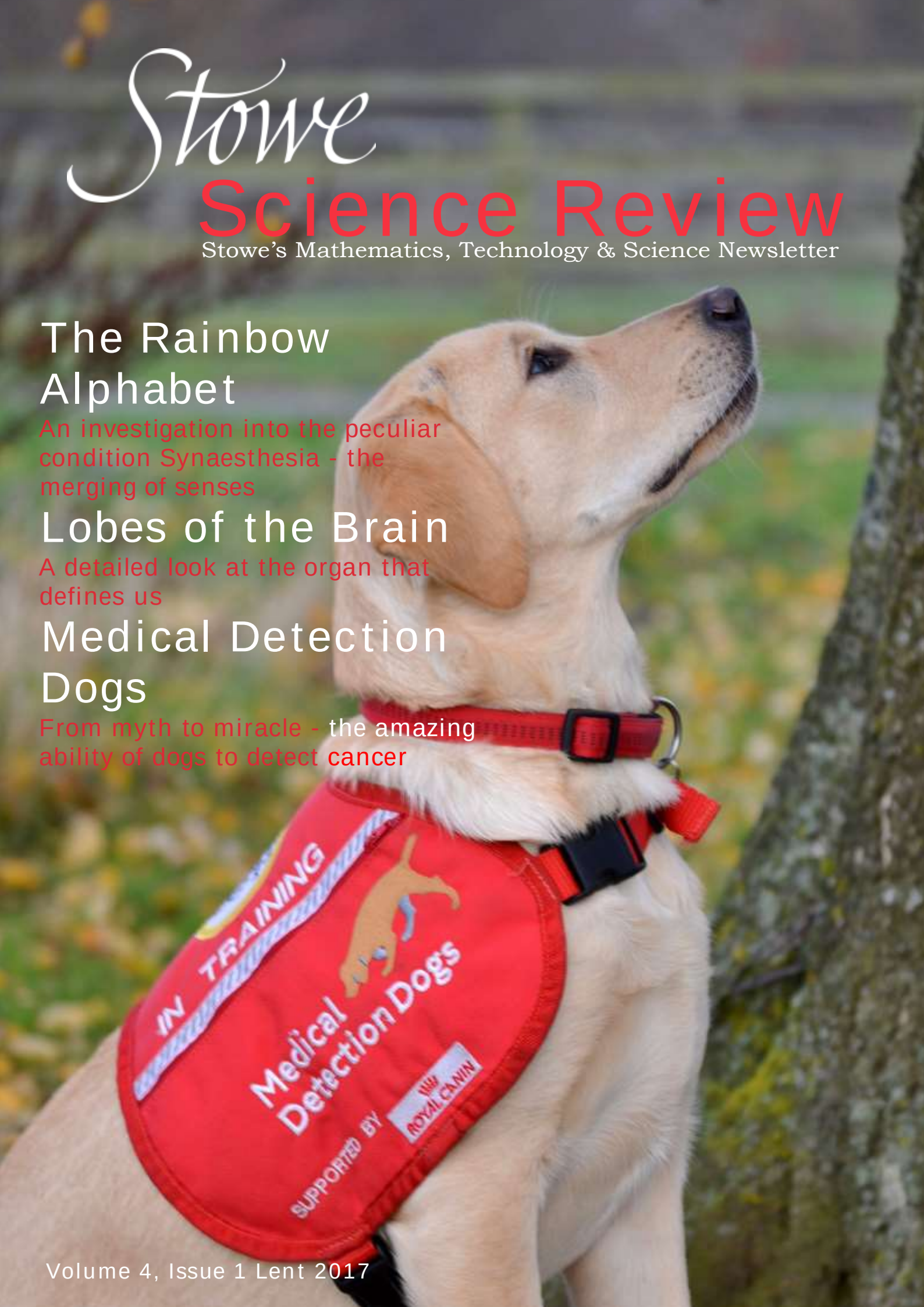
Stowe Science Review

Stowe's Mathematics, Technology & Science Newsletter



The Rainbow Alphabet

An investigation into the peculiar condition Synaesthesia - the merging of senses

Lobes of the Brain

A detailed look at the organ that defines us

Medical Detection Dogs

From myth to miracle - the amazing ability of dogs to detect cancer

Volume 4, Issue 1 Lent 2017

Welcome to Stowe Science Review!

The magazine that gives you a fascinating insight into the miraculous world of Mathematics, Technology and Science.

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Stowe Science Department
Mr Tearle
Mrs Roddy
and thank you also to the General Office.

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We look forward to hearing your views!

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Resistance Breakers

In the latest step of the bacterial resistance arms race scientists from across the world have been working on resistance breakers: a chemical cocktail, of sorts, that has the potential to allow previously useless antibiotics to kill resistant strains of bacteria. Resistance breakers work in various ways, but most attempt to puncture bacterial cell membranes allowing antibiotics to infiltrate their protective wall and cause damage from the inside. Resistance breakers have a temperamental past, but new research by a team at Merck research laboratories in New Jersey has yielded a resistance breaker for the mighty MRSA (a well-known resistant strain of Staphylococcus aureaus) that has opposed our most widely used antibiotic class beta-lactams since the 1940's.

Unfortunately, evolution always persists and scientists estimate that before long even resistance breakers will not defeat bacteria. With the ever looming crisis of antibiotic resistance various researchers have sought drastic solutions to the resistance problem. One method includes a combination of resistance breakers to reduce the likelihood of resistance developing, while another more liberal approach involves allowing the bacteria to live but instilling non-lethal traits so that it will not die, but it will also not kill you. This is the driving force of evolution and resistance.

Still many scientists search for the holy grail of medicinal science which is a new antibiotic; the discovery of Teixbactin last year gives people hope, but estimates state that as early as 2035 we may run out of usable antibiotics. There is hope however as research is advancing our understanding of bacterial resistance every day and if we can only buy ourselves some time with techniques like resistance breakers, then our dream of an infection free world may one day be reached.

