Rudolph is real

By using a form of microscopy, a study had found that reindeer actually have red noses

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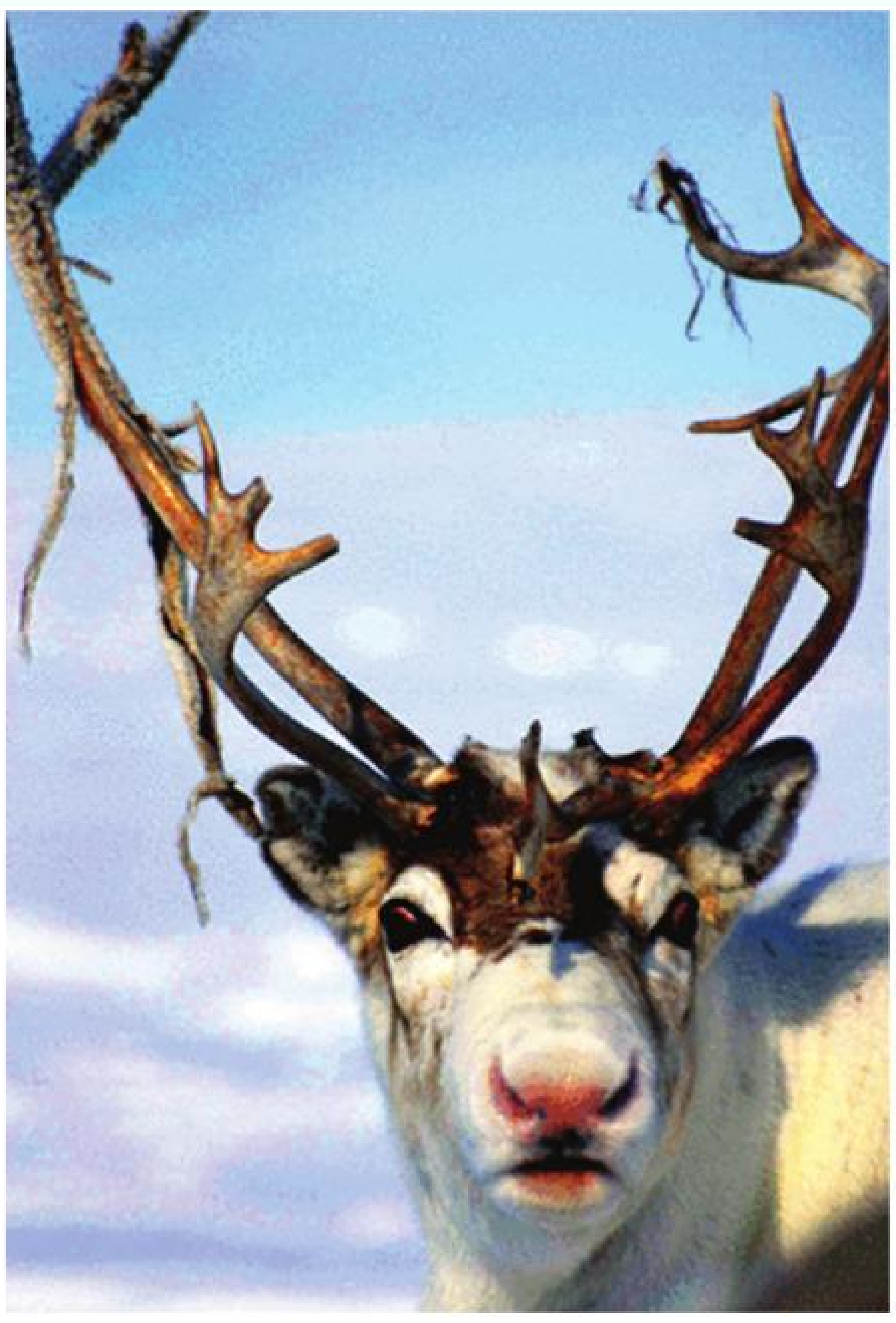

It is just past Christmas and Santa Claus may have got back to the North Pole, riding his sleigh drawn by reindeer. Legend has it that the leader of the pack is Rudolf, the reindeer who was "kept out of reindeer games" by other reindeer because of his "red nose". This was till Santa said, one Christmas eve, "Rudolph, with your nose so bright, won't you guide my sleigh tonight?" Scientists in The Netherlands and Norway have found that reindeer do have noses that are red, and for good reason.

