
University of
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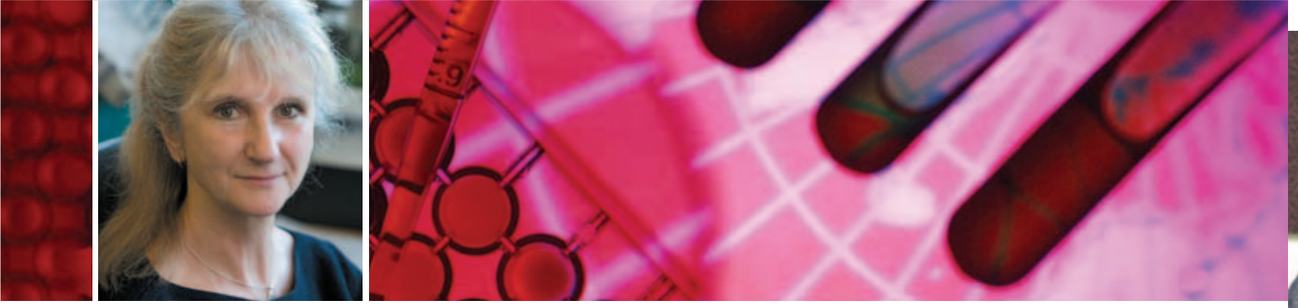
re:search
University of Bristol • Research Review • Issue 15 • Autumn 2007
The world's largest experiment



re: search editorial

Funding research

On 28 June the Government created the new Department for Innovation, Universities and Skills (DIUS). The Department will deliver the Government's long-term vision to make Britain one of the best places in the world for science, research and innovation. Key objectives of the DIUS include developing the UK research base and supporting innovation, for which it will have a total budget of £18.3 billion in 2007-08. It will ensure that the UK has the skilled workforce it needs to compete in the global economy.

More than 20,000 people are engaged in research in the UK, and research carried out in universities has led to some of the world's most important discoveries: the contraceptive pill, the first test-tube baby, proof that smoking damages your health, the structure of DNA, genetic fingerprinting, the laser technology that spawned CDs and DVDs, the world's first computer, and many, many other benefits too numerous to mention. It is essential to maintain this high level of innovation.

Public sources of funding are distributed through research councils, higher education funding councils and a number of UK government departments. In addition, much research is financed by charities such as the Wellcome Trust, which, for example, funded grants totalling over £1.4 billion to support biomedical research at UK universities between 2000 and 2005. Learned and professional societies, universities and research institutes also support research, and international sources include the European Union, NATO and a number of other European and international public bodies.

Often researchers work in collaboration with others in the UK or with specialists in other countries, and increasingly they are being encouraged to 'think outside the box' by seeking collaborators from other disciplines. Multidisciplinary research takes place across traditional subject boundaries, and many consider that such novel research is needed to solve the next decade's major challenges.

But perhaps it is less well known that individuals can also support cutting-edge research. For example, a generous donation recently given to the University by a married couple, went to the University's Cancer Research Fund. This important fund provides essential pump-priming resources to get new cancer research projects off the ground, which in turn allows them to attract much larger grants from other sources. These initial research steps, which are often difficult to fund through more conventional routes, can lead to life-saving discoveries. The impact of the donations that enabled them – whatever their size – cannot be overestimated.

At the moment we are gearing up for our centenary (2009) fundraising campaign and plan to raise £100 million over the campaign period, which runs until 2012. If you would like to find out more about how to participate, please see the information box on the opposite page.

Cherry Lewis
Editor

*re:*search is produced termly by the Public Relations Office, Communications and Marketing Services.

Articles about research at Bristol University are welcome, please contact the editor.

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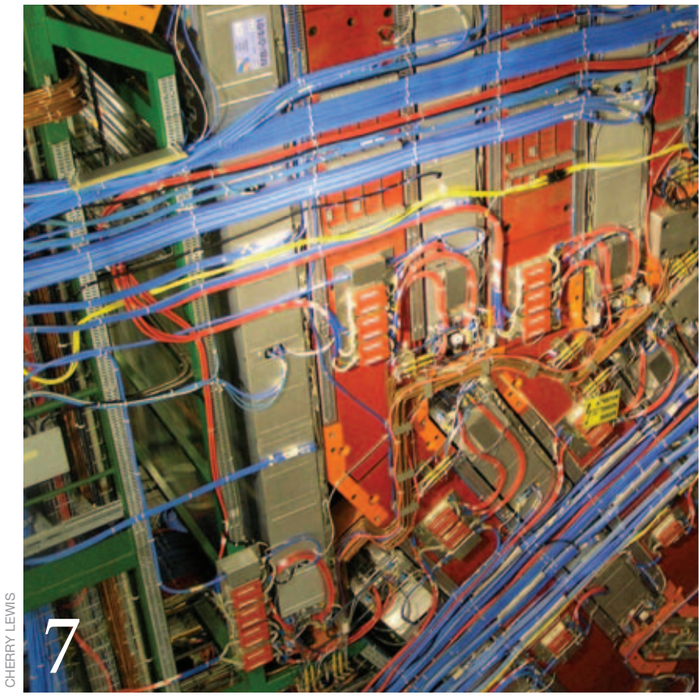
*re:*search No 15, Autumn 2007

SHELLEY HALES



CHERRY LEWIS

pre: view

Nasar Meer

Muslim schools in Britain?

British Muslims are currently subject to a great deal of attention that has often focused on questions of citizenship and integration. One key issue concerns the position of Muslim schools, which are often seen as an obstacle to social cohesion. ***Nasar Meer***, Research Assistant in the Department of Sociology, explains why some Muslim parents are seeking Muslim schools, and argues that these can improve – not undermine – social cohesion.

There are currently only seven state-funded Muslim schools in Britain – compared with more than 4,700 Church of England schools, 2,100 Catholic schools, 37 Jewish and 28 Methodist schools that are all state-funded – yet their place within the British education system remains a hotly debated issue. Indeed, the Chief Inspector of Schools, David Bell, has declared that separate Muslim schools 'do not fit pupils for their lives as Muslims in modern Britain'.

Muslim children of school age comprise nearly six per cent (500,000) of the school population, while Muslims overall represent only three per cent (1.8 million) of the UK's population. But it is important to note that Muslim pupils come from diverse ethnic backgrounds which, alongside the Pakistani (40%) and Bangladeshi (20%) contingent, include Turkish, Turkish-Cypriot, Middle Eastern, East Asian, African-Caribbean, Indian or other South Asians, those of mixed race or heritage, and a not insignificant number (1%) of White converts and Eastern Europeans. Despite these different ways of being Muslim, there are a number of reasons why many parents of all backgrounds want more Muslim schools.

First, there is the desire to incorporate more faith-based principles into an integrated education system so that the 'whole person' can be educated in an Islamic environment. Muslims also want to see more aspects of Islamic culture embedded within the teaching and ethos of school curricula than is normally offered within a Christian-European tradition. In addition, they would like schools to provide some specialist training in the Islamic religious sciences. This is motivated by the desire to have more British-trained theologians who can discuss theological issues within the context of living in Britain. Second, there is a desire for the development of 'safe' environments for post-pubescent children. In this regard, single-sex schools appeal to Muslim parents in the same way that they do to Catholic parents. Finally, there is concern over the lower educational attainment of some Muslim boys. For example, in 2000 only 30 ➜ per cent of boys with Pakistani and Bangladeshi ethnic origin achieved five GCSEs at grades A*–C, compared with 50 per cent of the national population. It is argued that this could reflect the sense of alienation and disaffection felt by many young male Muslims at school. There is a belief that greater accommodation of religious and cultural difference will help resolve this low achievement.