Jonathan Dale

One Step Closer to Immortality

5000 years ago, I was a giant. Or at least I could have been, if reincarnation and the largely disproportional carvings of Ancient Egyptians were real. However I would have been a giant with the life expectancy of what we now class as a middle aged man. At the same age that my father was flicking through catalogues of yachts that are far beyond anyone's price range, I would have been slowly descending into purgatory at the hands of some primitive disease. In today's world, we have learnt to stretch time so that it fits snuggly around what we class as a comfortable epoch of around 80 years in developed countries. However as a result of this, we have become victim to the effects of time and the ageing process; or have we?

Okinawa, Japan, is known as the land of immortals, where the effects of time are slowed to allow a high proportion of centenarians to exist on the island. As an isolated, island population with a restricted gene flow, there is a potential for clustering of genes that then impact human health and ultimately, our survival. Centenarians, who have survived natural selection, are likely to possess the alleles that convey longevity allowing them to not only slow the ageing process, but to also reduce its effects. The Okinawa Centenarian study (Wilcox et al) shows that siblings of centenarians had a 2.58 fold likelihood (females) and 5.43 fold likelihood (males) of reaching the age of 90 years versus their birth cohort. This is due to the familial components of human longevity (hereafter known as longevity genes). Although it is plausible that environmental factors e.g. diet and physical activity levels could have played a part in the siblings' longevity; mortality differentials caused by the environment tend to diminish at older ages. Furthermore, the general homogeneity of the Okinawan population with respect to these environmental factors further supports the hypothesis that longevity genes are responsible for the mortality differences between islanders. The risk of cancer was found to be reduced in elderly people as they had lower levels of free radicals in their blood and significantly lower levels of lipid peroxide; therefore they suffer less free radical induced damage – reducing mutations to their DNA and damage to cells.

But what if we take it a step further? Studies performed on *C.elegans* showed that mutations to the DAF-2 gene doubled the lifespan of the worm. In humans, the equivalent of this gene encodes for the IGF-1 hormone receptor which, when damaged, prevents growth hormones from forming hormone-receptor complexes, therefore slowing the ageing process. It was observed that the longer lived mutants were more resistant to age related diseases e.g. cancer and cardiovascular disease, and that centenarians were more likely DAF-2 mutants than not. Genetic variants that modulate the insulin growth factor (IGF-1) cause inflammation and stress resistance to differ significantly between centenarians and shorter lived humans, preventing damage to cells and mopping up free radicals that cause cancer. The DAF-2 mutation not only lowers the amount of free radicals found in blood plasma but also allows cells to repair themselves in times of stress, therefore reducing damage to cells by both prevention and repair. It is as if the mutation is causing the body to fight

the ageing process and its effects on two separate fronts.

In a human without the mutation, the IGF-1 receptor would attach to a hormone and send a signal into the cell, promoting nutrient uptake and growth. However in a DAF-2 mutant, the defective receptor does not work to its full function. These conditions allow a transcriptional factor protein called FOXO to travel into the nucleus of the cell and bind to a number of genes within the DNA, turning them on. Genes that are turned on include antioxidant genes which help other proteins to function well, as well as escorting and disposing of damaged cells to areas where they can be recycled. But why is this important? In times of favourable conditions, when nutrients are plentiful and there is a lack of stress in the environment, the IGF-1 and insulin hormones promote the uptake of nutrients for storing and use. However, under conditions of stress, the hormone levels of insulin and IGF-1 decrease, activating the FOXO protein to enter the cell and to trigger genes within the cell's DNA that are responsible for repair and protection, therefore almost regenerating 'aged' cells within the body and allowing humans to live longer.

The mutation to the DAF gene is linked to what is recognised as the longest lived population in the world. Nonetheless, if we take a second to consider the reasons that the mutation accumulated on the island, then we understand that the founder effect has a large responsibility for Okinawan centenarians becoming prevalent on the island (51.4 per 100,000 people). The life expectancy for an islander on average is 86 years (females) and 78 years (men) compared to 76.8 years on average in the USA – without taking into account the higher proportion of healthy centenarians.

Travel back 5000 years with me, where my theoretical giant self is living in what is by definition an isolated gene pool: Ancient Egypt. Technological modes of travel have not yet been invented and as an ancient population, exploration of the 'flat' world is not quite my priority. Nevertheless, if it is restricted gene flow that allows advantageous mutations like the defective IGF-1 receptor to amass within populations, then shouldn't I have another 90 or so years to look forward to? Instead I am celebrating my 17th year on earth and looking down the alarmingly short barrel of around 15 years before death. Maybe it is the lack of medicinal technology that prevents my long life from taking effect? Or maybe my extraordinary height is holding 90 years of nutrients captive? Either way we can deduce that it is a balance of medicine (environmental factors) – around 75% - and genetic factors (the accumulation of advantageous mutations within the population) – around 25% - that account for the exceptional longevity in Okinawa and other isolated populations globally.

From another perspective, the Okinawans' high quality of life is caused by resistance to age related diseases e.g. cancer, dementia and cardiovascular disease, which in turn is due to genetic factors like the DAF-2 mutation and the FOXO protein regulator. Overall, if we consider each Okinawan who participated in the Wilcox et al study, their time on earth has spanned three centuries, two world wars and the internet; now that is an epoch I would be happy with.

By Clarissa Llanaj

The Rainbow Alphabet

What colour is a banana? Yellow, but why? When the light hits the banana the object absorbs some of the light and reflects the rest. The wavelength of light reflected is determined by the properties of the banana and also determines what colour we perceive it to be. So, for a banana, wavelengths of about 575 nanometres are reflected: yellow light. This basic understanding of how humans perceive light still has not explained so many mysteries. One of the most interesting is synaesthesia.