Anne-Marije van Kuijen, Wytske J Fokkens, Arnoldus S Blix, Dan M J Milstein, Koray Yürük and Lars P Folkow, from Medical Centres in the Erasmus University, Rotterdam, and the University of Amsterdam, and the department of arctic and marine biology, University of Tromsø, Norway, harnessed the technology of "hand-held video microscopy" to delve into the blood flow in the tissues of the nose. Apart from human noses, they also studied reindeer, and in a paper in one Christmas issue of *BMJ*, the journal of the British Medical Association, they find that Rudolf's red nose is because of "highly dense and rich nasal microcirculation."

Microcirculation

Circulation of blood takes place through macro-circulation, or blood flow to and from organs. And within organs the flow is through finer blood vessels, the capillaries, which can be as narrow as 10 microns in diameter. It is at this "delivery end" of circulation that the finest blood vessels communicate with cell tissue to regulate blood pressure, fluid levels, exchange of nutrients and gases and temperature. Such finest blood vessels have specific structures to help these functions, to permit a smooth blood flow, transfer of water and dissolved material through the vessel wall and arrangements to constrict the vessels to regulate blood pressure.

A part of the body that is well provided with such blood vessels, for special functions, is the lining of the nose. "The nasal microcirculation has important physiological roles such as heating, filtering, and humidifying inhaled air, controlling inflammation, transporting fluid for mucous formation, and delivering oxygen to the main, functional nasal cells and also in the uptake of drugs and responses to allergens," says the paper.

The way the nasal blood-tissue interface senses and regulates much of the body's adaptation to the environment is through continuous contact and interaction with inhaled air. In many animals, the nose is an organ that is highly adapted. A well-known example is the cold nose of the dog, its unparalleled organ of scent. Another is the nose-like region in the head of the snake, which has evolved to be heat-sensing, and helps them locate prey.

In the case of humans, however, enquiry was hampered by difficulty of access, while people are conscious and their noses are in action. This, fortunately, has changed, with the development of devices that allow *in vivo* microscopy and even video imaging within organs. The devices have proved to be powerful diagnostic tools and it has been found that a most sensitive indicator of outcome and response to treatment is the microcirculation in the nose.

The researchers used adult volunteers to assess the nature and responses. The circulation was imaged using probes that allowed a lens to be inserted into the nasal cavity and the data was analysed using specialised software, and statistical methods. The imaging revealed dense capillary formations in loops or circles, with hairpin-like branching, to the exclusion of larger vessels. The analysis allowed an assessment of how the blood flow changes when different drugs are administered or when there are changes in the layout of capillaries in a volunteer with diseased nasal tissue.

While the focus has thus moved to the study of the nose in the case of humans, among animals, the nose has lent itself to a variety of ways of adaptation, by different species. A specific instance is that of the Arabian Ibex, an animal that can survive in desert conditions of heightened temperature and very low humidity. It economises on the use of water for cooling by allowing its body temperature to rise but still ensures temperature regulation of blood supply to the brain, with the help of a moisture-saving, evaporative cooling mechanism located in the nasal passage. While this is an adaptation for arid and high temperature, the Netherlands/Norway study has found a parallel adaptation of the reindeer nose, but to suit the sub-zero conditions of the Tundra.

Reindeer

The mammalian, or reptile, nose needs to be kept moist and irrigated, apart from temperature regulated, so that it can respond to gases and other factors in the environment. The moist nose of the dog is a great example of the organ being both sensitive and cool, for the best response. In the case of the reindeer, which inhabits ice-bound areas, cooling for better response may not be relevant. Conversely, at sub-zero temperatures, olfactory response comes down. And, there is the possibility of the moist reindeer nose getting covered with frost! The need of the hour is thus warming -- and this can come about by the flow of warm blood.

The authors of the *BMJ* paper carried out a hand-held video microscopy study of the reindeer nose cavity of reindeer in Norway. The results were that reindeer nose mucous tissue is a good 25 per cent richer in capillary structures than the human nose. Infra-red-light studies of reindeer showed that their nose is indeed red, and this is a result of concentration of blood supply to the nose, as an adaptation to extreme cold. The study also revealed gland-like structures in the mucous lining of the reindeer nose, which may be for maintaining humidity and fluids.

The study reported is of some years ago, and there may be better data available by now. But the study brings Christmas cheer, for it tells us that Rudolf's red nose is for real!

