Culture Guides Language Development

Ancestry determines the evolution of languages

We humans not only like to talk – and talk a lot – but we also do so in very different ways. It would appear that the structure of a language is defined by its cultural ancestry and not by the way the brain processes language. A group of researchers at the Max Planck Institute for Psycholinguistics in Nijmegen in the Netherlands has analyzed the order of sentence parts in more than 300 languages from four major language families. The researchers never found the same patterns consistently in all the families. Their new results contradict Noam Chomsky's idea of a universal grammar, and the theory of universal word order put forward by language researcher Joseph Greenberg. (Nature, published online, April 13, 2011)

Culture and language go together: Cultural development has a much stronger influence on how languages develop than do universal rules of language processing in the brain.

Wandering Women

Teeth reveal the home ranges of early hominids

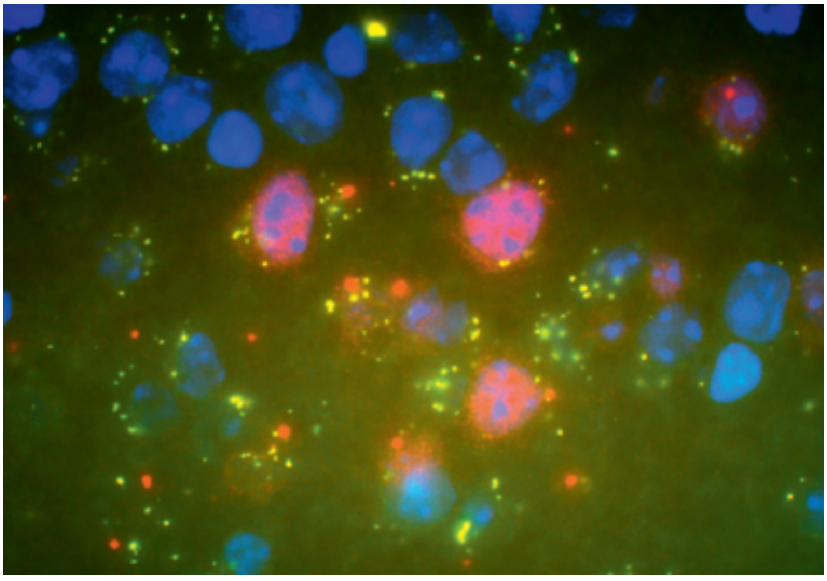
Approximately three million years ago, females left the groups they were born into more often than the males of their species. Scientists at the Max Planck Institute for Evolutionary Anthropology in Jena discovered this by using a new method to analyze strontium isotopes in tooth enamel. The isotope pattern characteristic for a region is absorbed with food and water and stored permanently in an animal's tooth enamel before it enters adulthood. The researchers examined 2.8- to 2-million-year-old teeth of *Australopithecus africanus* and 1.9- to 1.4-million-year-old *Paranthropus robustus* remains from caves in South Africa. In both prehistoric species, the isotope pattern in the teeth of the females was different from that of the region in which the skeletons were found; that of the men, in contrast, was the same. This indicates that, over the course of their lives, women left the group in which they were born and joined a new clan. The distribution pattern of the females in both species is thus similar to that of chimpanzees, bonobos and many human groups. (Nature, June 2, 2011)

P. robustus skull from the Swartkrans Cave in South Africa.

Photos: Daniel Etter (top), Darryl de Ruiter (bottom)

