Dogs & the language barrier

Researchers in Hungary have found that dogs can make out the tongue they are used to hearing

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Kun-kun and Laura V Cuaya

Does my dog understand language? Or does she only respond to sounds and gestures?

Many dog lovers believe that dogs understand "everything we say". The more grounded think dog "obedience" is conditioned response to sounds, not comprehension. Laura V Cuaya, Raúl Hernández-Pérez, Marianna Boros, Andrea Deme and Attila Andics, from the department of ethology, Eötvös Loránd University, Budapest, and the Lingual Articulation Research Group, a research programme in Budapest, describe in the journal, *NeuroImage*, their work that shows dogs display the ability to distinguish speech sounds from non-speech, and to make out the difference between languages.

The development of speech and language, which marks humans apart from other living things, has been the subject of study for a long time. The general view is that a child learns its mother tongue by constant exposure, trial and error, and begins to grasp what different sounds convey and can convey, from the names of things and actions to the rules of grammar that bind words together.

And then, there are theories of how the rules of grammar arise. On one hand, there's the idea that all languages have the same, basic grammar. And then, the observation that birdsong has a pattern, which is taught and learnt, that dolphins communicate using structured sounds, and so on. And at yet another level, the mechanics of language, programming a computer to read, speak, or translate. And this last challenge works by building computer structures to work like how neurons, or nerve cells, in the animal brain are believed to work.

Even if we accept that a child learns by repetition and trial and error, this does not address the question of what happens in the cells of the child's brain while it learns. Development of electronic circuits that can calculate or make choices suggested how brain cells, which are activated by electrical signals, could be structured. And in turn, studies of how humans and other living things perceive and learn has led to computer programmes that mimic the brain.

The participants

Name	breed	age(months)
Akira	Labradoodle	40
Barack	Golden retriever	104
Barney	Golden retriever	52
Bingo	Mix	37
Bodza	Golden retriever	51
Bran	Border collie	98
Dome	Cocker spaniel	71
Grog	Border collie	134
Joey	Australian shepherd	73
Kun-kun	Border collie	54
Maverick	Border collie	117
Maya	Golden retriever	97
Mini	Mix	126
Monty	Border collie	99
Odin	Border collie	54
Pan	Australian shepherd	44
Sander	Golden retriever	76

The understanding is that when the infant brain receives stimuli, from the retina or from the eardrum, for instance, brain cells react at random. When stimuli are associated with a pleasant event, like the presence of the mother, some brain cell responses to those stimuli are selected, get strengthened, and would then be repeated. Building on units of perception like this, the brain learns to associate shapes, sounds or action with objects, people or events. And as the child grows, this progresses to skills, language, reading, writing, and so on.

In Artificial Intelligence, typical stimuli are broken down to be represented by a collection of numbers. An image, for instance, is the intensity of pixels, a sound, the mix of frequencies. The AI system then carries out a calculation on the numbers, to select from a set of results. If the images are of digits, for instance, the results could be the numbers from zero to nine. And then, there is an arrangement of feedback, depending on whether the selection was correct or not. Based on the feedback, the system modifies the calculation, to come closer to the correct result.

The calculation used can be complex, to take into account many kinds of variable factors, and the process of feedback and correction can be repeated a huge number of times. The system then gets quite good at recognising specific shapes, be it handwritten digits or alphabets, objects or faces of people. In respect of sounds, the same process can identify phonemes, or units of speech, and the system can put sounds together as words and write them out, to work as a dictation machine. Or listen to a piece of music and write out the staff notation for each of the instruments.

There could even be a method of "parsing the words", that is, analysing the relationship of the nouns, verbs, and so on. It would, however, be instructive to understand the mechanics of how the simplest components of language are processed in rudimentary brains, as of animals.

In the case of the response, and "trainability", of animals, like dogs, even chickens and fleas, to sounds, this is understood as a case of conditioned response. In the classic experiment, a neutral stimulus, like a bell, was paired with a biological stimulus, food, which resulted in salivation. The result of repetition was conditioning, so that the bell, which was a neutral stimulation, by itself, led to salivation.

To train a dog, the word, "sit", for instance, is spoken, and the dog is encouraged to sit, perhaps by a tap on the hind quarters. If the dog sits, and every time she sits in response to the command, she is rewarded with a treat. As before, there is conditioning, and the dog learns to sit every time she hears the word.

This, of course, may not amount to "understanding" of language. But, in the case of the dog, the Budapest paper says, intense exposure to human speech creates powerful familiarity with a large number of words. "This makes dogs a useful comparison species for exploring the evolutionary bases of human voice and speech perception," the paper says.