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Wide open nose

An effect of alcohol in the bloodstream is that the peripheral capillaries, or the outermost, fine blood vessels of the body, get dilated or widen. There is thus increased blood flow and a rise in the body surface temperature. This is the reason that a shot of brandy gives a feeling of warmth, particularly if one is well-covered or indoors.

Conversely, the body adapts by constricting peripheral capillaries when it is cold. Swigging brandy when out in the cold could thus result in more loss of body heat. Or worse, a well-covered person could feel warm and unbutton a coat, resulting in exposure.

Readers of Asterix comics would recollect the dipsomaniac legionnaire Tremensdelirious, whom Caesar wanted to put in his place by gifting him the one village in all of France which the Romans could not control (*Asterix and Caesar's Gift*). The images of Tremensdelirious show him with a nose that is beetroot red -- all because the capillaries of his nose are wide open because of wine!

HOW DO FIREWORKS WORK?

PAUL E SMITH

A pyrotechnics chemist explains the science behind the brilliant colours and sounds

For many people around the world, the very first moments of the new year will be filled with the sounds and colourful light shows of fireworks. From loud bangs to long whistles, bright reds to pale blues, there are thousands of variations of fireworks and an entire branch of chemistry that explores these fun explosions.

I'm a chemist and president of the Pyrotechnics Guild International, an organisation that promotes the safe use of fireworks to celebrate holidays like the New Year.

There are hundreds of chemical formulas -- or as I like to think of them, pyrotechnic recipes -- for fireworks. These recipes are still based on an ancient mixture of chemicals that produces the quintessential bang, but modern fireworks use all sorts of chemical magic to put on the incredible shows of today.

It all starts with black powder

The first ingredient of any firework is the ancient explosive black powder. It was discovered by Chinese alchemists more than a thousand years ago, and the recipe has been virtually unchanged in the centuries since. To make black powder, all you need to do is mix 75 per cent potassium nitrate, 15 per cent charcoal and 10 per cent sulphur. To make a basic firework or firecracker, you just put this powder in a container, usually made of thick cardboard or paper.

Black powder is used to launch the firework in the air as well as ignite and propel the effects -- like colour -- into a pattern in the sky. So how does it work?

Once lit with a fuse or spark, the sulphur melts first at 112.8oC. The sulphur flows over the potassium nitrate and charcoal, which then burn.

This combustion reaction quickly produces a large amount of energy and gas -- in other words, an explosion. If there is a small hole for the gas to escape, the reaction launches the firework into the air. In a very confined space, it blasts the components of the firework apart and ignites everything nearby.

In addition to changing how confined the black powder is, changing the size of the granules of powder can change how fast it burns, too. Think about a campfire. When you add a large tree limb the flames burn longer and slower. If you toss a handful of sawdust into the flame it burns hot and fast. Black powder works similarly, and this makes it easy to control how much and how fast energy is released.

Different chemicals for different colours

If you put very fine black powder in a confined space it explodes in a cloud of heat, gas and noise. So, where do the colours and bright light come from?

When you heat up any material, what you're really doing is putting energy into the electrons of that material's atoms. If you excite the electrons enough, when they fall back to their normal energy levels, they release that excess energy as light.

There are several different elements that, when added to a firework and heated, release different wavelengths of light that appear as different colours. Strontium makes red. Barium produces green. Copper burns blue, and so on.

Making fireworks that produce blues has long been a challenge for fireworks chemists. Deep blues are too dark and can't be seen against the night sky. But if the blue is too light, it appears white. Therefore, the wavelength of the "perfect blue" must be very precise. This is hard to achieve because blue light has a shorter wavelength -- meaning the distance between the peaks and valleys of the wave of light are very close together.

Certain elements produce different colours, but what about sparkles and flashes? To make these effects, various metals can be added to the pyrotechnic formulas. Aluminum, magnesium and titanium all produce white sparks. By adding iron, you get gold sparks. Mixing in various types of charcoal can produce red and orange sparks. Each of these elements burns at a different speed and in a different way and so produces varying colours and intensities of light.

Making a whistle or a boom

The final piece of a good firework is an exciting sound effect.

To add sound effects to fireworks you need a formula that produces a large amount of gas very quickly. If a firework has a small opening for the gas to exit through it will produce a whistling sound. The velocity of the gas and size of the opening will vary the pitch and sound of a whistle.

