

MEDICAL RESEARCH COUNCIL COGNITION AND BRAIN SCIENCES UNIT

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- Bionic ears
- CALM
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- New traumatic brain injury research





Welcome to the CBU

The Medical Research Council Cognition and Brain Sciences Unit (CBU) is a leading research centre for advancing understanding of human cognition based in Cambridge, UK. We investigate fundamental aspects of brain function such as memory, attention, perception, language and emotion. Alongside basic research, we are active in translating research findings to improve health and wellbeing. This includes the development of psychological therapies for mood disorders, improving our understanding of cognitive problems in childhood, and optimising diagnostic and rehabilitative techniques for neurological conditions. We have onsite, state-of-the-art facilities for measuring brain function including Magnetic Resonance Imaging (MRI), Magnetoencephalography (MEG) and Electroencephalography (EEG) and are a leading international centre in the development of methods to enhance analyses using these techniques. The CBU is also home to the Centre for Attention, Learning and Memory (CALM), a clinic for the assessment of cognitive function in school-age children.

The CBU hosts around 150 researchers, post-graduate students and visiting scholars from around the world in addition to dedicated technical, administrative and IT staff. We enjoy close links with a range of Cambridge University departments, Addenbrooke's, clinical collaborators and national and international research centres.



Dear CBU volunteers

Congratulations on another outstanding year of volunteering at the unit.

Since our last newsletter, you have helped us complete 1800 MRI (Magnetic Resonance Imaging) scans, 900 MEG (Magnetoencephalography) scans and nearly 4000 computer tests, many of which have involved online training at home. This is a fantastic achievement and has helped our 13 research programmes immensely. Thank you.

You can read more about our research programmes here: <http://www.mrc-cbu.cam.ac.uk/our-research/> and about the specific studies we are recruiting for at the moment on our online system here: <http://bit.ly/ZedaWpt> before deciding which study to participate in.

A typical computer based test might involve learning how to read words written using different symbols to investigate the processes our brains go through when we learn to read, or investigating the effects of social interactions during a virtual ball tossing game on task performance.

These tasks might then be repeated in the MRI scanner to measure the brain functions taking place whilst performing them. An MRI scan typically takes 90 minutes with 20 minutes of training outside the scanner. Our mock scanner gives adults and children the opportunity to experience what the real MRI scan might be like before deciding whether to take part. MEG experiments take up to 2.5 hours and measure the small changes in magnetic fields generated by nerve cell activity inside the brain.

In the last year, volunteers between the ages of 16 – 84 have participated in our experiments and some of our oldest volunteers have been coming to the Unit for the last 21 years. Our most prolific volunteer has participated in 696 testing sessions since 1994 helping our Hearing, Speech and Language group with cochlear implant testing.

Without your dedication our researchers would not be able to continue translating scientific knowledge into benefits for health and wellbeing for our present and future generations. Thank you and please continue to play a role.

Visit our take part pages:

<http://www.mrc-cbu.cam.ac.uk/take-part/> or email: panel.office@mrc-cbu.cam.ac.uk



Volunteers are vital to our studies and without them we wouldn't have the same world leading research as we do now. Your help makes all the difference. We always need more volunteers so if you haven't yet, please sign up and let others know too.

News in brief

Working memory

Working memory (WM) the capacity to store information for brief periods, has been suggested to play a critical role in learning such as reading and mathematics. It has been claimed that this capacity is enhanced by intensive training. New findings indicate that the benefits of training do not extend to children's long-term academic achievements.



A randomised clinical trial of over 450 6-year old children in Melbourne investigated whether there are enduring academic benefits to WM training. No improvements in reading, spelling or mathematics were detected one and two years after training, although there were short-term gains in other WM tests similar to training activities.

Health economic analyses were conducted by the international team, which was headed by Gehan Roberts from the Murdoch Children's Research Institute and included CBU Director Susan Gathercole. These provided no justification for the use of WM training as a population-wide intervention for children with low WM.

Bipolar disorder

A paper by Emily Holmes and her team on using applications of time-series analysis to mood fluctuations in bipolar disorder to promote treatment innovation has been published in Nature.



The findings offer preliminary support for a new imagery-focused treatment approach. They also indicate a step in treatment innovation without the requirement for trials in illness episodes or relapse prevention. Importantly, daily measurement offers a description of mood instability at the individual patient level in a clinically meaningful time frame.