> 'Delayed assimilation' might enable Muslims to gain the confidence and security they need.

But what of the arguments against Muslim schools? These range from a principled philosophical opposition to all faith schooling, to more focused arguments concerning the nature of Muslim schools and their potential impact on social cohesion in Britain. The former position accuses all faith schooling of 'indoctrination' and implanting beliefs in the child that prevents them from being autonomous in thought. This argument can be met in a number of ways. One is to recognise that unless children have a sufficient depth of understanding about religion, they will not be able to exercise valid consent, thus the curriculum and environment of the religious school may be essential to the achievement of a level of understanding that makes informed consent (and thus autonomy) possible.

A much stronger objection, however, is to point to the degree of bad faith central to the charge of indoctrination against religious faith schools, specifically because secular schools have their own ideological assumptions about the ideal society, the ideal system of schooling and the meaning of human existence. While these assumptions may not be formally codified into a curriculum subject designated 'secular education' as an alternative to 'religious education', they characteristically permeate the ethos and culture of state-provided secular schools and form a crucial part of the 'hidden curriculum'.

With regard to the impact of Muslim schools on social cohesion, Muslim educators argue that one of the most effective ways to pass on knowledge about different people is through academic teaching, rather than via the naïve laissez-faire approach which assumes that mere exposure and contact with 'difference' will resolve prejudices. Contrary to impressions that might be gained from some OFSTED reports, the curricula of most Muslim schools proactively supports tolerance, universal dignity and worth, irrespective of ethnic, religious, or racial difference.

One argument that supports Muslim schools as a way forward towards social integration is that they could encourage a type of 'delayed assimilation'. Such a process might enable Muslims to gain the confidence and security they need as a minority struggling to reconcile their identity with broader citizenship imperatives. This means that majority groups and the government will also have to do some of the work in accommodating Muslims and not simply expect them to do all the running. This is a sentiment shared by David Konstant, the Roman Catholic Bishop of Leeds, who has stated that the effect of separate Catholic schools has been integration, rather than fragmentation because 'having our own school within the state system helped us to move out of our initial isolation and to become more confident and self-assured'.

If Muslim constituencies are granted the provisions for Muslim schools, it could contribute to the bringing together of faith commitments and citizenship requirements within a public arena that has historically included and incorporated many other religious minorities. ■

www.bristol.ac.uk/sociology

This research was funded by the Economic and Social Research Council.

Jo Elsworth

Illuminating the past

A remarkable collection of picture stories, that fascinated audiences before the invention of the movie camera, has been restored to life thanks to the University and technical support provided by Technical Advisory Service for Images. Keeper of the Theatre Collection, *Jo Elsworth*, describes how this significant collection has been conserved and made available to a 21st-century audience.

Lantern shows are known to go back as far as the 17th century. Their hey-day, however, was during the 19th century as technological advances allowed for more elaborate shows and the lanterns themselves became cheaper and more portable. In Victorian Britain the magic lantern was at the forefront of technology and fulfilled much the same role as TV and the cinema do today.

In the early years the optical system in lanterns was rather crude, consisting of a light source, usually an oil lamp, and a single lens to focus the picture onto a screen. Later, as an understanding of optics was developed, it was applied to the art of projection, resulting in ever-sharper images. At much the same time it was discovered that if lime was heated to a sufficiently high temperature it could produce a brilliant white light. The discovery was first employed by the military to signal over vast distances, but the theatre quickly adopted the device for spot lights (hence the term 'in the limelight') and its effectiveness as a magic lantern illuminant was soon exploited. A combustible gas (hydrogen, coal gas or ether) and oxygen were employed to achieve a high temperature, causing the lime to ignite. Needless to say, this operation was dangerous in the extreme and many fatal accidents occurred.

Lantern entertainment was diverse. In the early part of the 19th century there was a thriving trade of itinerant projectionists who travelled around the country with their magic lanterns and a large number of slides, putting on shows in towns and villages. But temperance crusades, illustrated sermons and missionary work, theatrical entertainment, current events and popular education also exploited the technology. Readings of recitations, stories or lectures would accompany the slide show, much like any PowerPoint presentation today.

The University's Theatre Collection archives contain 400 magic lantern slides, which, because of their fragile condition, have not been accessible until now. The slides fall into two categories. The first contains sets of story slides, mostly photographs that have been hand-coloured, dating from 1880 to 1900. These have evocative titles such as *Christmas in Paradise* and *Scrub, the Workhouse Boy*. The second category contains mostly black-and-white reference and lecture slides dating from 1910 to 1950. The Illumination Project has enabled the conservation, cataloguing and digital preservation of all these slides, creating both online and offline access to this amazingly important visual resource.

The construction of a lantern slide consists of two sheets of square glass between which the photographic image is sandwiched. The glass is bound together by tape around all four edges. When scanning a slide for the first time it was discovered that only the image as projected was captured. Whilst the image was good, it didn't reflect the slide as an object. Magic lantern slides hold many clues to their history in the way in which they are made – labels and titles adorn the glass, and taping can vary from one collection to another – thus it was important to ensure this information was recorded. The decision was therefore made to take two scans of the hand-coloured slides. The 'object' scan gave a clear idea of the slide's construction, condition and labelling. However, the slide's photographic image became fuzzy due to the scanner light penetrating the two layers of glass and causing a shadow effect against the panel in the lid. The fuzziness was resolved and the image became clear when doing a second scan with the panel removed using the backlight (to shine through the transparent areas of the slide), giving a copy of what would have been the projected image. They are now available for viewing and free educational use via the Theatre Collection's website, where this important collection is preserved for posterity. ■

www.bristol.ac.uk/theatrecollection/magic_lantern_slides.html

Christmas In Paradise

The demon of an overmastering appetite whispered to her …

The threepennorth was consumed, poor Tommy's last …

"Do take 'em, Sir, they're the last I have."

"Good night, slinkin' Bill" was Tommy's only response...

Paddling through the water with his bare feet …

"Never mind Mammy," he said …

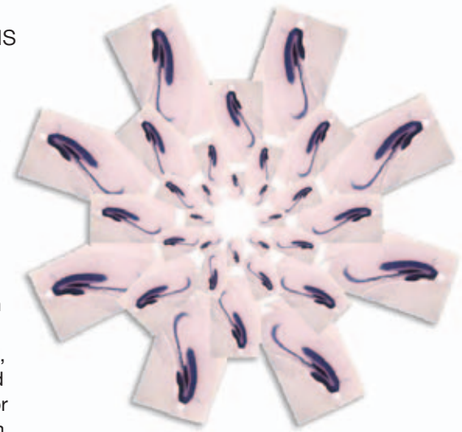
He whispered to her in tones of entreaty and tenderness …

The mission was inaugurated by a tea – "May the blessing of Christmas-tide be upon you"

The project was funded by BIRTHA, the Bristol Institute for Research in the Humanities and Arts, the Arts Faculty Research Director's Fund, and Friends of the Theatre Collection.

