

# Beautifully Sad

A new study shows why we enjoy negative emotions in film and art

We often perceive works of art that evoke negative emotions as more intense, more interesting and even more beautiful than a pure shower of positive emotions. Re-



Self-imposed pain: People who go to the movies also want to experience negative emotions, such as grief, fear and anger.

searchers working with Winfried Menninghaus, Director at the Max Planck Institute for Empirical Aesthetics, have developed a model that explains this apparent paradox. To this end, the scientists combined new findings in the psychology of emotion with basic principles of aesthetic perception. The model is based on two factors: First, people classify the perception of works of art in a different category of experience than that of day-to-day reality. This cognitive distancing creates a kind of safe space in which we can experience negative emotions. Second, art that involves us in the interplay of positive and negative feelings is more varied. The positively experienced narrative tension isn't possible without feelings of uncertainty or fear for the protagonists. In addition, the aesthetic power of the representation (the beauty of music, language or colors, for instance) renders the experience of negative emotions both more intense and more positive. And finally, searching for meaning can lead to discovering something positive even in negative feelings. ([www.mpg.de/11801437](http://www.mpg.de/11801437))

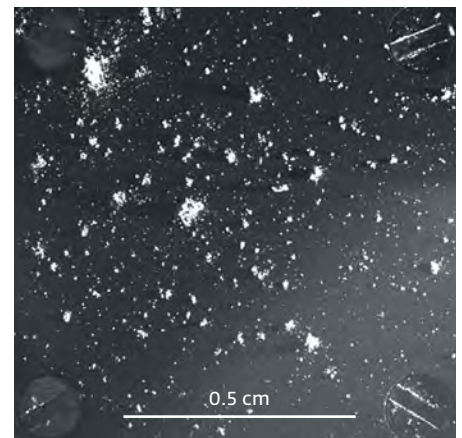
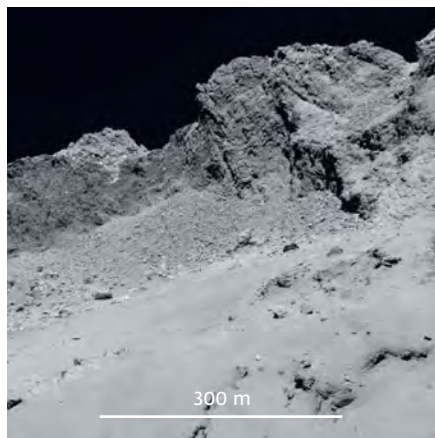
# Recipe for a Comet

Researchers analyze which chemical elements make up comet 67P/Churyumov-Gerasimenko

The dust that comet 67P/Churyumov-Gerasimenko spews into space consists of about 50 percent organic molecules. This material is also one of the most pristine and carbon-rich substances known in our solar system. These are the findings of a team that used an instrument on board the *Rosetta* space probe to investigate the comet. In their study, scientists from various institutes including the Max Planck Institute for Solar System Research are analyzing the chemical elements that make up comet dust more comprehensively than ever before. They collected and analyzed more than 35,000 dust particles of various sizes – from 0.01 to 1 millimeter in diameter – over a period of about two years. They bombarded these particles with a high-energy beam of indium ions, which released

secondary particles that they weighed and investigated in a mass spectrometer. The results showed that organic molecules account for about 45 per-

cent of the weight of the solid material; the rest is contributed by mineral substances, mainly silicates. ([www.mpg.de/11813538](http://www.mpg.de/11813538))



Glimpse of an alien world: As comet 67P/Churyumov-Gerasimenko approaches the Sun, frozen gases below the surface evaporate, dragging tiny particles of dust along with them (left). These dust grains can be captured and examined using the COSIMA instrument on board the *Rosetta* space probe. Targets such as this one, measuring only a few centimeters in size, act as dust collectors, retaining dust particles of up to 100 micrometers in size (right).