Memory suppression

Consciously suppressing memories of certain events can cause an amnesiac shadow which can disrupt other unrelated memories. A paper recently published by Michael Anderson and Rik Henson of CBU and Justin Hulbert now at Bard College in Nature Communications showed that deliberately suppressing unwanted memories can lead to amnesia of other events happening near in time to suppression.



The research showed that deliberately disengaging memory retrieval "broadly compromises hippocampal processes" necessary for the creation and stabilization of new memories. As such, continually suppressing the recollection of certain events may prevent the hippocampus from being able to fully encode memories of other experiences.

Previous work has shown that in the aftermath of a traumatic experience, traumatised individuals often show inexplicable forgetting for everyday events, which has been attributed to factors such as stress, loss of sleep, and distraction. However, the amnesic shadow generated intentionally suppressing unwanted memories and disrupting hippocampal activity "constitutes an unrecognized forgetting process that may account for otherwise unexplained memory lapses following trauma."

Pictures of You

This was performed at the unit as part of Cambridge Science Week. Inspired by 'mental imagery', emotion and the study and treatment of bipolar disorder, Pictures of You presented the intriguing meeting of two friends after many years apart. Full of unexpected lightness, warmth and love, the play explored the challenge of recalling the past and picturing the future. It was followed by a discussion including scientists and clinicians on the issues raised by the play.



7T neuroimaging in Cambridge

The new ultrahigh field MRI scanner, called the "7T", has arrived in Cambridge. The 17 tonne magnet lies at the heart of a world leading centre for brain imaging. The innovative Terra MRI system from Siemens will transform the ability to see in detail inside the working human brain, its structure, its function, its chemistry and the 'neural code' which brain cells use to think, perceive, move and remember. The new scanner represents a key partnership between the University of Cambridge and the MRC Cognition and Brain Sciences Unit. It will support Cambridge-wide research into the workings of the healthy brain and its disorders, including dementia and mental health, when it becomes fully operational.



Degraded speech

A new paper, published in the Proceedings of the National Academy of Sciences of the United States of America (PNAS) explains why and how a commonly used training method helps people with cochlear implants to understand speech. In the research, Ed Sohoglu and Matt Davis used brain imaging (combined magneto- and electro-encephalography, i.e. M/EEG) to study what happens when adults with normal hearing listen to degraded sounds that are similar to speech processed by a cochlear implant. They found that volunteers best learnt to understand degraded speech when using written subtitles. Measures of brain activity before, during and after learning showed that subtitles helped immediate understanding and longer-term learning in the same way; by reducing brain responses associated with "prediction error". A simple computer model of these processes helps explain the brain mechanisms responsible for learning to understand degraded speech.



Depression

The largest meta-analysis so far of Mindfulness-Based Cognitive Therapy (MBCT) for recurrent depression has found that MBCT is an effective treatment option that can help prevent the recurrence of major depression in those who are currently in remission. The paper published in the Journal of the American Medical Association (JAMA): Psychiatry and co-authored by Tim Dalgleish of the CBU used anonymised individual patient data from nine randomized trials of MBCT. It suggests that for the millions of people who suffer recurrent depression, MBCT represents an evidence-based treatment choice as an alternative or addition to other approaches such as maintenance anti-depressants.



MBCT is a group-based psychological treatment that helps people change the way they think and feel about their experiences and teaches skills that reduce the likelihood of further episodes of depression. MBCT was co-developed at the CBU by John Teasdale almost 20 years ago. This meta-analysis included individual patient data from trials that compared MBCT to usual care as well as to other active treatments such as maintenance antidepressants – the current mainstay approach to prevention of depressive relapse.

Welcome

PhD students at the CBU

Each October we have a new intake of PhD students here at the CBU, coming from all over the world to conduct research at the Unit and to gain their PhD from the University of Cambridge. Last October, we welcomed new faces to the unit, including both MRC-funded students and externally funded ones, several of whom won prestigious scholarships to come to Cambridge. MRC funded students are fully supported through three years of study, with the places restricted to UK nationals and other EU candidates who have lived in the UK for three years prior to study. The new students are already taking part in unit research and conducting their own experiments, working on diverse topics across the attention, language, memory and methods groups.



Sneha Shashidhara



Pei Huang



Courtney Spoerer



Johannes Mehrer



Shraddha Kaur



Tanya Wen



Verity Smith



Laura Forde

Goodbye

Along with lots of new faces at the CBU there are some that have also left the unit. We would like to wish Mandy (director's PA), Anthea (unit manager), Sam (researcher) and Helen (radiographer) all the best for the future.