This condition causes the senses to mix together so that sensations that are normally considered separate start to intermingle. The most common type is grapheme-colour synaesthesia. This is where people perceive words, letters and numbers as distinct colours. It was for many years ignored and snubbed for being ridiculous. Yet it could provide answers to some of the greatest questions we want to answer about the evolution of our species. At the start of the 19th Century studies on synaesthesia first began but there was little progress and by the 1960s most scientists had given up probably due to the widespread use of hallucinogenic drugs during this period which had similar effects to having the condition. But when Vilayanur Ramachandran, a renowned neuroscientist started his research he believed the condition could provide insight into many other situations. His first test to analyse if people were telling the truth was very simple. On a computer screen a simple shape was laid out using only one letter of the alphabet in an even pattern. Around this shape, 2 more letters were added to create a confusing and seemingly random image. The participants were asked to spot a shape in a very short space of time. Those who spotted the shape would only have been able to do so if they had synaesthesia. This was the first evidence the condition was real and further studies at the University of Edinburgh suggest about 4% of the UK population could be affected. In 1996, Baron-Cohen did more research and found more women have the condition (6:1) and that one third of people with the condition have family members they know with the condition too. This research showed the trait to be passed down through the X chromosome and that it may be dominant. Of course, the inheritance pattern is likely to be extremely complex due to the number of different types of synaesthesia with many genes being involved.

Synaesthesia is a genetic condition as in many cases it runs in the family. But each member is affected differently and will for example, see a different colour for different letters of the alphabet. This suggests the environment you are raised in also affects it. Dr James Ward studied many cases to see what environmental factors effected them. For James Wannerton, the condition is expressed in his ability to taste words. This condition is very rare with an estimate of 0.2% of the population having it. Words that sound similar often have similar tastes for him which reveals a structure and not just arbitrary connections. The next question seems to be: how did the connections occur? In James's case the connections to flavours occurred during childhood possibly hinting that the acquisition of vocabulary and tastes were distorted at this time.

Research has also taken place to determine what happens in the brain when the senses

intermingle. John Fullwood is blind yet still manages to see colours with specific words. This phenomenon means the condition is not triggered by the eye. To measure what occurs in the brain a test was devised. Specific regions of the brain are specialized for different functions and while John's brain was being scanned as words were said that for him were not associated to colour, only the regions associated with hearing lit up. Yet when specific words he associated with colour were said, the area of the brain called V4, which comprehends colour, lit up too without any visual stimuli. The conclusion of this experiment is that the areas of the brain that are usually separate are in this case connected in some way.

So what is the purpose of this ability to combine the senses? It might assist many people with intellectual concepts such as using numbers as well as with memory. Often a form of synaesthesia means people see numbers in 3D space and could be a manifestation of how the brain has learnt to deal with abstract concepts like manipulating numbers. Numbers have defined how our species has evolved and therefore researching the origins of the human ability to use them is vital.

But perhaps this seemingly non-functional gene has another purpose. There is a clue in the fact that synaesthesia is eight times more common in artists, poets and novelists. This could show that creativity and synaesthesia are very closely linked. Many very famous artists such as Miles Davies, Kandinsky and Hockney have the condition and although it is unreasonable to think it causes creativity, it is easy to see the similarities between creativity and synaesthesia. Creativity and imagination are the ability to make unexpected or seemingly random links. In a way all of us have an inherent ability to merge senses. For example, a metaphor such 'loud shirt' combines vision and sound yet we know the shirt is vividly coloured and not shouting at us. The ability to express one thing in the terms of another is the foundation of creativity. There is no apparent logic of the benefits of being able to link two unrelated events with each other but the gene for synaesthesia could make you more prone to be able to make these links and therefore think in a more abstract way. This made Ramachandran wonder if creativity and synaesthesia have similar genetic routes. This seems very probable and our need to define things in other ways especially with language implies there are similarities in the way the brain work when we communicate and when we are creative. Language is what sets us apart from other species and the ability to express everything from the most mundane to the most extraordinary is astounding. One of the greatest mysteries we are trying to uncover is the origin of language; synaesthesia.

Humans have the ability to link certain sounds with certain shapes because of the connection between our senses. If you were to present people with two different shapes: a bulbous, roundish object and a sharp, spikey object, and asked which sounds more like a 'bubba' than a 'kiki', about 95% of people would agree the round shape sounds like a 'bubba' and the spikey shape like a 'kiki'. Although neither words have any meaning, the mimicking of the undulating sound of the 'b' seems to link with the round shape and the harsh 'k' sound looks spikey. This could have been a starting point for the discovery of language when our ancestors started expressing themselves by using sounds that evoked what they wanted to describe. This theory proposed that language evolved form a mix of more than one sense and this directly corresponds to the idea of synaesthesia.

To conclude, Language, art and music are as much part of our life as maths or science so exploring the origins of these topics is highly important as it is combining the link between science and creativity. Synaesthesia, by providing a bridge between senses relates to many more important topics that include making links between areas we would usually keep separate and the ability to mix them is what makes humans so good at thinking of new things and therefore evolving.

Fabiola Koenig

Working on the Front Lines of Medicine:

DR SEMPLE ON EBOLA

Thanks to the wonders of modern technology, on Thursday the 11th of February members of the Biomedical society eagerly huddled around a microphone and webcam to Skype interview Dr Calum Semple, a clinical virologist at the University of Liverpool. He is one of the leading investigators of a confirmed new case of Ebola in Sierra Leone. At the time of the Skype call he was sitting at his working desk in the Ebola Treatment Centre, Freetown, Sierra Leone.

Student: How has the ebola virus returned?