# Bacteria Replace Laboratory Animals

A new method to produce antibodies could reduce the need for animals in research

The antibodies of the immune system normally protect humans and other vertebrates against pathogens, but they are also indispensable tools for research, for example in microscopy. Researchers obtain them from the blood of such animals as donkeys, goats and rabbits by injecting these animals with a tiny amount of a substance the researchers want to investigate. The animals then form antibodies against the substance. As thousands of research laboratories around the world use these antibodies, the demand for animals is enormous. Researchers at the Max Planck Institute for Biophysical Chemistry in Göttingen have now developed an alternative that may soon drastically reduce the number of animals needed for antibody production. It relies on what are known as nanobodies: fragments of particularly simple miniature antibodies from the blood of camels and their relatives, the alpacas. The researchers in Göttingen can produce these nanobodies in any quantity using bacteria. This is not possible with conventional antibodies due to their complex structure. ([www.mpg.de/11868152](http://www.mpg.de/11868152))



Alpacas, which are native to the Andes, have special antibodies in their blood: they are much smaller and have a simpler structure than those of most other mammals, enabling them to be produced in large quantities using bacteria.

## Revenge Is Sweet

Living together in a community requires that members cooperate with each other. To achieve this, uncooperative behavior is often punished. Researchers at the Max Planck Institutes for Evolutionary Anthropology and for Human Cognitive and Brain Sciences in Leipzig have now discovered that even six-year-old children reprimand antisocial conduct. To investigate children's behavior, the researchers staged a puppet show: a friendly character gave the children their favorite toy, a mean one kept the toy for itself, and a third played the role of punisher. In the case of the friendly puppet, the children usually did not want to watch it suffer. If, in contrast, the mean one was punished, many six-year-olds even spent money to witness the punishment – but the four- and five-year-old spectators did not. The researchers observed similar behavior in chimpanzees in a zoo, but they don't know yet whether the children or the chimpanzees feel something like spite when watching the punishment. ([www.mpg.de/11866358](http://www.mpg.de/11866358))

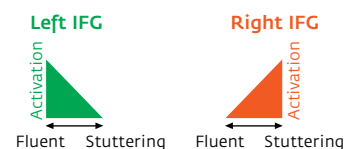
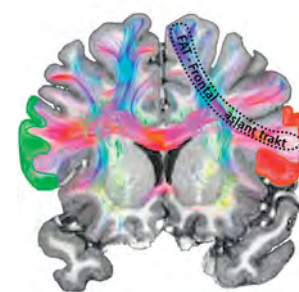
Photos: Irene Böttcher-Gajewski/MPI for Biophysical Chemistry (top), MPI for Human Cognitive and Brain Sciences (bottom)

## Stop Signals in the Brain

A hyperactive network in the right frontal lobe inhibits the flow of speech

Roughly one in every one hundred adults in Germany stutters. Based on previous studies, we know that an imbalance in activity in the left and right hemispheres inhibits the flow of language: a region in the left frontal lobe is underactive while the corresponding region in the right hemisphere is overactive. Using magnetic resonance imaging (MRI), scientists at the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig have now found that overactivity in the right inferior frontal gyrus is actually what causes stuttering. In people with speech disorders, this region is linked to other areas of the brain via an unusually strong fiber tract. This part of the frontal lobe is particularly active in all people when we stop speech movements. Exces-

sive inhibition of the motor functions required for speaking could therefore be the real cause of stuttering. ([www.mpg.de/11856655](http://www.mpg.de/11856655))



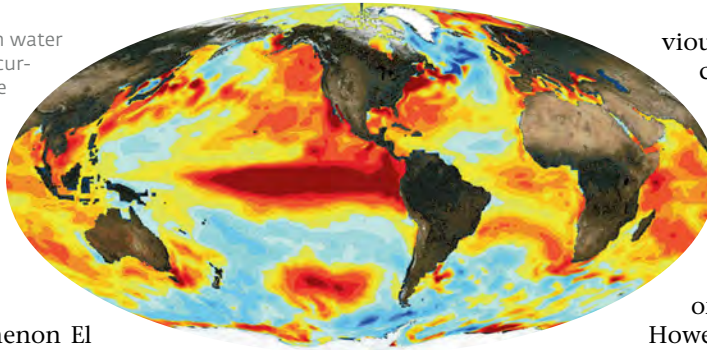
Normally, the right inferior frontal gyrus (IFG) in the frontal lobe stops the flow of speech, while the left one supports it. In people who stutter, these two areas are conversely activated: the right IFG is overactive and shows stronger connections with the frontal aslant tract. This inhibits activity in the left IFG and thus the flow of speech.



# El Niño Intensifies the Greenhouse Effect

The climate phenomenon causes a rise in atmospheric carbon dioxide

El Niño wreaks havoc with water temperatures and ocean currents in the Pacific near the equator every two to seven years. Most recently, this climate phenomenon significantly increased water temperatures in the eastern and central Pacific (red) in December 2015.