Dogs' brain activity

The group working in Budapest carried out a trial where they assessed physical changes in dogs' brains when text, fragments from a chapter from Saint-Exupéry's *Le Petit Prince*, were read out, in different languages. Eighteen dogs, which had been raised in homes and were familiar with the sound of the language spoken, were exposed to fragments in the same language, to the same text in a scrambled form, which distorts the rhythm of sounds, and to the same exercises in another, unfamiliar language.

The dogs had been trained to lie still in a magnetic resonance imaging scanner, and while the sounds were played to them, the activity of the primary and secondary auditory cortex of their brains was scanned. The idea was to see which portions of the brain were excited when the dogs heard a familiar language, and scrambled sounds, from the same language, or in an unfamiliar language.

The results were that the primary auditory cortex showed different activation when the matter heard was natural speech, as opposed to scrambled sounds. The effect was the same with both the familiar and unfamiliar language. The languages, in fact, were Hungarian and Spanish, which, the paper says, have similar rhythms of vowels and consonants. The result hence indicates that the natural flow had been internalised and the novelty of a new language was detected. It was also found that longer headed dogs were more adept, suggesting a physical basis.

The activity in the secondary auditory cortex showed different activations when the matter heard was of the familiar or unfamiliar language. And there, the difference was more marked in the case of older dogs. This suggests that dogs can learn the specific regularity, or rhythm, characteristic of a language, through exposure.

The study shows that the dog brain has the capacity to detect speech naturalness and distinguish between languages. That there are different portions of the brain that handle the two kinds of discrimination may lead to greater understanding of how language is processed, by living things, or could be processed by a machine.

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PLUS POINTS

Golden eye

The National Aeronautics and Space Administration's new space telescope opened its huge, gold-plated, flower-shaped mirror last Saturday, the final step in the observatory's dramatic unfurling.

The last portion of the 21-foot mirror swung into place at flight controllers' command, completing the unfolding of the James Webb Space Telescope. "I'm emotional about it. What an amazing milestone. We see that beautiful pattern out there in the sky now," said Thomas Zurbuchen, Nasa's science missions chief.

More powerful than the Hubble Space Telescope, the $ (United States) 10 billion Webb will scan the cosmos for light streaming from the first stars and galaxies formed 13.7 billion years ago. To accomplish this, Nasa had to outfit Webb with the biggest and most sensitive mirror ever launched -- its "golden eye," as scientists call it.

Webb is so big that it had to be folded origami-style to fit in the rocket that soared from South America two weeks ago. The riskiest operation occurred earlier last week, when the tennis court-size sunshield unfurled, providing sub-zero shade for the mirror and infrared detectors.

Flight controllers in Baltimore, United States, began opening the primary mirror last Friday, unfolding the left side like a drop-leaf table. The mood was even more upbeat on Saturday, with peppy music filling the control room as the right side snapped into place. After applauding, the controllers immediately got back to work, latching everything down.

This mirror is made of beryllium, a lightweight yet sturdy and cold-resistant metal. Each of its 18 segments is coated with an ultra-thin layer of gold, highly reflective of infrared light. The hexagonal, coffee table-size segments must be adjusted in the days and weeks ahead so they can focus as one on stars, galaxies and alien worlds that might hold atmospheric signs of life.

The independent/agencies

Covid-19 study

Researchers from the Indian Institute of Technology-Mandi have identified the states with a high probability of being the first hotspots for the spread of Covid-19. The researchers reviewed the spread of Covid-19 and past pandemics in India for this study.

According to the study performed on 640 districts from 1 April to 25 December 2020, the hotspots of the pandemic in India have been states with high international migration and districts located close to large water bodies. States such as Maharashtra, Tamil Nadu, Gujarat, Rajasthan, Karnataka, Delhi, Uttar Pradesh, and Andhra Pradesh were hotspots for the pandemic in India. In almost all these states, international migration is a significant factor. For this reason, the researchers recommend that in future cases of pandemic outbreaks, travel to and from these states should be carefully monitored.

Researchers reviewed past pandemics and found common patterns between the Spanish Flu (1918-1919), H1N1 (2014-2015), Swine Flu (2009- 2010), and Covid-19 (2019-ongoing) outbreaks. They show water bodies have a strong influence on a region's microclimate in terms of temperature and humidity, contributing significantly to regional climate change. It is commonly referred to as the "lake effect".