Nature and Science

Nature and *Science* are the world's two most prestigious academic journals. Every researcher lives in hope of their paper being accepted for publication by one or the other, since acceptance relays a message that your work is world class. Here are two recent examples.

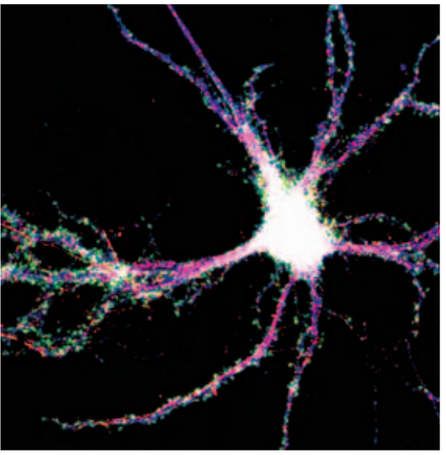


Dentate gyrus pattern.
Image by Matt Jones

SUMO wrestling in the brain

The brain contains about 100 million nerve cells, each having 10,000 connections to other nerve cells. These connections, called synapses, chemically transmit the information that controls all brain function via proteins called receptors. A major feature of a healthy brain is that the synapses can modify how efficiently they work, by increasing or decreasing the amount of information transmitted. In disorders such as epilepsy, for example, the synapses transmit too much information, resulting in over-excitation in the cells.

A research team, led by *Professor Jeremy Henley* in the Department of Anatomy, showed that increasing the amount of SUMO, a small protein found in the brain, could be a way of treating diseases such as epilepsy by preventing this over-excitation. When one type of receptor – the kainate receptor – receives a chemical signal, the SUMO protein becomes attached to it. SUMO pulls the kainate receptor out of the synapse, preventing it from receiving information from other cells, thus making the cell less excitable.



Distribution of SUMOylation enzymes (red) in a hippocampal neurone.
Photo by Stephane Martin.

The discovery that SUMO proteins can regulate the way brain cells communicate may provide insight into the causes of, and treatments for, brain diseases that are characterised by too much synaptic activity. This discovery also provides new potential targets for drug development that could one day be used to treat a range of such disorders. The findings were published in *Nature* (17 May 2007). ■

www.bris.ac.uk/Depts/Anatomy

This research was funded by the Medical Research Council, the Wellcome Trust and the European Union.

Have I been here before?

When we enter a new place a set of neurons called 'place cells' fire to provide a kind of blueprint for where we are. The next time we see that place those same neurons fire, thus we know when we've been somewhere before and don't have to relearn our way around familiar territory. But similar places may activate overlapping neuronal blueprints, leaving room for confusion if the neurons are not fine-tuned.
Dr Matt Jones in the Department of Physiology, working with a distinguished team at the Massachusetts Institute of Technology that included the Nobel Laureate, Professor Susumu Tonegawa, has identified a neuronal mechanism that our brains may use to rapidly distinguish similar, yet distinct, places.

Forming such memories of places and contexts engages a part of the brain called the hippocampus. The team has been exploring how each of the three hippocampal subregions – the dentate gyrus, CA1 and CA3 – uniquely contribute to different aspects of learning and memory. In the current study it was revealed that the learning in the dentate gyrus is crucial to rapidly recognising and amplifying the small differences that make each place unique.

The team's findings, published in *Science* (6 July 2007), demonstrate that a particular protein signalling molecule (the NMDA receptor) found in a specific network of brain neurons (the dentate granule cells of the hippocampus) is essential for these rapid discrimination processes. The work could lead to treatments for memory-related disorders, as well as helping with the confusion and disorientation that plague elderly individuals who can have trouble distinguishing between separate but similar places and experiences. ■

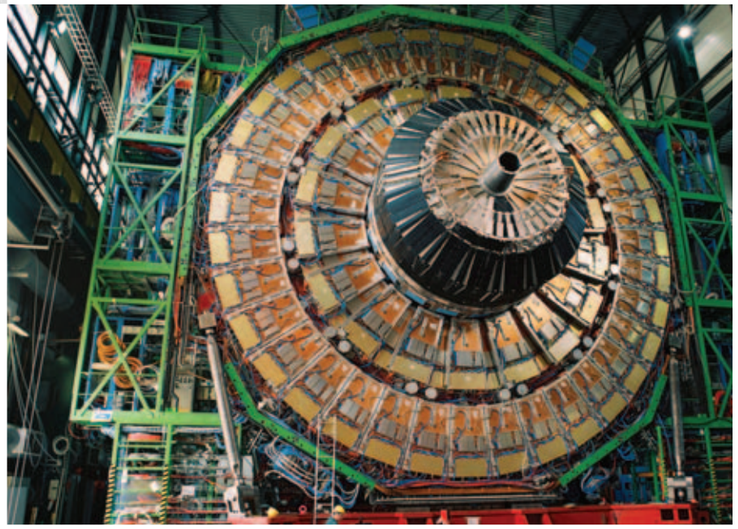
www.bristol.ac.uk/Depts/Physiology

This research was supported by the National Institute for Mental Health and the National Institutes of Health.

Dr Jim Brooke and Dr Dave Newbold –
two Bristol physicists working on the CMS detector

Understanding almost everything

A hundred metres beneath the Swiss-French border, between Geneva and the Jura mountains, lies a 27-kilometre circular tunnel containing the world's largest scientific experiment. When it is switched on early next year, the Large Hadron Collider at CERN could transform our understanding of, well, almost everything. ***Cherry Lewis*** went to CERN, with teams from the local media, to discover more about the role Bristol physicists are playing in this remarkable project.



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Above left: The original (1927) front door to the Physics Department. The carvings over the doorway represent discoveries in experimental physics. *Left:* The dispersion of sunlight by a prism, Newton 1666. *Right:* The tracks of alpha particles from radium, Wilson 1911.

Above: Part of the Compact Muon Solenoid (CMS) detector being constructed on the surface above the CMS cavern.

It may come as something of a surprise to discover that about 95 per cent of the Universe is missing. Only five per cent of the matter that physics predicts should be present is visible; the rest is what we call 'dark matter' (~20 per cent) or 'dark energy' (~75 per cent). Even worse, we don't even know why matter exists at all, because we don't know why things have mass. To try to solve these sticky problems, physicists at Bristol University have, for the past fifteen years or so, been part of an international collaboration involved in designing and building the Large Hadron Collider (LHC), an instrument that, it is hoped, will find some of the missing dark matter and, indeed, explain why matter exists at all.