The climate phenomenon El Niño fuels the greenhouse effect more than previously assumed. According to an international team of researchers from the Max Planck Institutes for Chemistry in Mainz and Biogeochemistry in Jena, the concentration of carbon dioxide in the atmosphere rose by 8.8 billion tons as a result of the 2015-16 El Niño. That corresponds to about one quarter of the world's annual carbon dioxide emissions caused by human activities. Pre-

viously, geoscientists assumed that this climate event releases 1.2 billion tons of carbon dioxide, as droughts result in more peat, bush and forest fires in these years. The much larger amount that has now been determined from satellite data is apparently due primarily to plants absorbing significantly less carbon dioxide in regions influenced by El Niño. However, the researchers assume that, unlike man-made emissions and the increase in carbon dioxide caused by fire, this increase in greenhouse gases due to reduced biomass production will be reversed after El Niño years because plants absorb more carbon dioxide. But human activity is likely to exacerbate the problem: particularly peat fires that are deliberately set, for instance, tend to get out of control more easily in regions that have been dried up by El Niño.

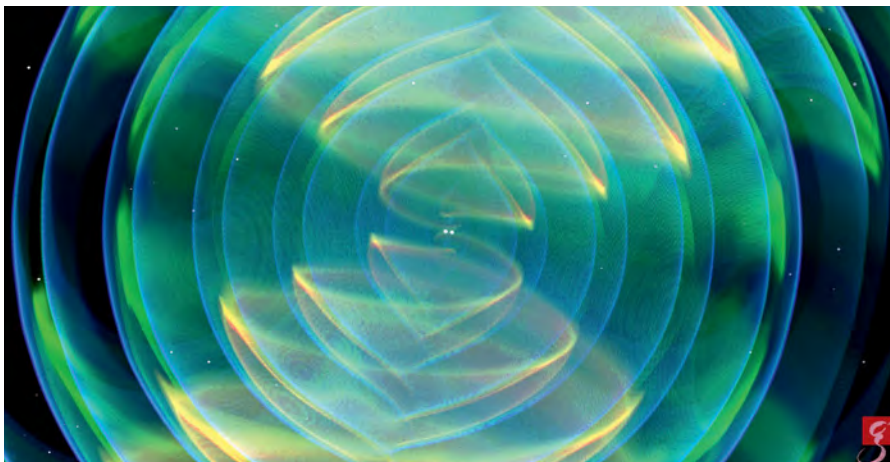
# Gravitational Waves from Neutron Stars

The cosmic event was also observed in visible light and provides an explanation for gamma-ray bursts

For the first time, researchers simultaneously measured the gravitational waves of two merging neutron stars and registered the light from this event in several areas of the electromagnetic spectrum. This discovery on August 17,

2017 confirms what theorists had long suspected: that the collision of neutron stars leads to a short gamma-ray burst. In addition, the explosion that follows, known as a kilonova, is the source of heavy elements such as gold, platinum

and lead. The two LIGO detectors in Hanford, Washington (USA) and Livingston, Louisiana (USA) observed the signal referred to as GW170817 for around 100 seconds, and the simultaneous measurements of the Virgo detector in Tuscany improved localization in the firmament considerably. Meanwhile, the Fermi and Integral satellites registered a gamma-ray burst from roughly the same direction as the gravitational wave signal. Finally, optical telescopes discovered a point of light located in the NGC 4993 lenticular galaxy system, approximately 130 million light-years away – apparently the origin of the cosmic collision. ([www.mpg.de/11646260](http://www.mpg.de/11646260))



Dance of the heavyweights: Two neutron stars orbit each other, spiraling ever closer together, radiating gravitational waves in the process.

# Light Makes Algae Sticky

The fine hairs of *Chlamydomonas*, a unicellular alga, adhere to surfaces only when illuminated



Sunlight enables green algae to do more than just carry out photosynthesis, with which they produce sugar. As physicists at the Max Planck Institute for Dynamics and Self-Organization in Göttingen have now observed for the first time, blue light also makes the flagella of these unicellular organisms sticky. The microorganisms use these fine hairs to swim in the dark through their aqueous habitat, but the light-controlled adhesion allows them to latch onto surfaces that are suitable for their nutrient production. These findings could help genetically paralyze the light switch in algae for the production of biofuels. This would prevent the microorganisms from forming on the glass of reactors and reducing their efficiency. ([www.mpg.de/11493896](http://www.mpg.de/11493896))

In blue light, the proteins in the flagella of green algae rearrange themselves, moving sticky protein molecules toward the outside and causing the fine hairs to adhere to surfaces.