Hungry for Rewards

Insulin in the mid-brain and in the hypothalamus regulates eating behavior



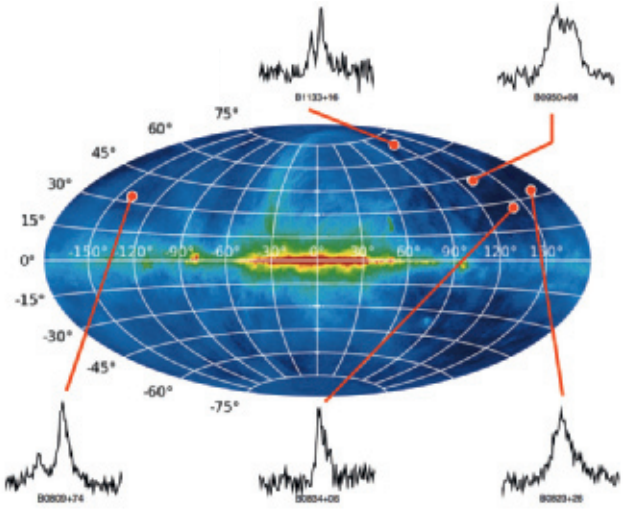
Visualisation of how insulin affects the SF-1 neurons of the hypothalamus. After stimulation with insulin, the SF-1 cells (red) form the signalling molecule PiP_3 (green). The cell nucleus is pictured in blue.

The brain controls the way we eat and suppresses hunger when the body has consumed enough energy. Various messenger substances inform the brain about our level of satiety; one of these is insulin, which is produced in the pancreas. Scientists at the Max Planck Institute for Neurological Research in Cologne have discovered that, in mice, insulin influences the appetite through nerve cells in the hypothalamus and in the mid-brain. According to the researchers, insulin in the hypothalamus suppresses the feeling of satiety when a high-fat diet is consumed. Insulin in the mid-brain, in contrast, signals satiety. Insulin-sensitive cells in the mid-brain are part of the brain's dopamine reward system. Their signals can override the network in the hypothalamus. This might explain why we continue to eat when an appropriate reward is offered, even though our energy requirement has been met – like when we eat chocolate despite being full. (Cell Metabolism, June 7, 2011; Nature Neuroscience, June 5, 2011)

Finger on the Pulse of Pulsars

European Lofar telescope provides the most sensitive observation to date at low frequency

An international team of astronomers including German scientists succeeded in recording the most sensitive observations to date of pulsars at low frequency. The measurement was undertaken with the European *Lofar* radio telescope network. Pulsars are fast-rotating neutron stars formed in the explosion of very massive stars (supernovae). *Lofar* is the first of a whole series of new types of radio telescopes used to investigate the universe at the lowest frequencies that are accessible from the ground. Finding and researching new pulsars in this "radio window" is considered a key project. The astronomers using *Lofar* have now returned to the frequency range of the first pulsar measurements taken in the 1960s. However, the power of the telescopes is increased many times over with modern computer technology and by connecting individual telescopes with high-speed fiber optic cables. *Lofar* will make it possible to investigate the radio pulses in detail, and also to study effects of gravitational physics and the properties of the interstellar medium in our Milky Way. (Astronomy & Astrophysics, DOI: 10.1051/0004-6361/201116681 astro-ph)



Thanks to its unique design, *Lofar* can record radiation from different parts of the sky. For this image, *Lofar* was used to observe five pulsars distributed throughout the sky.

Photo: MPI for Neurological Research; graphic: Tom Hassall/U.Man./ASTRON

Trust No One Over 50

Max Planck researchers investigate criminal behavior in older people

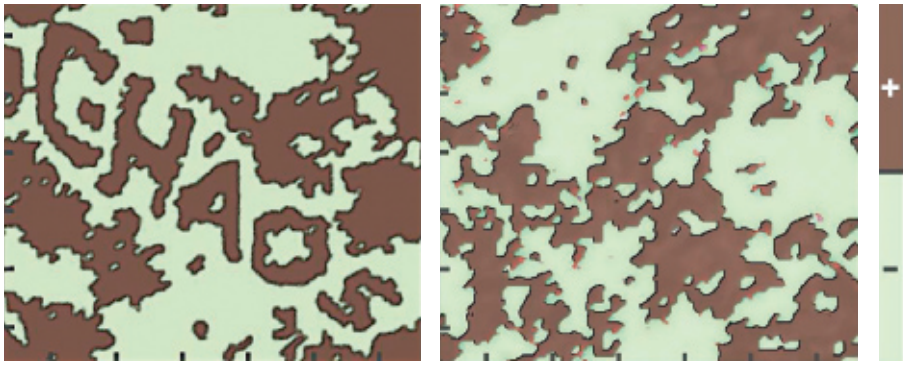
A study of women and men between 49 and 81 carried out by scientists at the Max Planck Institute for Foreign and International Criminal Law in Freiburg has indicated that criminal behavior is not a rarity among older people. The study reveals that they mainly commit fraud and offenses against property; examples include dishonesty in their tax declarations, making false insurance claims, driving while intoxicated, fare dodging and stealing. The delinquents are frequently financially secure and socially well integrated. The most frequent crime is drunk driving: almost all of those surveyed admitted to having sat behind the wheel of a car while under the influence of alcohol. However, in contrast to the commonly held view of crimes committed by older people, shoplifting did not feature significantly. Men offend more frequently than women, but with a ratio of 60-40, the male-female distribution is much more evenly balanced than with younger people. (Zeitschrift für Gerontologie und Geriatrie, February 2011)