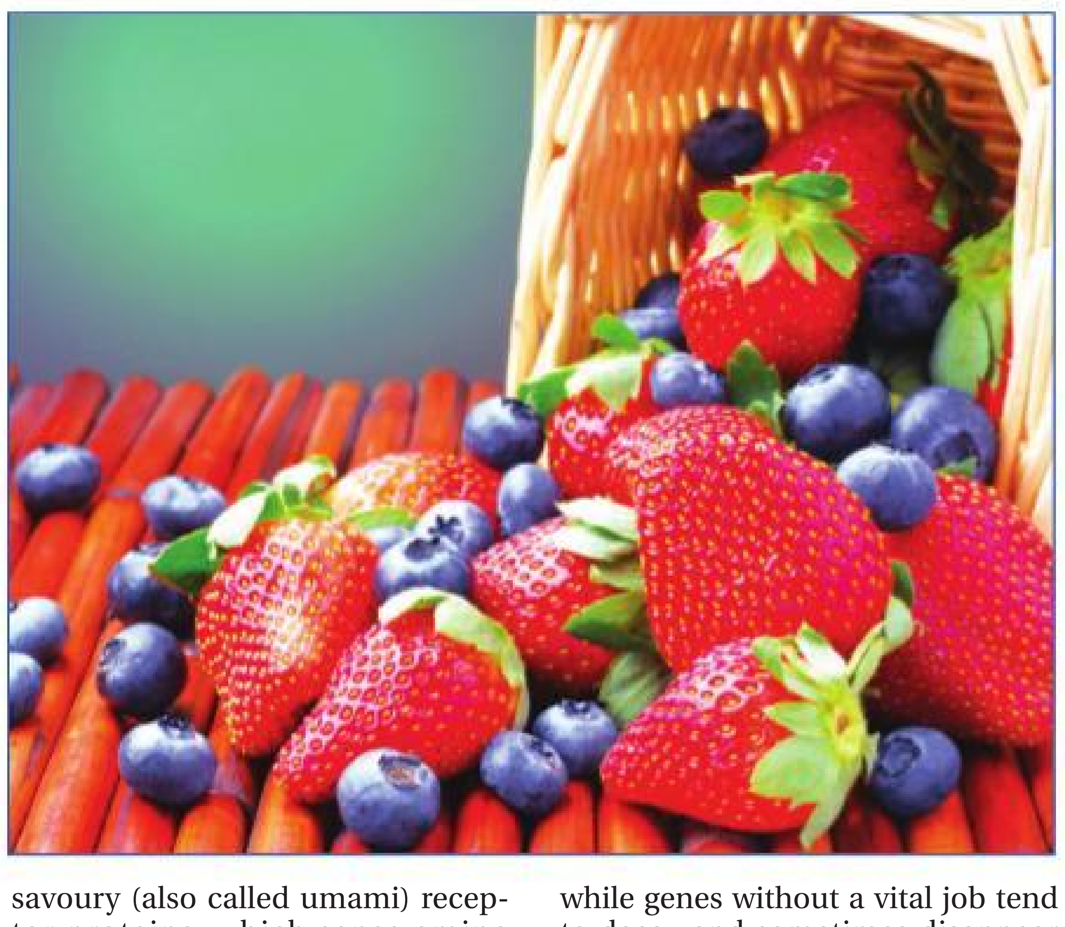
The research was led by Sarita Azad, associate professor, School of Basic Science, IIT-Mandi, and co-authored by Neeraj Poonia, research scholar, IIT-Mandi. The findings of the research have been published in *Current Science*.

The researchers have also examined the temperature variations across districts that are close to large bodies of water to understand the spread of Covid-19 in those areas. The average minimum and maximum temperatures in these districts are about 3 and 5 °Celsius lower than their neighbourhoods in July, which is attributed to the "lake effect". The cooler climate conditions may have contributed to the increase in cases in districts that are close to water bodies.

A TASTE FOR SWEET

An anthropologist explains the evolutionary origins of why you're programmed to love sugar

STEPHEN WOODING



The sweetness of sugar is one of life's great pleasures. People's love for sweet is so visceral, food companies lure consumers to their products by adding sugar to almost everything they make: yogurt, ketchup, fruit snacks, breakfast cereals and even supposed health foods like granola bars.

Schoolchildren learn as early as kindergarten that sweet treats belong in the smallest tip of the food pyramid, and adults learn from the media about sugar's role in unwanted weight gain. It's hard to imagine a greater disconnect between a powerful attraction to something and a rational disdain for it. How did people end up in this predicament?

I'm an anthropologist who studies the evolution of taste perception. I believe insights into our species' evolutionary history can provide important clues about why it's so hard to say no to sweet.

Sweet taste detection

A fundamental challenge for our ancient ancestors was getting enough to eat.