Dr. Calum Semple: Leone remained at high risk of additional small outbreaks of Ebola mainly due to the virus persisting in semen of male survivors after recovery. Our results show that 26% of the men had semen that tested positive for Ebola Virus Disease between 7-9 months after their illness began. The main source of transmission of Ebola is through direct contact with the body or bodily fluids of a person with the virus. Ebola Virus Disease can persist in the bodily fluids of survivors during recovery, which has resulted in its current transmission during sexual intercourse. This study provides further evidence that survivors need continued, substantial support for the next 6-12 months to meet these challenges and to ensure their partners are not exposed to the potential virus.

Student: What made the Ebola virus spread so quickly?

Dr Calum Semple: Apart from prostitution, burial ceremonies have played a major role in the spreading of the virus. Mourners have had direct contact with the body of the deceased person through traditional rituals. I recall one village where a tribal leader passed away (in Sierra Leone), and as per tradition his body was thoroughly washed and cleansed. The bathing water was then splattered onto the faces of the entire village to symbolise the tribal leader passing his blessing on to the community. Consequently, the entire village was infected with the virus and was wiped out. If these rituals are ignored, the dead are thought to wander the Earth eternally and plague the community.

Student: How are you treating ebola?

Dr Calum Semple: Prior to the new case I was aiding in developing a convalescent plasma protocol in readiness for an Ebola outbreak, as part of the outbreak preparatory work by the ISARIC. Plasma is the liquid part of blood that in survivors contains antibodies against the Ebola virus. Convalescent plasma therapy has been used since 1891 to treat severe infectious diseases. We are currently trying to find out whether Ebola survivor's plasma contains protective antibodies and if their plasma can be used safely to reduce the number of deaths and future outbreaks. The information we have suggests that there could be subgroups of patients that are more likely to benefit, such as young children and pregnant women.

Student: How is the virus able to overcome the human immune system?

Dr Calum Semple: The virus appears to shed a massive excess of the same surface protein that it uses to a make the virus. It then proceeds to consume some of the antibody response that the body makes. Therefore, the virus is able to break down surfaces of many different cells and tissues (e.g kidneys, brain).

Student: Why do some people survive infection?

Dr Calum Semple: As expected, patients are more likely to survive with supportive care, including rehydration that can buy time for the body to fight off infection. But, it has also been identified that genes and other markers seem to be predictive of survival. Patients who recuperated tended to have higher levels of activated T cells in their blood and had certain variations of a gene that codes for surface proteins that white blood cells use to communicate.

Student: Are there any cures for ebola?

Dr Calum Semple: Zmapp is currently being clinically tried to treat Ebola.

Dr Semple has worked on malaria, heatstroke and dehydration; his determination to overcome these illnesses and achieve his vision of curing Ebola was truly inspiring. His closing comment to us was: "there is something in medicine for everyone, it seems daunting at the moment applying for medical school, but you shall always find yourself in something you have a passion for."

Thank you very much to the Biomedical Society and especially Mrs Rawlins for being able to provide us with such an amazing opportunity.

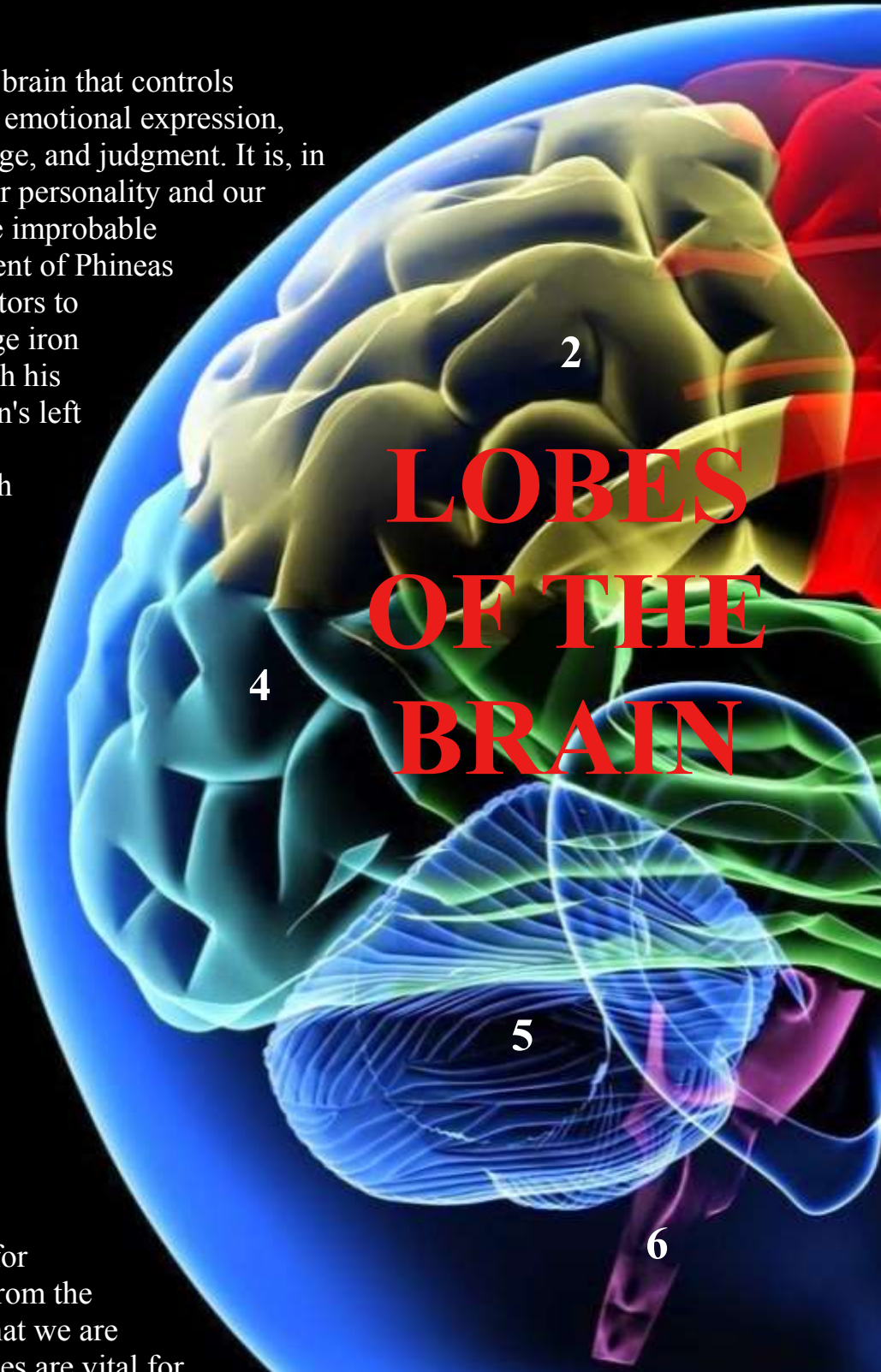
Interview by Sophie Sander & members of the Biomedical Society