There's no fool like an old fool: As a result of demographic changes, criminal behavior is increasingly exhibited by older people in Germany.

Strong Protection for Weak Passwords

The combination of simple codes and CAPTCHAs, which are encrypted even further in a chaotic process, yields effective password protection

In the future, passwords might be more secure and yet easier to remember. Researchers working with Sergej Flach at the Max Planck Institute for the Physics of Complex Systems use a two-part password and the physics of chaotic systems to provide innovative protection from computers that try out every possible combination of characters. They generate a CAPTCHA in a simulated physical system – this is the actual password that protects access to a file, for example. A CAPTCHA is a combination of characters with an indistinct outline that cannot be read by a computer. Currently, CAPTCHAs are used to test on a case by case basis whether a human or a computer program is retrieving data. The CAPTCHAs generated by the physicists in Dresden are too long and complicated for random attacks. As long as it is not necessary to read the CAPTCHA, it is rendered unrecognizable by a reversible chaotic system development and encrypted with a second password that is easy to remember and therefore weak. If this password is not entered correctly, a meaningless image results. There is no advantage in trying to crack the password with a computer program, as the distinction between a meaningful and meaningless image can be made only by a human. Using software would take an impractical amount of time. Online forums concerned with such matters deem the password-protected CAPTCHAs to be very secure. (arXiv, March 31, 2011)



Not machine-readable: The CAPTCHA, shown here with a simple password, is very grainy because it is generated in a physical system close to a critical phase transition (left). A reversible chaotic process makes it completely illegible.

Photo: iStockphoto (top); graphic: MPI for the Physics of Complex Systems – Sergej Flach

Negative Image of People Produces Selfish Actions

People's opinions of others determine how cooperative they are

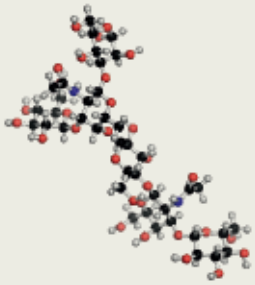
The "broken windows" theory: Broken windows in deserted buildings or garbage in the streets can lead to a neighborhood becoming completely run down. This is because these signs of decay give people the impression that social norms no longer hold sway. Funding for maintaining residential areas is also a good investment against crime.

The expectations people have about how others will behave play a large role in determining whether people cooperate with each other or not. This means that expectations become a self-fulfilling prophecy: someone who assumes that other people are egoistic will indeed encounter uncooperative behavior more frequently. Researchers at the Max Planck Institute for Research on Collective Goods in Bonn illustrated this with games for the common good played by people from Bonn and London. Players must decide between self-interest and socially minded behavior. It is best for society when everyone invests in the community; individually, however, freeloaders profit most. In the study, players from London behaved more egoistically than their counterparts from Bonn. This is presumably due to the Londoners' more pessimistic view of other people. When the players from Bonn found out about the more egoistic behavior exhibited by the Londoners, they were similarly less prepared to cooperate. (Max Planck Institute for Research on Collective Goods, 2011/05)

A Sweet Defense against Lethal Bacteria

A potential vaccine against an antibiotic-resistant pathogen that causes infection in hospitals can be manufactured synthetically