Mandy Carter



Anthea Hills



Sam Wass



Helen Lloyd

Awards for CBU staff and students

Susan Gathercole

Susan Gathercole has been awarded an OBE in the Queen's Birthday Honours List for her services to psychology and education.



Susan has been the Director of the MRC Cognition and Brain Sciences Unit since 2011 and is a professor at the University of Cambridge. Her academic interest is in memory and learning, including the causes of specific learning difficulties in children and how they might be overcome. Her current projects examine the cognitive mechanisms of working memory and how they might be modified through training, and to investigate, through a new research clinic, the dimensions of cognition and the brain that can be impaired in children with problems in attention, learning and memory.

She has previously held academic posts at Lancaster, Bristol, Durham, and York and became a Fellow of the British Academy in 2014.

Elizabeth Byrne

Elizabeth Byrne, a PhD student at CBU was awarded a Fellowship from the British Council of Japan to take part in the Japan Society for the Promotion of Science Summer Programme. The aim of the programme is to foster young researchers and promote scientific collaboration between Japan and other countries.



Elizabeth spent 2 months working in Dr Satoru Saito's group at Kyoto University this summer. Her current research investigates methods of improving working memory, our ability to store and process information in the mind for short periods of time. Working memory is important for many everyday activities, including learning and following instructions. Dr Saito's lab has expertise in studying the underlying mechanisms involved in working memory tasks. Working together on a project provided a unique opportunity for Elizabeth and Dr Saito to combine their expertise to develop our understanding of the specific processes that are important for learning and that are amenable to practice.

Alan Archer-Boyd

Alan Archer-Boyd, a post-doctoral scientist at the CBU, and his sponsor, CBU deputy director Bob Carlyon, have been awarded a Pauline Ashley Fellowship from Action on Hearing Loss. The aim of the scheme is to build research capacity in hearing research by supporting new investigators towards becoming independent scientists. Pauline Ashley was a campaigner for disadvantaged people and the wife of the profoundly deaf MP and campaigner Jack Ashley.



The 12-month project (starting May 2017) will investigate the effect of cochlear-implant dynamic-range compression, reverberation and head movement on cochlear-implant users' ability to segregate sound sources. It combines Alan Archer-Boyd's previous research into the utilization of head movement in hearing-aid processing and virtual acoustics, with Bob Carlyon's extensive research experience in the fields of cochlear-implants and sound segregation.

The research could lead to a significant improvement in cochlear-implant outcomes and advice for users, especially in acoustically challenging environments.

We would like to congratulate all our recent winners and achievers.

The Cambridge Cognitive Neuroscience Research Panel

Sharon Erzinclioğlu

The Cambridge Cognitive Neuroscience Research Panel is a world-renowned centre for research into how the brain works. But there is always more to learn, which is why the Volunteer Panel at the CBU is so important.

But what fewer people know is that as well as having a large and very active panel of healthy volunteers of all ages, we also have a very special group of patient volunteers. Back in 1995, John Duncan from the CBU, working with a Consultant Radiologist at Addenbrooke's Hospital, asked patients who had what is called a non-traumatic acquired brain injury if they would like to form a new research panel, the Cambridge Cognitive Neuroscience Research Panel or CCNRP.

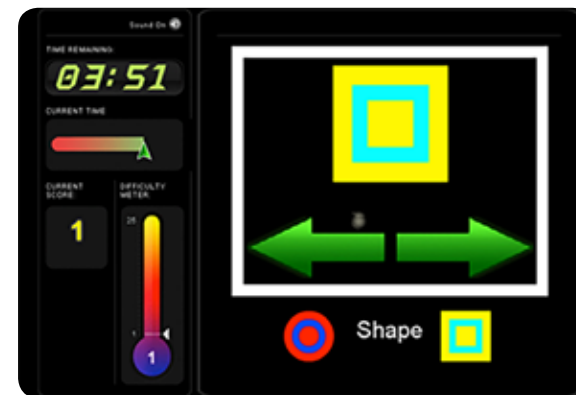
So, what do we mean by acquired brain injury? As the name suggests, it is an injury to the brain that has happened after a person's birth rather than being a congenital or genetic disorder that they were born with. Acquired brain injuries can be divided into two types: traumatic and non-traumatic. Traumatic brain injuries or TBIs are the result of an external force injuring the brain, in other words a physical trauma to the head and brain such as being involved in a serious road traffic accident, falling from a height, or being assaulted with a weapon. Traumatic brain injuries can often result in very severe physical, cognitive, social, emotional and behavioural effects and the outcomes can range from complete recovery to permanent disability and death. Both the causes of a TBI, and its effects in terms of the parts of the brain affected, the resulting problems and the rate of recovery, can vary dramatically from person to person.