The University has a long history of particle physics dating back to before its first physics building was opened in 1927 by Sir Ernest Rutherford, then President of the Royal Society. Indeed, the carvings over what used to be the main entrance still reflect what our benefactor, Henry Herbert Wills, considered was the 'value to humanity' that had been made by physics over the previous decades – the discovery of radioactivity, X-rays, the electron, isotopes and various other elementary particles. Famous names associated with the department include Paul Dirac, who predicted the existence of antimatter – more of which later – for which he won a Nobel Prize in 1933. Cecil Powell, Hans Albrecht Bethe and Nevill Mott ➜

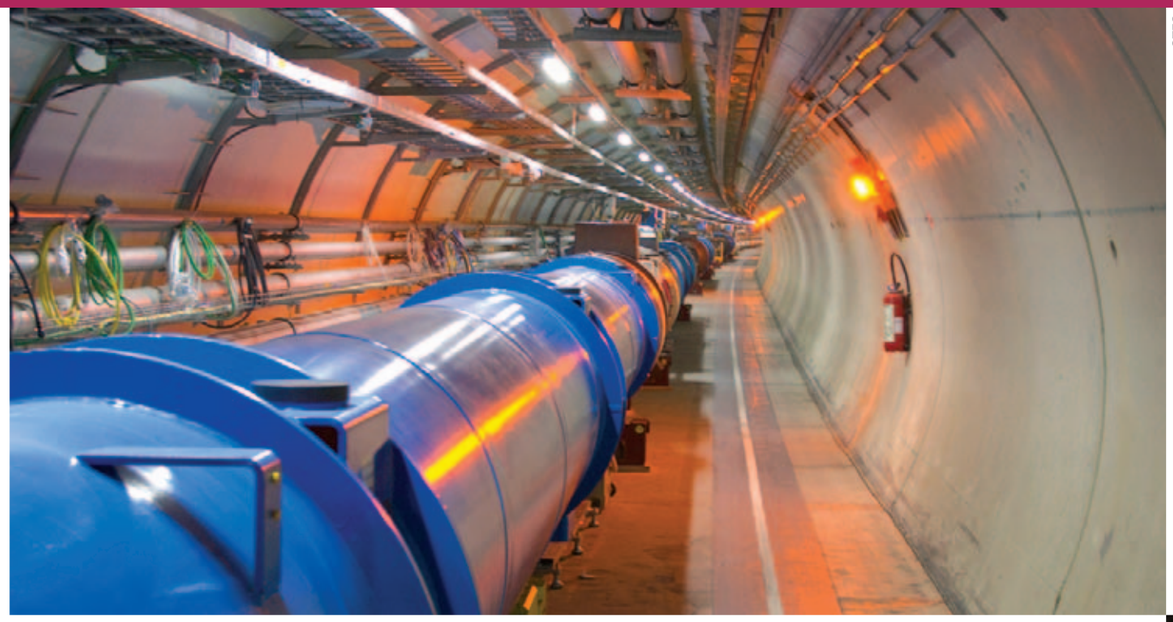
→ also won Nobel prizes for their contributions to physics, and were also at Bristol. Today, another Nobel prize beckons to the team that finds the 'Higgs boson particle' (fondly known as 'the Higgs'), for that, it is hoped, will explain why things have mass.

Peter Higgs, after whom the Higgs is named, predicted that space is filled with a field, rather like a gravitational field, that permeates the entire Universe. The Higgs field plays a fundamental role in that it gives mass to every elementary particle, including the Higgs boson itself. That it exists is

> We don't know why matter exists, and we can't explain why things have mass

indicated by the fact that without it the Standard Model of particle physics – the theory that describes the fundamental interactions between all the fundamental particles – breaks down because without the Higgs boson we cannot explain the large difference in mass between different fundamental particles that make up ordinary matter, and other particles, such as photons (particles of light), that have no mass at all. Without the Higgs in the model, everything would be as insubstantial as light. So finding the Higgs is the Holy Grail of the LHC experiment, and scientists there are confident that it will be found – assuming it exists. If they don't find it, then it doesn't exist and we will have to completely rethink our understanding of the basic principles of particle physics – no small task, given how long it has already taken us to get this far.

So how will they look for it? Within the LHC tunnel two beams of protons (which belong to a family of particles known as hadrons) travelling in opposite directions will be accelerated to near the speed of light. When going at full speed they will travel around the 27-kilometre tunnel more than 11,000 times a second. At four locations along the tunnel the protons will be forced to collide with each other at the rate of 40 million times per second. When this happens new particles will be formed in the collision, spraying out in all directions. It is in these collisions that the Higgs, and other particles we may not have seen before, will form and exist for considerably less than a nanosecond before they die away. While this may seem an incredibly short life, in particle physics a nanosecond is a long time.



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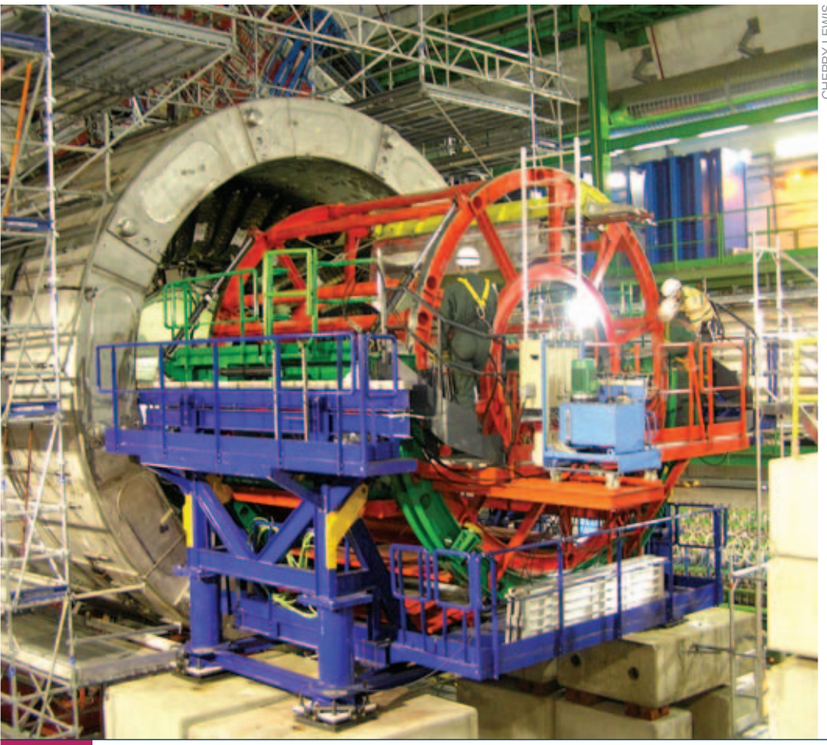
Left: Part of the 27-kilometre-long circular tunnel.

Below: Constructing the LHCb's electromagnetic calorimeter.



CHERRY LEWIS

Building the CMS detector in the cavern.