There is now a promising candidate for a vaccine against the *Clostridium difficile* pathogen that causes one of the infections most frequently found in hospitals. An international team working with Peter Seeberger at the Max Planck Institute of Colloids and Interfaces in Potsdam has manufactured a vaccine in which the key ingredient is a hexasaccharide from the bacterium's cell wall. To begin with, the team's chemists developed an efficient method to manufacture the complex sugar. The sugar-based vaccine elicited a specific and effective immune response in mice. The researchers also found antibodies in the stools of patients infected with C. *difficile*. As the antibodies help the natural immune response of humans to the infection, the researchers anticipate a powerful reaction to the synthetic vaccine.
(Chemistry & Biology, May 26, 2011)



Stimulating the immune system: The chemists in Potsdam have developed a hexasaccharide-based vaccine against the *Clostridium difficile* bacterium – a pathogen that causes serious gastrointestinal disease in hospitals.

Photo: istockphoto (top); graphic: MPI for Colloids and Interfaces

An Anabolic Steroid for Diatoms

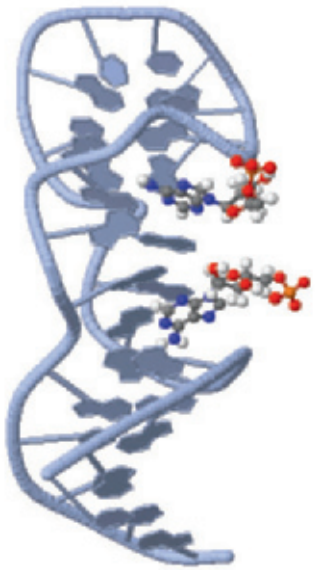
Nitrogen from the urea cycle makes diatoms superior to other single-celled organisms

An efficient processor of nitrogen:
The marine pennate diatom *Phaeodactylum tricornutum*.

In mammals, the urea cycle is a metabolic pathway that incorporates excess nitrogen in urea and eliminates it from the body. However, scientists from the Max Planck Institute of Molecular Plant Physiology have found that, in diatoms, it plays a key role in building compounds containing carbon and nitrogen. In the laboratory, they compared the reaction of algae cells with a functioning urea cycle and of those without to an excess of nutrients following a starvation period. They found that cell lines without a functioning urea cycle grew more slowly by 15 to 30 percent. The scientists therefore conclude that the urea cycle makes a significant contribution to the diatom's ability to respond to an increased supply of nutrients with a higher metabolic rate and growth. It would appear that the urea cycle in animals developed from a metabolic path that evolved earlier. Diatoms could thus be more closely related to animals than was previously suspected. (Nature, May 12, 2011)

Smelling the Genetic Code

It may soon be possible to identify very different substances, such as antibiotics, sedatives and explosives, with a type of multipurpose detector. To do this, researchers from the Max Planck Institute for Polymer Research use aptamers, which, generally speaking, are made from components of the genetic substances DNA or RNA. There are many different kinds of aptamers. Depending on the aptamers' chemical composition, molecules of the type to be detected attach themselves to them. The researchers place one end of the aptamer on a substrate and fix the other to the tip of a scanning force microscope. The tip is situated on the end of a very sensitive lever that the scientists raise in order to measure the force required to pull the aptamer apart. This changes when molecules of the substance being looked for are attached to the aptamer. (J. Am. Chem. Soc., February 2, 2011)



Versatile yet selective: The appropriate detectors for numerous substances can be found among the many different kinds of aptamers.
The molecule being analyzed, here AMP, binds to the matching location. This changes the force required to break the bond between the two halves of the aptamer.