The basic activities of day-to-day life, such as raising the young, finding shelter and securing enough food, all required energy in the form of calories. Individuals more proficient at garnering calories tended to be more successful at all these tasks. They survived longer and had more surviving children -- they had greater fitness, in evolutionary terms.

One contributor to success was how good they were at foraging. Being able to detect sweet things -- sugars -- could give someone a big leg up.

In nature, sweetness signals the presence of sugars, an excellent source of calories. So, foragers able to perceive sweetness could detect whether sugar was present in potential foods, especially plants, and how much.

This ability allowed them to assess calorie content with a quick taste before investing a lot of effort in gathering, processing and eating the items. Detecting sweetness helped early humans gather plenty of calories with less effort. Rather than browsing randomly, they could target their efforts, improving their evolutionary success.

Sweet taste genes

Evidence of sugar detection's vital importance can be found at the most fundamental level of biology, the gene. Your ability to perceive sweetness isn't incidental; it is etched in your body's genetic blueprints. Here's how this sense works.

Sweet perception begins in taste buds, clusters of cells nestled barely beneath the surface of the tongue. They're exposed to the inside of the mouth via small openings called taste pores. Different subtypes of cells within taste buds are each responsive to a particular taste quality -- sour, salty, savoury, bitter or sweet. The subtypes produce receptor proteins corresponding to their taste qualities, which sense the chemical makeup of foods as they pass by in the mouth.

One subtype produces bitter receptor proteins, which respond to toxic substances. Another produces savoury (also called umami) receptor proteins, which sense amino acids, the building blocks of proteins. Sweet-detecting cells produce a receptor protein called TAS1R2/3, which detects sugars. When it does, it sends a neural signal to the brain for processing. This message is how you perceive the sweetness in a food you've eaten.

Genes encode the instructions for how to make every protein in the body. The sugar-detecting receptor protein TAS1R2/3 is encoded by a pair of genes on chromosome one of the human genome, conveniently named TAS1R2 and TAS1R3.

Comparisons with other species reveal just how deeply sweet perception is embedded in humans. The TAS1R2 and TAS1R3 genes aren't only found in humans -- most other vertebrates have them, too. They're found in monkeys, cattle, rodents, dogs, bats, lizards, pandas, fish and myriad other animals. The two genes have been in place for hundreds of millions of years of evolution, ready for the first human species to inherit.

Geneticists have long known that genes with important functions are kept intact by natural selection, while genes without a vital job tend to decay and sometimes disappear completely as species evolve. Scientists think about this as the use-it-or-lose-it theory of evolutionary genetics. The presence of the TAS1R1 and TAS2R2 genes across so many species testifies to the advantages sweet taste has provided for eons.

The use-it-or-lose-it theory also explains the remarkable discovery that animal species that don't encounter sugars in their typical diets have lost their ability to perceive it. For example, many carnivores, who benefit little from perceiving sugars, harbour only broken-down relics of TAS1R2.

Sweet taste liking

The body's sensory systems detect myriad aspects of the environment, from light to heat to smell, but we aren't attracted to all of them the way we are to sweetness.

A perfect example is another taste, bitterness. Unlike sweet receptors, which detect desirable substances in foods, bitter receptors detect undesirable ones -- toxins. And the brain responds appropriately. While sweet taste tells you to keep eating, bitter taste tells you to spit things out. This makes evolutionary sense.

So, while your tongue detects tastes, it is your brain that decides how you should respond. If responses to a particular sensation are consistently advantageous across generations, natural selection fixes them in place and they become instincts.

Such is the case with bitter taste. Newborns don't need to be taught to dislike bitterness -- they reject it instinctively. The opposite holds for sugars. Experiment after experiment finds the same thing -- people are attracted to sugar from the moment they're born. These responses can be shaped by later learning, but they remain at the core of human behaviour.

Sweetness in humans' future

Anyone who decides they want to reduce their sugar consumption is up against millions of years of evolutionary pressure to find and consume it. People in the developed world now live in an environment where society produces more sweet, refined sugars than can possibly be eaten. There is a destructive mismatch between the evolved drive to consume sugar, current access to it and the human body's responses to it. In a way, we are victims of our own success.

The attraction to sweetness is so relentless that it has been called an addiction comparable to nicotine dependence -- itself notoriously difficult to overcome.

I believe it is worse than that. From a physiological standpoint, nicotine is an unwanted outsider to our bodies. People desire it because it plays tricks on the brain. In contrast, the desire for sugar has been in place and genetically encoded for eons because it provided fundamental fitness advantages, the ultimate evolutionary currency.

Sugar isn't tricking you; you are responding precisely as programmed by natural selection.

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