## Flying South Pays Off

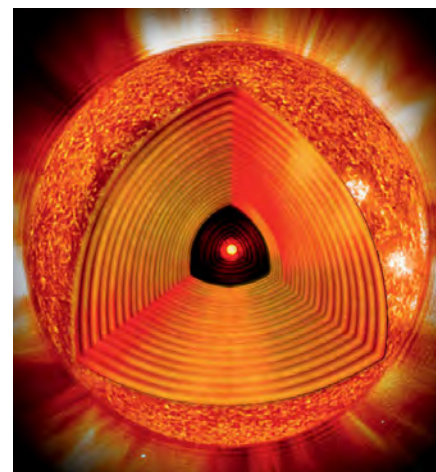
About half of the songbirds that live in Germany fly south in the fall – it's warmer there, and there's plenty of food. However, the journey is arduous and dangerous. So, is it really worthwhile for migratory birds? Blackbirds are ideal subjects for studying this question, as only some of the birds in central Europe fly south in the fall, while the rest of them brave the cold here. That's why, for several years, researchers at the Max Planck Institute for Ornithology in Radolfzell ringed almost 500 blackbirds at Lake Constance or fit them with small tracking devices, then looked for ringed returnees from the south in spring. Automatic recording devices installed in the study area also indicated whether birds wearing a radio transmitter were still alive. The researchers found that winter is the most critical phase in the life of a blackbird. Most of them die in this period, regardless of whether they migrate south or remain here. However, the migratory birds are considerably more likely to survive the winter than those that remain in central Europe. ([www.mpg.de/11778765](http://www.mpg.de/11778765))

# Looking Deep into the Heart of Stars

Researchers measure the structure of distant suns from their oscillations

Looking inside a star would seem to be an impossible task. Now, for the first time, a team led by Earl Bellinger and Saskia Hekker at the Max Planck Institute for Solar System Research has succeeded in doing just that. To this end, the researchers observed the oscillations of the stars, which propagate like sound waves inside them, based on fluctuations in the stars' brightness – a method used in the field of asteroseismology. By analyzing the oscillation frequencies, the scientists determined the structure of binary stars 16 Cygni A and B, located 70 light-years away from Earth. Bellinger and Hekker

adapted various stellar evolution models until one of them fit the observed frequency spectrum. Finally, the inverse method showed that the speed of sound in the central regions of the two stars is greater than that predicted by the models. In the case of 16 Cygni B, these differences can be explained by correcting the mass and size of the star. For 16 Cygni A, however, no model could be found that explains the observations: it seems that some physical phenomena have not yet been taken into account in the current theories of stellar evolution. ([www.mpg.de/11872053](http://www.mpg.de/11872053))



Into the heart: An artist's impression of the interior of the star, which can be studied through oscillations on its surface.



# On the Leash!

Max Planck researchers discover the oldest images to date of dogs on leashes

Dogs are considered to be man's oldest companions, but the role these animals played in early human history remains shrouded in mystery. While conducting research in Saudi Arabia, scientists from the Max Planck Institutes for the Science of Human History and for Evolutionary Anthropology discovered images that provide the first ever insight into life with dogs at that time. The rock carvings are estimated to be between 8,000 and 9,000 years old. They depict hunting scenes: men with bows and arrows shooting at gazelles and antelopes, dogs holding lions and leopards in check, and dogs killing smaller game by biting them. It is notable that individual dogs are kept on leashes. Images of leashes had previously been found only in ancient Egyptian art, which is much more recent. People may have wanted to prevent valuable dogs that were particularly adept at picking up the scent of prey from getting injured during the hunt. Or they may have wanted to keep the dogs close to them for their own protection. Another possibility is that they put leashes on young dogs that they wanted to train. ([www.mpg.de/11802436](http://www.mpg.de/11802436))

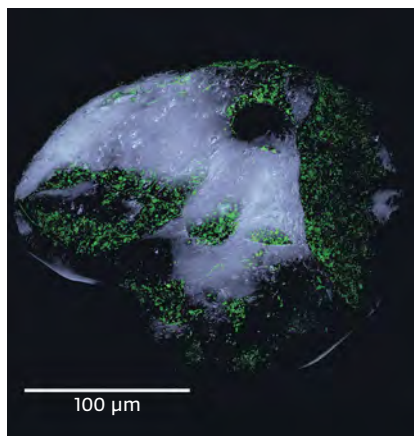


Large hunting scene: The lines connecting two of the dogs to the hunter on the right are clearly recognizable. The carvings were highlighted in white to make the images clearer.