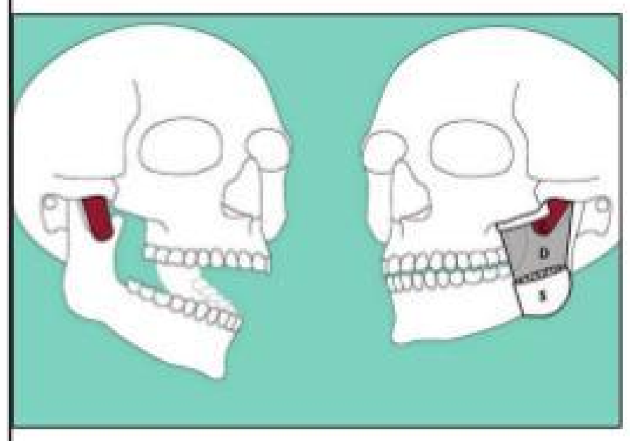
Making a boom is much easier. Simply put an energetic formula in a confined space with nowhere for the gas to go. When ignited, the pressure will build and the firework will explode, producing a sudden boom or bang.

As you watch the fireworks this New Year's Eve or launch some of your own in the backyard, you'll now know how they work. Fireworks are a lot of fun, but the explosions and burning chemicals are dangerous -- even if they do come in colourful packaging. If you can legally launch consumer fireworks in your town, please handle them properly.

The writer is a lecture demonstrator for chemistry, Purdue University, United States. This article first appeared on www.theconversation.com

PLUS POINTS

New muscle layer



Scientists have identified a new layer of muscles behind the cheeks that stabilise the lower jaw, a new finding that could rewrite anatomy textbooks.

The masseter muscle at the back of the cheeks -- considered the most prominent of the jaw muscles -- was until now thought to be made of one superficial and one deep layer, said scientists led by Szilvia Mezey from the University of Basel in Switzerland. The action of this muscle is prominently felt at the back of the cheeks when one presses the teeth together, they said.

The study, published in the journal *Annals of Anatomy* on 2 December, describes the structure of the masseter muscle as consisting of an additional third, even deeper layer. "This deep section of the masseter muscle is clearly distinguishable from the two other layers in terms of its course and function," Mezey explained in a statement. She said this layer is involved in the stabilisation of the lower jaw and could be the only part of the masseter that can pull the lower jaw backwards toward the ear.

Earlier studies had also suggested there could be three layers to the masseter muscle, but researchers said these divided the superficial section of the masseter into two layers. They had agreed with standard works in their description of the deeper section.

In the new research, scientists assessed jaw muscles preserved in formalin and computer tomographic scans of stained tissue sections of the muscles from deceased individuals who had donated their bodies to science. They proposed that this new layer be given the name *Musculus masseter pars coronidea*-- the coronoid section of the masseter in other words -- indicating it is attached to the muscular or "coronoid" process of the lower jaw.

Jens Christoph Türp from the University of Basel said, "Although it's generally assumed that anatomical research in the last 100 years has left no stone unturned, our finding is a bit like zoologists discovering a new species of vertebrate."

The Independent

Looking in

A collaborative research team comprising scientists from the Indian Institute of Technology-Mandi, National Brain Research Centre, India and University at Buffalo, United States, performed mathematical simulation studies on non-invasive brain simulation techniques. The results of the team's recent work in the area have been published as an abstract in the journal, *Brain Stimulation*. It has been co-authored by Shubhajit Roy Chowdhury from IIT-Mandi, Yashika Arora from the National Brain Research Centre and Anirban Dutta of University at Buffalo.

Transcranial electrical stimulation, or TES, is a non-invasive brain stimulation technique that passes an electrical current through sections of the brain to study or alter brain function. This is not a new concept, and dates back even before the discovery of electricity.

In modern day TES, multiple electrodes are applied to the scalp of the patient, and current is passed between the electrodes through the soft tissue and skull. Part of the current penetrates the brain and affects the nerves, resulting in altered activity. Beyond being explored as a curative, TES is considered useful to map the functions of the brain.

Given the important nature of the brain, the use of electricity on it can be dangerous if outcomes are not known. The response of various blood vessels in the cranium and various neurological pathways to TES must be clearly understood to get maximum benefit of the procedure, with minimum damage. The multi-institutional research team has, therefore, developed a mathematical model to understand the physiological effects of non-invasive brain stimulation.