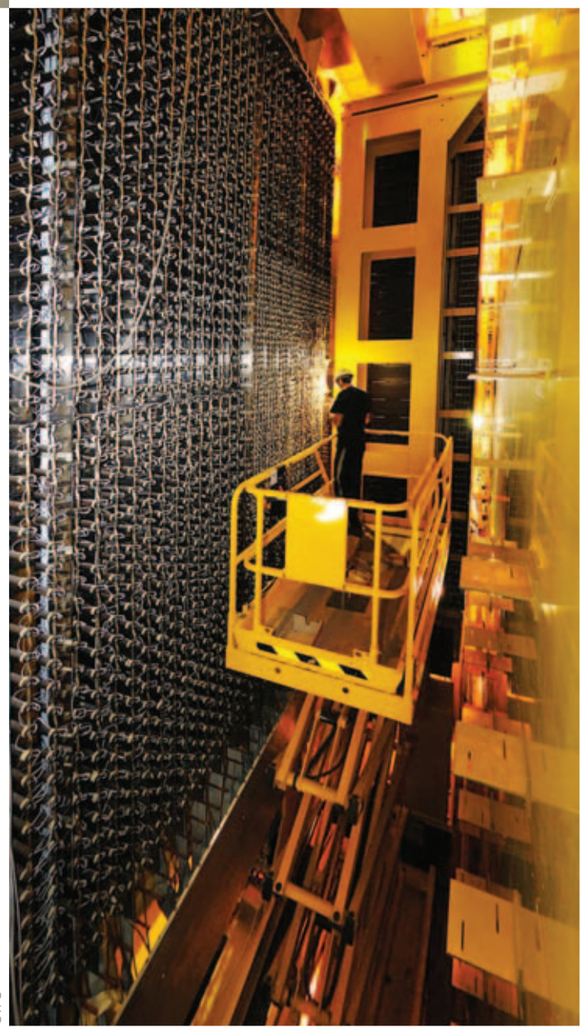
Detectors have been built at the four collision points in order to 'see' the new particles as they form. Two of these detectors – ATLAS and CMS – are what are called 'general purpose' detectors, while the other two – LHCb and ALICE – have been designed to detect specific effects. ATLAS and CMS are both expected to see the Higgs, but in different ways – each being needed to verify the findings of the other. Thus there is fierce competition between the two groups working on the different detectors, each determined to see the Higgs first. Seventeen Bristol physicists are among the 2,300 scientists from 36 different countries who work on CMS. In particular, Bristol physicists have helped design and build part of the detector known as the Electromagnetic Calorimeter, which measures the energy of the particles produced in collisions and will be the most important component in looking for the Higgs. These detectors are giants – the CMS is 22 metres long → and 16 metres high, and the cavern required to house it is about six storeys high. It weighs 12,500 tonnes in total and because of its size, pieces are constructed on the surface – some of these alone weigh 1,500 tonnes – and lowered into place in the cavern using enormous cranes. Remarkably, for something so huge, there were only ten centimetres to spare on either side when the largest piece was lowered.

So how will they know when they have found the Higgs – or anything else, come to that? The different layers of the detectors measure different properties of the particles produced, and tracking devices reveal the paths of electrically charged particles as they fly away from the collision. The new particles are typically unstable and will rapidly 'decay' into a cascade of lighter, more stable and better understood particles which leave behind characteristic signatures in the different layers of the CMS, allowing them to be identified. The presence, or otherwise, of any new particles can then be inferred from these signatures. But so much data is generated in these collisions – every second it would

> Particles travel around the 27-kilometre tunnel more than 11,000 times a second

fill all the books held by the whole of the British Library – that it is only possible to keep data from one in every million collisions. Even this requires huge computing power and enormous storage facilities. One of the most impressive parts of CERN is the computer centre, where thousands and thousands of PCs – just like the one on your desk – are lined up in banks piled high on top of each other, in a room that seems to go on forever.

To enable scientists to access the data produced by the LHC from anywhere in the world, the LHC Grid is being developed that will link computers around the world via the internet, which was, by →



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The mirrors of the RICH2 detector of the LHCb experiment are meticulously assembled in a clean room.

➜ the way, itself invented at CERN to help people working there share results. Data from the LHC experiments will be distributed around the globe for processing and analysis, so a high-performance computing facility is being installed on the top of Bristol's physics building which, at peak performance, will be able carry out over 13 trillion calculations per second. Thus scientists sitting in Bristol could be the first to find the Higgs – you don't have to be at CERN to see evidence of it.

> At less than the cost of a pint of beer per person per year, it seems an absolute bargain

The other experiment that eight Bristol physicists are involved with is the LHCb (b for beauty), which seeks to find out why more matter than antimatter exists in the Universe, even though equal amounts were created at the time of the Big Bang. Antimatter is not the stuff of science fiction – it really does exist and will be created by the LHC so that it can be studied. Antimatter is the mirror image of matter; thus when the two come into contact they annihilate each other, which means that the Universe as we know it should not exist. But it does, suggesting that matter and antimatter behave differently in a very subtle way. In order to recreate the moment immediately after the Big Bang, when the Universe was only a hundredth of a billionth of a second old, the LHC will accelerate particles to the highest energy levels ever achieved in a laboratory. In those collisions, particles called beauty and anti-beauty quarks will be produced in pairs, just as they were the moment the Universe formed. The LHC will create about a thousand billion pairs of beauty and anti-beauty quarks per year in the hope of detecting the asymmetry that explains why it is that nature prefers matter to antimatter. It is possible that in the process this ground-breaking research will reveal a new kind of physics, not previously known about.

So what's all this going to cost? Not very much, actually. The total cost of building the LHC over the 13-year construction period is about £2.7 billion, and the UK's contribution to that is £511 million. The funding is provided by the Science and Technology Facilities Council. This compares very favourably with the £757 million for Wembley Stadium and £4.3 billion for Heathrow's Terminal 5, and is dwarfed by the £9.4 billion (and still rising) cost of the London Olympic Games. What's more, who knows what spin-offs there might be? Particle physics has already been instrumental in various medical breakthroughs.

For example, the University has just been awarded a large grant by the Medical Research Council to develop radioactive tracers that will track noradrenaline, a chemical in the brain known to be associated with depression (see page 16). The noradrenaline tracer will be tracked using PET scanners, the development of which owes much to previous research done at CERN. PET scanners have recently provided significant advances in understanding how the brain works, which in turn contributes to our understanding of how to control disease. With this new collider, we might discover other technologies so far undreamt of.

Admittedly it's the taxpayer – you and me – who foots the bill for the LHC. But at less than the cost of a pint of beer per person per year it seems an absolute bargain to me, paticularly if it's going to help us understand, well, almost everything. ■

www.phy.bris.ac.uk

Many thanks to the Science and Technology Facilities Council for funding the trip to CERN. It was the chance of a lifetime. Gill Ormrod, press officer for the STFC and James Gilles, Head of Communications at CERN, worked very hard to make it all happen, and many members of the Physics Department, particularly Nick Brook, Dave Newbold, Jim Brooke and Helen Heath, were crucial in helping the visiting teams understand what they saw.

Rain forests: ancient and modern

Rain forests are crucial to the well-being of our planet, so it is important that we understand their evolution and ecology.

The world's first rain forest

What must have been one of the first-ever rain forests to grow on this planet has been discovered in the USA by *Dr Howard Falcon-Lang* from the Department of Earth Sciences, and US colleagues. The spectacular 300-million-year-old forest is composed of a bizarre mixture of extinct plants. Abundant club mosses, more than 40 metres high, tower over a sub-canopy of tree ferns, intermixed with shrubs and tree-sized horsetails.

It is the largest fossilised forest ever found, covering an area 10 by 10 kilometres (which would cover the city of Bristol). The forest was preserved following a major earthquake which caused the whole region to drop below sea level, whereupon it rapidly became buried in mud, preserving it forever. The fossils provide a unique snapshot of what tropical rainforests were like 300 million year ago, at a time when gigantic woodlice, several feet across, crawled on the forest floor and equally large dragonflies flew through its branches.

The study reconstructs a Carboniferous rain forest at the largest spatial scale ever attempted. The fossils show that the Earth's first rain forests were highly diverse and that the kinds of tree species changed across the ancient landscape. Prior to this work very little was known about the ecological preferences and community structure of these ancient plants. This magnificent discovery allows the team to track how the species make-up of the forest changed across the landscape, and how that species make-up is affected by subtle differences in the local environment. ■

www.gly.bris.ac.uk

This research was funded by the Natural Environment Research Council.