The Amygdala Detects Spontaneity

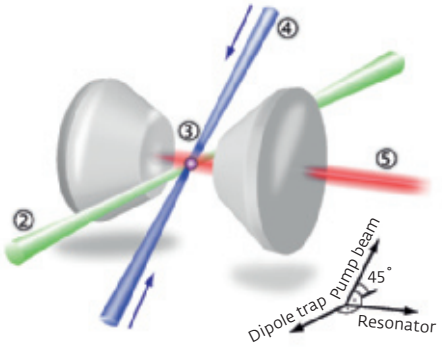
Jazz musicians demonstrate how the brain processes improvisations

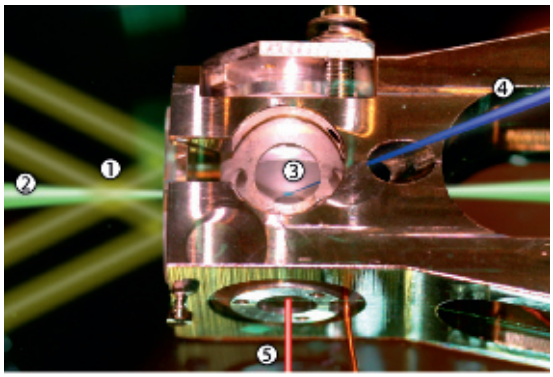
It is known that the amygdala and other parts of the brain simulate internally the perceived behavior of others. Scientists at the Max Planck Institute for Human Cognitive and Brain Sciences have now discovered that this network of areas responds extremely sensitively to improvisation. Researchers examined brain activity in jazz pianists who were asked to judge whether a melody was improvised or memorized. If it was thought to be improvised, the amygdala and several other areas of the brain were particularly active. The amygdala is very sensitive to stimuli that are difficult to predict or that are new. It can respond to the almost imperceptible fluctuations in volume and rhythm that occur in improvisations.
(Frontiers in Auditory Cognitive Neuroscience, published online, May 3, 2011)

Photo: Andrew Allen, Adrian Marchetti (top); graphic: MPI for Polymer Research

Single Atom Stores Quantum Information

It might be possible to construct a powerful quantum computer with a tiny memory





The information is held in the direction of polarization (left: diagram, right: original apparatus with laser beams drawn in): Vaporized rubidium atoms are caught with laser pulses in a magneto-optical trap (1) and cooled. In another laser beam, a dipole trap (2), single atoms are transported into the optical resonator (3) from two tapered mirrors. Weak light impulses from single photos (5) are stored with the aid of a control laser and read out again after a time in storage.

Data storage could hardly be smaller: Researchers working with Gerhard Tempe and Stephan Ritter at the Max Planck Institute for Quantum Optics in Garching have written the polarization – that is, the direction of spin orientation – of a single photon to a single rubidium atom. After it had remained in storage for a while, they read it out again. It was previously not possible to exchange quantum information between single photons – light particles – and single atoms, as they interact very weakly. The researchers thus placed a rubidium atom between the mirrors of an optical resonator. Using very weak laser pulses, they introduced photons singly into the resonator. These were reflected to and fro several times, making the interaction between the photons and the atom much stronger. This process can be used to construct powerful quantum computers and to network them over large distances. Photons are particularly suitable for exchanging information between individual components. The spin of individual atoms, in contrast, can be used to store and process the information. (Nature, May 1, 2011)

Photo and graphic: MPI for Quantum Optics (top), ESA/AOES Medialab (bottom)

Huge Storms Empty Galaxies

The Herschel Infrared Observatory discovers how Milky Way systems lose their substance

Space winds: The illustration shows a very bright infrared galaxy with massive outflows of molecular gas.

Huge clouds of molecular gas whirl around the centers of many galaxies, generating wind speeds of up to 1,000 kilometers per second – many thousands of times faster than storms on Earth. This discovery was made by astronomers from the Max Planck Institute for Extraterrestrial Physics in Garching using the Herschel Space Observatory, and it brought them considerably closer to solving a cosmic puzzle: When the universe was young, gas-rich galaxies merged, which not only created more stars, but also caused the black hole at their center to expand. However, this fertile phase came to an abrupt end when, within just a few million years, the number of star births fell rapidly and the black hole ceased to grow. During this period, which was short in cosmological terms, it is possible that extremely strong winds catapulted huge quantities of raw material (around a billion solar masses) out of the galaxy. They thus halted precisely those activities that had given rise to them in the first place, as they are driven by newly formed stars and by the shock waves from stellar explosions and the central black hole. (Astrophysical Journal Letters, Vol. 733, page L16)