## Sand Is a Paradise for Bacteria

A single grain of sand harbors as many as 100,000 microorganisms

Anyone who builds a sandcastle at the beach is also installing billions of bacteria: according to a study carried out by researchers at the Max Planck Institute for Marine Microbi-



A grain of sand under a fluorescence microscope: The green spots are stained bacteria that have colonized primarily the depressions on the surface.

ology in Bremen, between 10,000 and 100,000 microorganisms live on each individual grain. They bustle about almost exclusively in protected cracks and depressions in the grains, avoiding exposed areas. The diversity of bacteria is impressive, too, with species numbering several thousand. Together, the sand and its inhabitants act as a purifying filter that breaks down substances dissolved in seawater. The distribution of the bacterial species is important for this filter function: more than half of the species are found on all grains. Each grain thus has the same fundamental population. Thanks to the great diversity, sand cleans seawater even under diverse environmental conditions. ([www.mpg.de/11830658](http://www.mpg.de/11830658))

## Less Fertilizer Decreases Fine Particulate Matter

There are many sources of particulate matter – not just traffic, which is a frequent target of particular scrutiny for this. Calculations performed by researchers at the Max Planck Institute for Chemistry in Mainz show that the amount of harmful particulate matter could also decrease considerably if fertilization and livestock breeding were to be reduced, thus releasing less ammonia. Reducing ammonia emissions by 50 percent worldwide would lower the impact of particularly harmful particles with a diameter of less than 2.5 micrometers by 11 percent in Europe, 19 percent in the US and 34 percent in China. Since ammonia and the resulting particulate matter spread out over large areas, this would also have a major impact on the health of exceptionally polluted cities: according to calculations by the researchers in Mainz, a 50 percent reduction in agricultural emissions could decrease deaths attributable to air pollution by 8 percent globally – corresponding to 250,000 deaths each year. ([www.mpg.de/11667398](http://www.mpg.de/11667398))

# Less Stress, More Social Competence

Adults, too, can acquire skills such as empathy – and can personally benefit from them

The human brain can change and adapt to new conditions throughout life. Until recently, it was unclear to what extent this also applies to brain areas that control our social behavior. To find out, a research team led by Tania Singer, Director at the Max Planck Institute for Human Cognitive and Brain Sciences, developed special meditation techniques that train social skills. One method focused on socio-affective skills, such as compassion, gratitude and dealing with difficult emotions. This involved two people from a larger group sharing their emotions with each other. A second technique targeted socio-cognitive skills – in particular the ability to assume others' perspectives – through partner-based exercises and classical meditation. For comparison, there was a third module that used conventional mindfulness training. The researchers found that the brain regions trained in each case actually grow larger and the specific social skills or attention improve in all participants. In addition, the two so-

cially oriented methods strengthened the stress resistance of the participants measurably. The mindfulness training,

which is frequently used with burn-out patients, failed to achieve this effect. ([www.mpg.de/11533187](http://www.mpg.de/11533187))



Chilling out: One of the goals of meditation is to forget about life's adversities. The best way to reduce social stress is with special partner-based meditation exercises.

## Fibers Spun from Slime

Under the influence of shear forces, nanoparticles from the secretion of velvet worms form stiff polymer threads that can be recycled in water



Nature is always a good teacher for materials scientists. Chemists, for instance, could develop reusable polymers using velvet worms as a model. These small, worm-like animals shoot a sticky secretion at prey and predators. As soon as the victim moves and tries to escape, the secretion hardens into firm threads. Scientists at several institutes including the Max Planck Institute of Colloids and Interfaces have now found that this slime con-

tains tiny globules that are each made up of balled-up protein filaments and fat molecules and measure 75 nanometers in diameter. Under the influence of force, the proteins unravel to form elongated fibers, which the fat molecules surround. The biomolecules retain this shape when they dry. In water, however, the fibers dissolve again and form the same nanoparticles contained in the original secretion. ([www.mpg.de/11550818](http://www.mpg.de/11550818))

Sophisticated hunting weapon: Velvet worms, which look like caterpillars with short legs, capture their prey with a secretion that forms polymer threads as soon as their victim moves.