Highway maintenance in the rain forest

In some modern rain forests of Central and South America certain army ants (*Eciton burchellii*) conduct predatory raids, containing up to 200,000 foraging ants. But the trails they follow can be extremely uneven and full of 'potholes' as they pass over leaves and branches on the forest floor. Remarkably, some of the ants use their bodies to plug potholes in the trail leading back to the nest, making a flatter surface so that prey can be delivered to the developing young at maximum speed.

Dr Scott Powell and *Professor Nigel Franks*, from the School of Biological Sciences, observed this behaviour by getting the ants to 'walk the plank'. They drilled different sized holes into planks of wood and then inserted the planks into the army ants' trails. They found that individuals size-match to the hole they plug, and that several ants would co-operate to plug larger holes. When the traffic has passed, the down-trodden ants climb out of the potholes and follow their nest-mates home.

This research demonstrates that a simple but highly specialised behaviour performed by a minority of ant workers can improve the performance of the majority, resulting in a clear benefit for the society as a whole. In other words, the behaviour of the pothole pluggers more than compensates for them not carrying prey themselves. It also suggests that these benefits are a consequence of the unusual and derived foraging strategy of the army ant, which highlights the importance of considering ecology and evolutionary history in the study of social organisation in animal societies. ■

www.bio.bris.ac.uk

This research was funded by the Biotechnology and Biological Sciences Research Council.

Alexandra Bright-Paul (left)
Christopher Jarrold (right)

The suggestibility effect

Both adults and children may think they remember witnessing detail that is merely suggested to them at a later time. Understanding why these memory confusions occur frequently in children is important since they can now provide evidence in criminal proceedings. *Alexandra Bright-Paul* and *Christopher Jarrold* from the Department of Experimental Psychology set out to investigate the 'suggestibility effect'.

Participants in studies of this nature are generally asked to witness an 'event', such as watching a film. They are later subjected to information that contradicts key elements of that event. Later still, they are tested for their memory of the original event. A common finding is that individuals, and in particular young children, incorporate the misleading information into their reports of the original event.

One set of explanations proposes that suggestibility results from individuals misremembering the 'source' of experiences. Even when details of

Memories for events do not simply fade away over time

events are remembered accurately, individuals may nevertheless have difficulty remembering when or where they had occurred. However, what is less clear is why memory for source is poor. Two accounts offer alternative possibilities. Fuzzy-Trace Theory suggests that the origins of experiences are remembered as a separate aspect to the experience itself. With the passage of time, the memory of the source 'fades' and as a result its link with the memory of the experience becomes progressively weaker. This theory predicts that individuals will make more errors in remembering the origins of their experiences if more time has elapsed since the time of remembering it. In contrast, the Source-Monitoring Framework suggests that we make inferences about where and when we experienced memories, by evaluating them at the time of remembering. This account suggests that source errors are more likely when the sources themselves are less 'distinctive'.

We explored 'fading' and 'distinctiveness' explanations in one large study by examining how the time delays between event, misinformation and test phases of the procedure affect suggestibility. We examined 'fading' by simply examining whether memory confusions were more likely when the gap between the event and being tested was lengthened. For example, this theory would expect that memory would be poorer 24 days rather then 12 days after an event. However, testing the 'distinctiveness' explanation was more complex so we adapted an established theory of 'temporal distinctiveness' typically applied to short-term memory. For this we calculated a 'distinctiveness ratio', which was the size of the time gap between the event and the misinformation, relative to the size of the time gap between misinformation and recall. For example, if two events are separated by three days and then recalled nine days later, memory confusions will be similar to those from two events separated by six → days and recalled 18 days later (the ratio is 1:3 in both cases). This theory suggests that the time between the event and recall is irrelevant, and that only the apparent spacing between events influences memory errors.

In our study 150 five-year-olds watched a film (the 'event'). At a specified later date they listened to a story that was a misleading version of the event (the 'misinformation'). Finally, we tested their memory by giving them pictures that showed items that had appeared in either the event only, the misinformation only, both the event and the misinformation, or new items they had never seen before. They were asked to post each picture into one of four boxes that corresponded to the four options: seen in the film, heard in the story, seen in the film and heard in the story; and completely new. For half of the children the time interval between the event and the test was 12 days, and for the remaining participants it was 24 days. Within each group there were five different distinctiveness ratios of event-misinformation/misinformation-test delay (11:1, 3:1, 1:1, 1:3, 1:11). In other words, taking the first ratio (11:1) as an example, for the first group there were 11 days between watching the film and being told the misinformation story and one day between the story and being tested, and for the second group there were 22 days between watching the film and being told the misinformation story and two days between the story and being tested.

One way in which we measured suggestibility was by looking at the number of items that had only been presented in the misinformation phase, but which the child said had occurred in the event. The results showed that the length of the delay between the event and the test did not significantly affect this type of memory confusion, implying that memory for context does not fade over time. Even when the time between the event and the test was lengthened from 12 to 24 days, the number of errors was similar if the 'distinctiveness' ratio remained the same, eg, three days/nine days or six days/18 days (1:3). However, the 'ratio' of the two intervals did significantly influence how well the children performed. When the distinctiveness ratio was large (ie, the event and misinformation were widely spaced apart) children were much less likely to confuse the misinformation for the event.

ALEXANDRA BRIGHT-PAUL

This research provides the first empirical demonstration that relative delays are more influential than absolute delays in determining the magnitude of suggestibility. This in turn suggests that memories for events do not simply fade away over time, however intuitive the idea of

These findings inform us about how child witnesses may confuse memories

decaying memories may seem. Rather, we confuse the details of events that occurred in relative proximity. This is probably because memory traces interfere with one another, and the degree of interference will be largest when we think back to events that, relative to the point of recall, are closely bunched together in time.

In practical terms, these findings are informative about the ways in which child witnesses may confuse memories. On the positive side they imply that children will not necessarily forget events that occurred to them simply as a result of the passage of time. However, they also indicate that information about the context in which events occurred is subject to interference, and that young children will be particularly suggestible to misinformation when that occurs relatively close to the event and relatively far from the point of recall. In a forensic context, in which children are serving as eyewitnesses in criminal proceedings, it is important to bear in mind that suggestibility is likely to be highest when there is a small gap between the event in question and any potentially misleading questions, coupled with a long gap between these questions and the child's testimony itself. ■

http://psychology.psy.bris.ac.uk

This research was funded by the Economic and Social Research Council.

Pompeii – a prototype ground zero

Shelley Hales is a lecturer in Art and Visual Culture, in the Department of Classics and Ancient History. Dry stuff, you might imagine. On the contrary, Hales is currently researching the enormous impact Pompeii has had on popular culture since its rediscovery in 1748.

On 24 August 79 AD, Mount Vesuvius erupted over the bay of Naples, wiping out several towns and killing tens of thousands of people. The disaster was witnessed by Pliny the Younger, who was staying across the bay at Misenum, and later wrote an account of the catastrophe in two letters to the Roman historian Tacitus. They make harrowing reading: "You could hear the shrieks of women, the wailing of infants, and the shouting of men; some were calling their parents, others their children or their wives, trying to recognise them [in the darkness] by their voices. People bewailed their own fate or that of their relatives, and there were some who prayed for death in their terror of dying. Many besought the aid of the gods, but still more imagined there were no gods left, and that the universe was plunged into eternal darkness for ever more." Thus began our fascination with Pompeii, although it wasn't to be uncovered for another 1,700 years.

