (its closest approach to the Sun), the mission was really only just beginning. "The papers are starting to flow."

Electricity from the air - Drayson's big idea

Rory Cellan-Jones Technology correspondent

30 September 2015

From the section Technology 197 comments

More from Rory

My day with a robot

Facebook dislikes: Thumbs up or down?

Apple and Microsoft - peace at last

Could mobile advertising be consigned to history?

Free energy from the air. It sounds like a fantasy but that is what the entrepreneur and former science minister Lord Drayson has just unveiled at London's Royal Institution.

He claims that a technology called Freevolt can be the power source for the "internet of things", allowing low energy devices from wearables to sensors to operate without being plugged in.

The technology involves harvesting radio frequency energy from existing wireless and broadcast networks, from 4G to digital television. Lord Drayson says it's a world first: "It doesn't require any extra infrastructure, it doesn't require us to transmit any extra energy, it's recycling the energy which isn't being used at the moment."

The technology was demonstrated in the lecture theatre at the Royal Institution, where Michael Faraday worked on electromagnetism in the 19th Century. Lord Drayson first showed how much radio frequency energy was in the room, and then used his Freevolt system to power a loudspeaker.

He also demonstrated the first product to use the energy system, a personal air pollution monitor called the CleanSpace tag. It has been created by Drayson Technologies as part of a drive to improve air quality in cities and give individuals some insights into the extent of pollution. A battery in the device is continually recharged by a Freevolt energy harvester.

The technology, which has been patented, could now be used by organisations such as supermarkets which are preparing for the next phase of the internet, where billions of small cheap sensors are online providing data about their operations.

But Dean Bubley, a mobile technology analyst and founder of Disruptive Analysis, is cautious about the prospects for Freevolt. After watching the demonstration he tells me the idea of air-quality sensors and crowdsourced monitoring is "fascinating". But he says "it doesn't need Freevolt. The

same thing could be achieved with a battery and low-power transmitter."

He says there are also questions to answer about the possible impact on the mobile networks, which own the spectrum that Freevolt would be harvesting, suggesting that that the "free" energy might actually be needed for communication.

I put it to Lord Drayson that the networks might demand a fee. He is confident that there is no legal basis for that and indeed is confident they would see his technology as a "really cool thing". He says it "closed the loop" on the internet of things and the industry would embrace it because it did not involve building more infrastructure.

Others have tried the same idea, but have struggled to produce energy with enough efficiency to make the technology commercially viable. Now this British company believes it has found a solution. If it is right, then Freevolt could turn into a very lucrative business.