1 - FRONTAL LOBE

The frontal lobe is the part of our brain that controls important cognitive skills such as emotional expression, problem solving, memory, language, and judgment. It is, in essence, the “control panel” of our personality and our ability to communicate. It was the improbable survival and change in temperament of Phineas Gage in 1843, which allowed doctors to discover this. In an accident a large iron rod was driven completely through his head, destroying much of his brain's left frontal lobe – the effects were sufficiently profound and although he survived those who knew him said he was "no longer Gage."

FACTS

- The frontal lobe is larger and more developed in humans than in any other organism.
- Frontal lobe dementia accounts for 10-15% of all dementia cases and affects personality, emotions, behaviour and speech of the sufferer.
- Frontal lobe dementia has one known risk factor: our genes. Do you think this fact will give weight to the ethical argument of genetically screening and genetically engineering embryos?

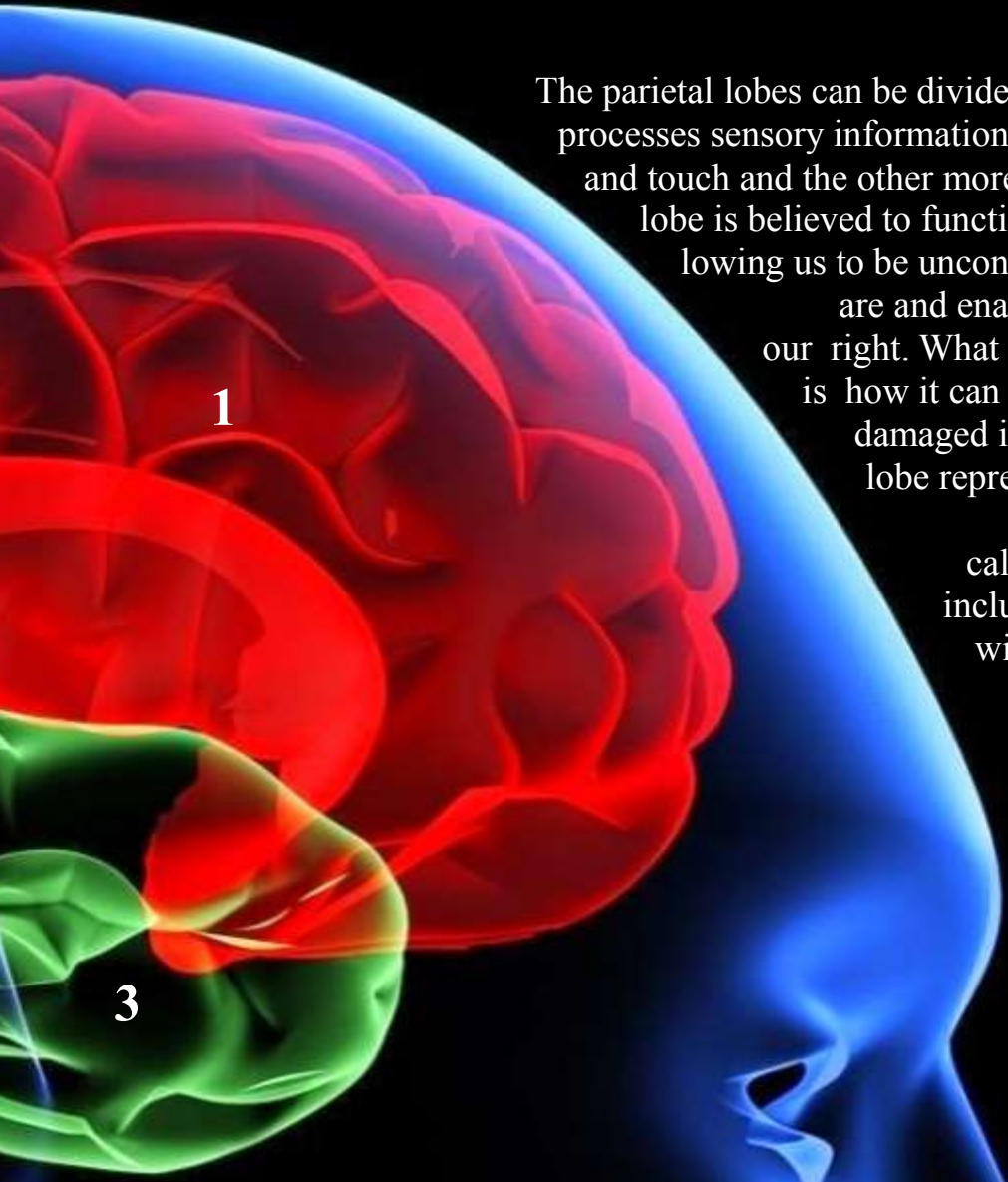


3 - TEMPORAL LOBE

The temporal lobe is responsible for processing auditory information from the ears and enables us to process what we are hearing. The medial temporal lobes are vital for the retention of long-term memories of events and facts, however certain regions are important only in the detection of familiarity as opposed to the detailed recollection of specific events. Therefore temporal lobe epilepsy (TLE) - a chronic disorder of the nervous system characterized by recurrent, unprovoked focal seizures in the temporal lobe - is interestingly linked to déjà vu. However, instead of the random and fleeting experience that occurs in 60%-80% of people, the déjà vu experienced in people with TLE prior to an epileptic seizure is said to be more enduring rather than a fleeting feeling in those who don't have epileptic seizures.