> You could hear the shrieks of women, the wailing of infants

Collage of Tsunami and Vesuvius victims by Kitty Winslet. Highly commended.

In 1748, Charles III, then king of Naples, sent military engineers to explore a site called Cività, rumoured to be an ancient city. Skeletons and moulds were found in the earliest excavations and the human stories of Pompeii began to filter throughout Europe almost immediately. The remains of a wealthy woman found in the gladiators' barracks instantly created the scandal of an aristocratic lady conducting a secret affair with a common gladiator. A group of people who suffocated in the subterranean corridors of a villa included the remains of a wealthy young girl and a man with a large key and money bags – the greedy villa owner and his beautiful daughter, perhaps? All that was left of the girl was the imprint in the ash of her ample bosom. ➜

Model of cast dog by Farah Fatima and Jessica Thomas. First prize under-14s.

➜ On show in the museum, this bosom inspired several authors, including Théophile Gautier, the French novelist, who wrote *Arria Marcella* (1852) about the bosom's owner. Falling in love with the imprint, the hero finds himself seduced by her ghost in Pompeii at night, only to have his passion thwarted by daybreak as she crumbles to dust in his hands. These erotic, romantic visions allowed the audience to enjoy the lure of the ruins whilst acknowledging one of the more enduring themes associated with Pompeii, that it was punishment by the gods for the Pompeians' decadent lifestyle. The single most famous book was Bulwer Lytton's *Last Days of Pompeii*. Vesuvius erupted on the eve of publication in 1834, providing the most timely publicity.

> 'New Orleans, New Pompeii', was soon all over the internet

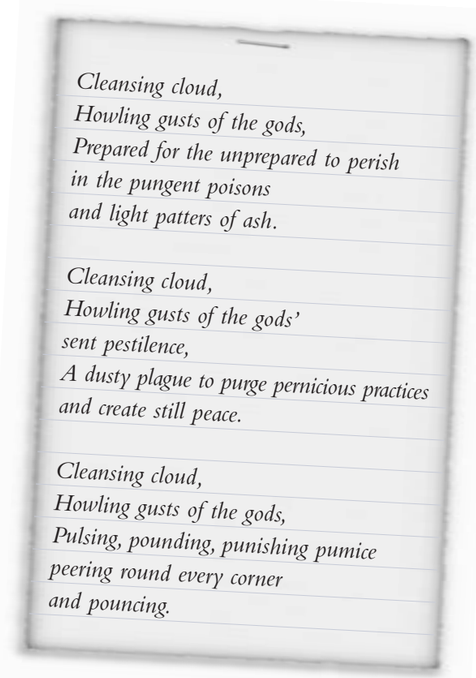
Pompeii's ghosts seemed to come increasingly to life as excavations progressed. No more so than the moment in the 1860s when Giuseppe Fiorelli, superintendent of the excavations, first realised a method of 'resurrecting' the victims whose bodies had decayed in cocoons caused by hot ash setting around their bodies as they fell. By injecting these empty cocoons with plaster of Paris, he produced spectacular casts of humans and animals as they died. Pompeii's petrified victims have continued to provide a crucial emotional and political connection between the humanity of present and past. After the Second World War, Primo Levi, a concentration camp survivor, used a cast of a young Pompeian girl to represent the dead children of the Holocaust and Hiroshima. More recently, after 9/11, the *New York Times* likened the disaster zone of Ground Zero to Pompeii, whilst the American scientist Charles Pellegrino wrote a book comparing the down-blast that felled the World Trade Towers, with the pyroclastic surges that devastated Pompeii. After Hurricane Katrina's trail of death and destruction, the headline 'New Orleans, New Pompeii', was soon all over the internet. The potential of these allusions that Americans have been creating for themselves has been recognised on several Islamic internet chat sites, where contributors have revived the theme of divine retribution to claim: "The story of the destruction of the cities of Pompeii and Herculaneum by Mount Vesuvius are one of the most excellent signs of Allah and his treatment of the disbelievers." These analogies show how much the classical world still anchors people today.

In order to further explore modern reactions to the remains of Pompeii, Hales devised the *Casts Project*, a national competition for school children, in which students were shown images of the body casts and asked: Does Pompeii matter today? Can we have any connection with the victims of Vesuvius? How should we treat their remains? Should we encourage sentimental connection or look on as objective, scientific observers? As an illustration of Pompeii's enduring appeal, she was inundated with over 200 entries, including stories, poems, essays, models, paintings, casts, plays, songs and broadcasts. The winning entries will be displayed at a conference Hales is holding later this year. Called *Ruins and Reconstructions: Pompeii in the Popular Imagination*, the conference brings together academics and policy-makers with artists who have made use of the theme of Pompeii, such as the novelists Robert Harris and Lindsey Davis, and the artist Victor Burgin.

Ironically, whilst the recent surge of popular interest in Pompeii has seen the city find a wider audience than ever before, the site itself has reached a critical state of decay, and the key players are seriously considering drastic action, including closing large parts of the site to the public and possibly even reburying it. Through the conference Hales is hoping to show the policy-makers of this World Heritage Site how Pompeii continues to be a major source of inspiration to western imaginations, and that it represents far more than just an expensive ruin. ■

www.bristol.ac.uk/classics

The Casts Project was sponsored by the University's Alumni Foundation.



Cleansing cloud,
Howling gusts of the gods,
Prepared for the unprepared to perish
in the pungent poisons
and light patters of ash.

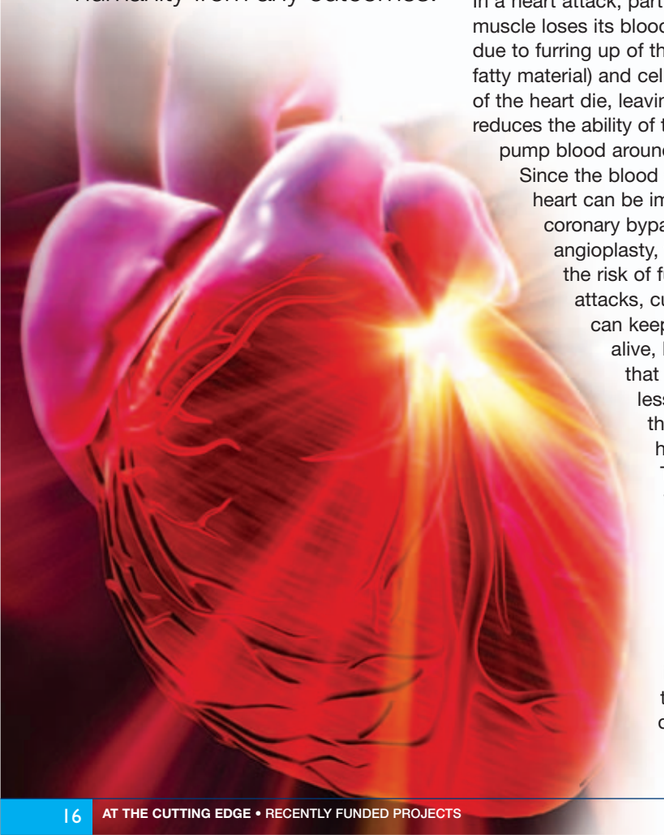
Cleansing cloud,
Howling gusts of the gods'
sent pestilence,
A dusty plague to purge pernicious practices
and create still peace.

Cleansing cloud,
Howling gusts of the gods,
Pulsing, pounding, punishing pumice
peering round every corner
and pouncing.

The thoughts of a person caught in the eruption, taken from *Hide and Seek, 30 tck, 29 tck…* by Emily Wright. First prize over-14s.

At the cutting edge – recently funded projects

The competition for funding is fierce, with only the very best proposals maturing into a project. Much is at stake: the principal investigator's reputation, the department's position in the league tables, the University's status as a research establishment, and perhaps the livelihood of a young researcher on a short-term contract – to say nothing of the benefits to humanity from any outcomes.



Stem cells to repair damaged heart muscle

In the first clinical trial of its kind in the world, 60 patients who have recently suffered a major heart attack will be injected with selected stem cells from their own bone marrow during routine coronary bypass surgery. The trial will test whether the stem cells will repair heart muscle cells damaged by the heart attack. *Dr Raimondo Ascione*, Reader in Cardiac Surgery Sciences, and colleagues at the Bristol Heart Institute have been awarded a grant of £210,000 from the British Heart Foundation to conduct the double-blind, placebo-controlled trial.

In a heart attack, part of the heart muscle loses its blood supply (usually due to furring up of the arteries with fatty material) and cells in that part of the heart die, leaving a scar. This reduces the ability of the heart to pump blood around the body. Since the blood supply to the heart can be improved with coronary bypass surgery or angioplasty, thereby reducing the risk of further heart attacks, current treatments can keep the patient alive, but with a heart that is working less efficiently than before the heart attack. The viability and function of the area already damaged is not restored. Cardiac stem cell therapy aims to repair the damaged heart as it has the potential to replace the damaged tissue.

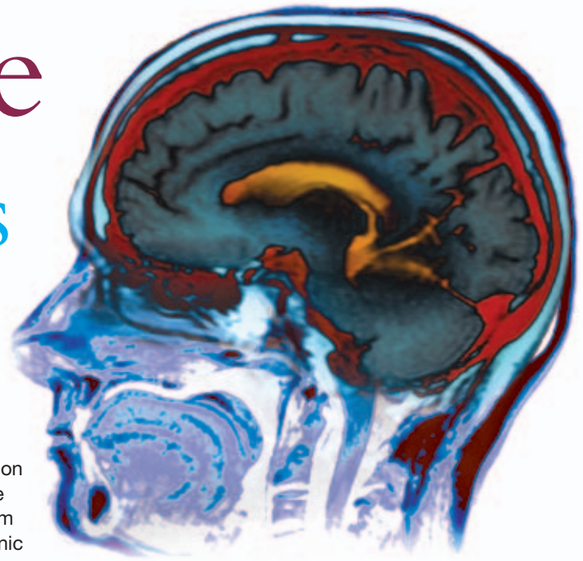
By electing to use a very promising stem cell type selected from the patient's own bone marrow, this approach ensures no risk of rejection or infection. It also gets around the ethical issues that would result from the use of stem cells from embryonic or foetal tissue. ■

www.bris.ac.uk/clinicalsciencesouth

Tracing the path of depression

Depression is an extremely debilitating disease that has a major impact on health. It is estimated to cost the UK around £12 billion a year, yet little is understood about the changes in the brain that underlie this disorder. A grant of £364,000 to develop radioactive 'tracers' that will help in understanding the cause of depression has been awarded to the University and its partners, with further funding from pharmaceutical company, GlaxoSmithKline, which will contribute £667,000 to the project.

Powerful techniques such as PET (positron emission tomography) scanning have recently provided significant advances in understanding how the brain works. These techniques allow the study of brain function and chemistry in living human brains, but they rely on the availability of specially designed radioactive 'tracers' to monitor brain function. Noradrenaline, a chemical found throughout the brain, has been implicated in depression and many other debilitating brain diseases, but it cannot be studied in living human brains at present, since no tracer is available to monitor it. ➜



➜ The funding awarded to *David Nutt*, Professor of Psychopharmacology, and colleagues will be used to develop tracers to track noradrenaline's activity in the brain. This in turn will allow us to better diagnose depression, which will lead to a much better prognosis for the sufferer. It will also permit the refinement of treatments that we already have, and the development of new and better ones.

The grant is one of 18 such projects being spear-headed by the Medical Research Council. The total value of the grants is £17 million for projects that will develop new ways to assess health, monitor disease, or determine responsiveness to treatment. ■

www.bris.ac.uk/Depts/Psychiatry

Untangling the entangled

Quantum mechanics tells us how the world works at its most fundamental level. It predicts very strange behaviour that can only be observed when things are very cold and very small. It has an inbuilt element of chance, allows 'superpositions' of two different states, and admits super-strong correlations – entanglement – between objects thousands of miles apart that would be nonsensical in our everyday world.

Despite this strange behaviour, future technologies anticipated to utilise what is known as 'quantum information science' include quantum computers with tremendous computational power, quantum metrology, which promises the most precise measurements possible, and quantum cryptography, which offers perfect security and is ready to be used in commercial communication systems.

Single particles of light – photons – make excellent quantum 'bits' or qubits, because they suffer from almost no noise (at these scales even heat is 'noise'), so they have great potential for application in future quantum technologies. There has already been a number of impressive proof-of-principle demonstrations of photonic information science; however, this technology has now reached a roadblock – it is stuck in the research laboratory, unable to be scaled up into a practical application.

To address the problems, *Dr Jeremy O'Brien*, who is affiliated to the Department of Physics and the Department of Electrical and Electronic Engineering, and his research partners, have been awarded over a million pounds by the Engineering and Physical Sciences Research Council. The project aims to reach the high performance levels required by developing single photon sources based on diamond nanocrystals, optical wires on optical chips, and superconducting single photon detectors. It also aims to integrate all of these components on a single optical chip.

Already O'Brien has demonstrated a way to almost double measurement precision by using photons of light with which to gauge distances. The findings were reported in *Science* (4 May 2007). The Japanese-British team showed how the precision of such a measurement depends on the wavelength of the light used. By using a group of four photons, the set behaves as if it had a shorter wavelength than a single photon. It is rather like using a ruler with spacing four times as fine. Bringing this kind of technology from lab-scale to chip-scale is a key target of this grant. ■

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Trauma, drug misuse and transforming identities

In issue 12 of *re:search* we reported on The Southmead Project that was set-up to help residents deal with the drug problems that had hounded the community for many years. Professor Kim Etherington, the original report's author, has now written a book that highlights the therapeutic value of listening to drug users' life stories, and the importance of understanding how social environments and the wider cultural influences shape people's lives. *Trauma, Drug Misuse and Transforming Identities – a life story approach*, looks at the lives of ex-drug users through their own words.

Published in August 2007, the book offers insights into the nature of addiction and how it can be tackled. It also examines the links between early childhood experiences and drug misuse, and shows pathways to recovery and transformation. Monty Don (of *Gardener's World* fame), who is involved with helping drug users through The Monty Project, has written a foreword: 'I welcome this study by Professor Etherington because it is part of the process of understanding our drug problem and the whole chain of issues that lead to addiction. It tells the stories of real people and in doing so holds a mirror not just to other people's lives, but to our own.' ■

All royalties will be paid to The Southmead Project, Bristol, UK. ISBN: 9781843104933, 240pp, £19.99.

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