5 - CEREBELLUM

The cerebellum receives information from the sensory systems, the spinal cord, and other parts of the brain and then regulates motor movements. The cerebellum coordinates voluntary movements such as posture, balance, coordination, and speech, resulting in smooth and balanced muscular activity.



2 - PARIETAL LOBE

The parietal lobes can be divided into two functional regions. One processes sensory information associated with taste, temperature and touch and the other more substantial portion of the parietal lobe is believed to function in visual special processing, allowing us to be unconsciously aware of where our limbs are and enables us to distinguish our left from our right. What is most fascinating about the brain is how it can affect specific functions when it is damaged in a specific region and the parietal lobe represents this well. Damage to the left parietal lobe can result in what is called Gerstmann's Syndrome, which includes right-left confusion, difficulty with writing and mathematics. It can also lead to disorders of language and the inability to perceive objects normally. However damage to the right parietal lobe can impair many self-care skills such as dressing and washing but also cause difficulty in making things and the ability to draw. Bi-lateral damage can cause Balint's Syndrome, which is a visual attention and motor syndrome, characterized by the inability to voluntarily control vision. Damage to the parietal lobe is most likely to be caused by a stroke.

6 - BRAINSTEM

The brainstem which includes the medulla, the pons and the midbrain, controls breathing, digestion, heart rate and other autonomic processes, as well as connecting the brain with the spinal cord and the rest of the body.

4 - OCCIPITAL LOBE

The occipital lobe is responsible for processing visual information from the eyes, so that we can correctly understand what it is that we are seeing. Did you know that the phrase " I have eyes at the back of my head" comes from the position of the occipital lobe which is also the least prone to injury due to its location on the back of the head? Malfunction of the occipital lobe can lead to occipital lobe epilepsy, which cause seizures, hallucinations, seeing the same object over and over again, constant blinking or eye movement, and exceptional eye pain.

Georgie Skinner

Medical Detection Dogs

Interview with Dr Claire Guest

We walked into Claire Guest's office at the Medical Detection Dogs centre near Milton Keynes and saw her surrounded by pictures of dogs on the walls and three dogs resting at her feet. After a short introduction we sat down to ask her some questions about her education, work and hopes for the future.

How did you start your career?

I started my career after switching from an agriculture degree to a psychology degree as I decided that humans' relationships with animals interested me most. On farms the economic interest of the animals is seen as more important and so did not suit my interest. While waiting for funding for my Masters I worked with 'Hearing Dogs', a charity studying the relationship between deaf people and their dogs. The study was published in the Journal for Deaf Studies and Education and used well established psychological questionnaires and a longitudinal study to measure quality of life of the patients. In 2001 Dr John Church published a letter in The Lancet on 26 cases where dogs seemed to smell cancer. All the stories were anecdotal but in 2004 Dr Church and I did a study with the Buckinghamshire NHS Trust which was published in the British Medical Journal. The sample size was small and we used pet dogs but it was the first study that showed that what we had hoped was actually true.

Was this a major stepping stone?

Yes, in the sense of knowing it actually worked. Cancer is far more difficult to detect than a lot of other diseases we now know. But was it world changing? No. Ten days after the article was published and the hype was over we had no funding. The charity was only made in 2008 because of this shortage of funding. By that point, I had published a new study in the Journal of Cancer Biomarkers and was working on my PhD. I had heard anecdotes of dogs detecting low blood sugar in breath. It's very hard to collect and the volatiles often are contaminated by the air. But to be honest, we haven't found a disease or condition that we can't train dogs to find yet.

What is the most fulfilling part of your job?

Definitely working with the dogs. Of course I enjoy being chief executor; it's a dream come true but I love trying to understand dogs better.

Why do you use dogs? Do any other animals have similar abilities?

Yes, other animals do have this ability. For example, Giant African pouched rats, rats in general really. Obviously they're not a great choice for assistance animals but they might be good for future work where testing is on a larger scale. They're already being used by the charity APOPO to detect

Tuberculosis. Pigs have good noses too but dogs socialise well and our understanding of communication with dogs is very developed which is very important during this learning phase that we are in.

How do they detect the aroma?
The Jacobson's organ at the back of their throat is subject to air being drawn in through the nostrils. In cancer we don't know what the dogs are actually detecting.

What is it they are actually smelling?
They smell volatiles. This draws parallels to music because they don't just detect a note, they detect a whole bar of music; a volatile pattern. That they're detecting a 'pattern' is what makes the training particularly difficult. We're doing work with the University of Bedford, Manchester and the London School of Hygiene and Tropical Medicine to produce an 'E-nose' (electronic nose). They're using mass spectrometry and gas chromatography to narrow down what it is that the dogs are finding.

What are the ultimate aims of medical detection **dogs' projects?**
Well there's already a machine called the Lucid, a breathalyser being tested on the NHS. It's a disease breathalyser picking up breath volatiles which was done from our work on the medical detection dogs, but focusing on lung cancer. Because this is a fantastic opportunity for this disease we're not actually focusing on lung cancer.

I suppose if you ask where ultimately it will lead, hopefully in your lifetime, would be that people give samples of breath and urine and these are all screened for cancer volatiles. If the screening picks up the volatiles, the patient can then go back for further tests. The issue in the UK, and why there are so many deaths, is the stage of detection and not in the treatment processes themselves - we need to try and improve early detection. We have a study now collaborating with Milton Keynes hospital, with 3000 patients. We're looking to see how reliably dogs can detect prostate cancer in a urine sample. If dogs can detect it reliably Milton Keynes Hospital has said they will use the test.

What would reliable be?
After proof of principle, so you know in theory dogs can smell cancer, you have to go into a big clinical trial – quite frustrating really. Currently what Milton Keynes is saying is anything above 75% accuracy would be a very valuable test. Accuracy is broken down into sensitivity and specificity. Sensitivity is how reliably the disease can be detected if you have it. Specificity is if you haven't got the disease, how often does the test say you haven't got the disease. Diagnostic accuracy is a combination of these two things. It's interesting to know that the PSA test, which is currently the most accurate test for prostate cancer, has a rate of 75% false positives, *and* is very invasive (but has a good sensitivity.) If we ran a very specific test alongside the PSA the accuracy of diagnostics would be really valuable. Taverna did a paper in Milan two years ago and they got really high levels of accurate disease detection, they got 95% + levels of specificity, so we are looking to replicate this. We have been over there but it has been very difficult to convey the intricacies of specificity and sensitivity with a translator. Daisy here, (Dr Guest's dog) is working at a rate of 93%, but she's about to retire. It's really hard to train dogs as we're not sure how many volatiles are in a cancer sample.

What work are you doing with Malaria?
We're actually doing a project with Durham University and the London School of Hygiene and Tropical Medicine; in Gambia they are collecting special socks worn by little children in schools which collect volatiles, and we are then trying to train dogs with malaria positive and negative socks. We know there is a volatile for the disease as mosquitos smell it - they are drawn to the odour of malaria. So if you walk into a malaria free zone with malaria, mosquitos are drawn to you, and they then spread it around – so there is the possibility of having malaria dogs at certain borders.

How practical do you think the 'E-nose' will be?
Will the NHS incorporate it into their system?
The potential is huge. But it will take time, like all of these processes.

What have been the breakthroughs?
A major breakthrough is the communication system allowing the dogs to say whether they are unsure. Using a reward system can encourage false positive bias so we give the dogs a reward with the right answer even if it is a negative result. The dogs are far more sure of what they're doing if we work this way. Also, although the 'E-nose' might be a major breakthrough soon, they still have a long time before they catch up with the dogs.

Heading back to school, the interview with Dr Guest gave us a lot of food for thought. Perhaps one avenue for medical research in the future is to look at commonplace and often overlooked aspects of the world around us. Who knew that pet dogs may be able to warn of a cancerous mole, possibly saving your life? The scope and importance of this charity's work is amazing, and very inspiring – we look forward to seeing where it could go next. We would like to thank Dr Guest for giving up her time in a very busy work schedule to talk to us about the important work Medical Detection Dogs are doing.

A Darwinian Perspective on Cancer Treatment

In a very influential book, Dawkins argued convincingly that the gene is the unit of inheritance and therefore subject to natural selection. We are merely "survival machines" built to carry genes and pass them on to the next generation. Aggression and courtship, for example, are evolutionary stable strategies to ensure the best possible chance of propagating genes. We have evolved so our genes can continue long after we are gone.

Yet, in today's advanced society evolution is almost halted; modern medicine has cured diseases which would have been a death sentence a hundred years ago, and we care for the less able in society - not what a "selfish" gene theory would predict, perhaps. Despite this, we must bear in mind that molecules are subject to natural selection. For example, RNA developed to be characteristically short because it's a fast replicator, therefore it drove longer RNA molecules to extinction. This may seem counter-intuitive, for the second law of thermodynamics states that molecules want to become more stable and therefore less reactive, yet shorter RNA is more reactive, but this is because it has a higher dynamic kinetic stability. It's more stable in the sense of persisting in the population. Hence, today RNA is short. Here we can see how natural selection acts in a chemical sense.

How does this apply to cancer? Cancer is very much the modern medical war. Hugely publicised, hugely prevalent, and hugely destructive. The approach to try and eradicate tumours is to kill all of the mutated cells. However, if we view this approach through the perspective of evolution, this doesn't seem wise. An example to illustrate this is the use of antibiotics. Due to overuse, and misuse, of antibiotics, bacteria have become resistant to our drugs and are forming "superbugs". We can draw parallels between this and cancer treatment. If we blast tumours with treatment, some mutated cells will become resistant to survive and reproduce, never really killing the cancer. Due to this issue, resistant cancer cells become more common and have more space to multiply, and therefore are more stable in the dynamic kinetic sense, as they become persistent. By using intensive therapy, surely we are propagating the survival of drug-resistant cancer cells?

A new approach would be to try to harness evolution in our favour. If you treated patients with low levels of cancer drugs you could maintain a small population of non-resistant cells and resistant cells. Non-resistant cells could outcompete resistant cells, as we presume they must be weaker in some other sense due to the development of the resistant gene. This could be more effective, leaving only non-resistant cells in the population which could *then* be treated.

So is the way forward with modern medicine and diseases such as cancer less is more? Through the eyes of evolution, the answer is possibly yes.

Skye Longworth

DID YOU KNOW?

A kestrel can see in UV light, yet hunts for prey in the dark, but vole's urine emits UV light, so it can trace its prey based on this!

An ostrich's eye is bigger than its brain.

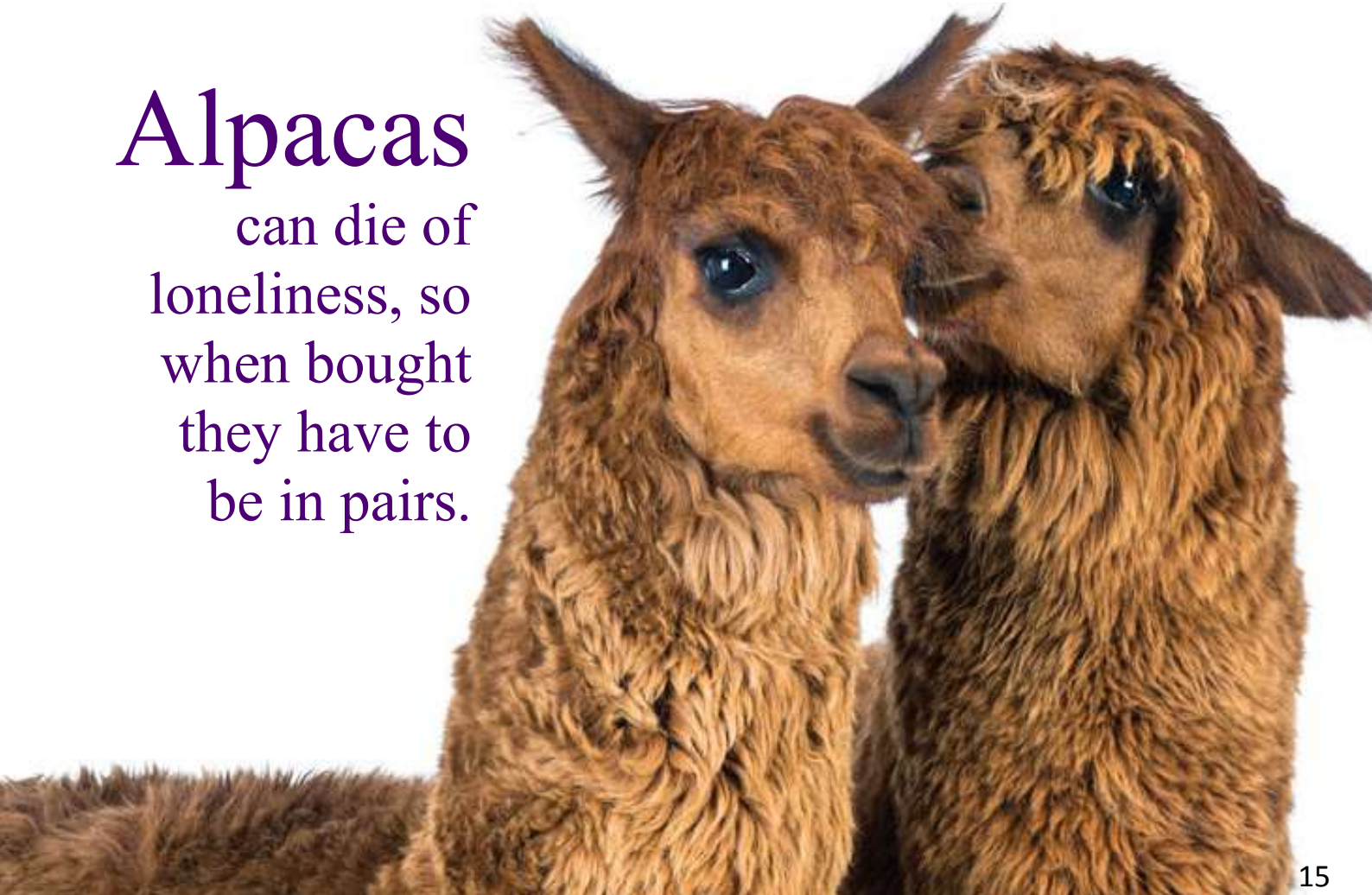
There are 10 times as many bacteria in our bodies than our own body cells

An octopus' tentacles can stick to almost anything, apart from its own tentacles.

NASA has 2 satellites chasing each other around the Earth tracking the distance between themselves to measure gravitational anomalies - their nicknames are Tom and Jerry.

Alpacas

can die of loneliness, so when bought they have to be in pairs.



R i d d l e s !

Two politicians go into a bar and are set up to be poisoned. They both order a vodka on the rocks: the first man drinks his in one gulp, and orders a second, again drinking it quickly; he decides to wait before ordering a third. The second man drinks his slowly, taking his time - they both leave. That night the second man dies, but the first man doesn't. Why?

Four people are stuck in a line, unable to turn around, with the fourth person behind an opaque wall. They are each wearing a different coloured hat, blue or red. In order to leave, they must say, correctly, which colour hat they are wearing (they only have one chance to say the correct answer). Who speaks first, and what do they say?

A king decided to let a prisoner escape with his life. The king placed two marbles in a jar that was glued to the table, one of the marbles was supposed to be black the other was supposed to be blue. If the prisoner could pick the blue marble he could escape with his life, if he picks the black he would be executed. However, the king was very mean and wickedly placed two black marbles in the jar, and no blue marbles. The prisoner witnessed the king only putting two black marbles in the jar, if the jar was not see through and the jar was glued to the table, and the prisoner was mute, how did he escape with his life?

A woman went to visit her bank manager and took her young daughter **with her. The bank manager said the woman's daughter could stay with his** secretary during the meeting. When the woman and her daughter left, the secretary turned to a friend and said, that girl is my daughter. How can this be?

Note from the Publisher

This eighth issue is the first Science Review issue to be edited and developed by Fabiola Koenig (Upper Sixth Lyttelton), Skye Longworth and Georgie Skinner(Upper Sixth Nugent). This is our longest issue yet, and we have worked hard to get this one out. We would like to extend our thanks to the writers for their contributed articles towards the issue. Finally, we would like to thank Mr Tearle and Mrs Roddy for their help and support with the editing.