Non-traumatic acquired brain injuries can result from either external or internal causes e.g. strokes; brain tumours; infections or inflammations such as meningitis and encephalitis; poisoning; substance abuse; lack of oxygen to the brain (hypoxia) e.g. as a result of near drowning, a severe asthma attack, smoke inhalation, choking; lack of blood flow to the brain (ischaemia) e.g. as a result of heart problems, a burst aneurysm, a brain haemorrhage. Some of these causes may overlap and, like TBIs, they can result in physical, cognitive, social, emotional and behavioural effects and again outcomes can range from complete recovery to permanent disability and death. A difference is that, with

TBI, injuries are often spread widely through the brain, making it difficult to link particular effects to a particular region of damage. This is much easier with non-traumatic injuries, which usually affect one specific area.

Why did we develop a clinical panel? At the CBU we study human cognition and the brain and we are funded by the Medical Research Council, whose aim is to turn scientific knowledge into benefits for health and well-being.

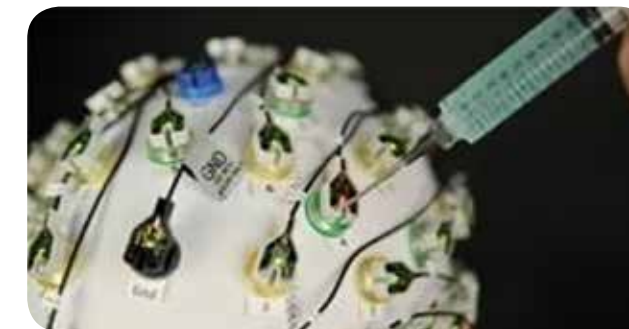
Our researchers are interested in how our brains work, which part does what and how the different parts work together. A lot of our research relies on the help of healthy volunteers, who assist our scientists and students to test their theories about how the mind and brain functions, by helping us with studies on language, memory, attention and emotion processing. But it can be equally helpful to see what happens when a particular part no longer works properly. All of the patient volunteers on the CCNRP have had a brain scan, either a CT scan or an MRI scan, so that we know exactly which part of their brain has been injured. They also volunteer to take part in psychological testing, examining the same functions in language and memory that we study in healthy people. The CBU is also part of the wider Cambridge Neuroscience community, so we have strong links to the research that is carried out in the University of Cambridge's Department of Psychology and the Medical School's Department of Clinical Neurosciences. All of these groups have access to the CCNRP, strengthening research across the Cambridge community.



Stroke study: Attention training task

Since 1995, we have recruited around 550 patient volunteers. Most have stayed on the panel for around 10 years, but some of our earliest recruits are still making valuable contributions. Currently we have over 300 active members from all across East Anglia. Many have had a brain scan to help us understand exactly which part of the brain has been injured. Over the years our volunteers have taken part in a variety of studies, ranging from those that involve pen-and-paper tasks or simple computer-based tests designed to understand basic functions of the brain to intervention studies testing out specific new rehabilitation therapies.

For example, we have a 3 year project that is well underway with patients who have had a stroke that has resulted in them 'neglecting' one side of their field of vision. The outcome of this is that these patients often bump into objects on their 'bad' side, or, even more strikingly ignore food on that side of their plate for instance. This study is using two kinds of computer-based training exercises to see whether either remembering to look to the 'bad' side or learning to pay more attention to the 'bad' side is the most helpful way to deal with this problem.



Adding conducting gel to the sensors in an EEG cap to aid in picking up electrical signals from the brain

In a recently completed study, we collaborated with some researchers from Majorca who have particular expertise in using a technique called electroencephalography (EEG), where we can record the electrical activity as the brain does a particular task using a special cap fitted with recording sensors. This is a very non-invasive technique for looking at the workings of the brain and could potentially be a useful way of picking up any problems without having to ask patients to have an MRI scan.

The aim of this particular study was to see if EEG could be used as a novel way of assessing what is called executive dysfunction – this is the term used for the range of cognitive, emotional and behavioural difficulties which often occur after injury to the frontal lobes of the brain. Impairment of executive functions is common after an acquired brain injury and has a profound effect on many aspects of everyday life such as the ability to make decisions, to plan and organise things that you want to do, to 'multi-task', to concentrate and take in information, to learn rules and so on, as well as having an effect on controlling emotions and behaving appropriately in different social situations.

The idea for this study was to see if patient volunteers who had some damage to one of the two frontal lobes of the brain and another group of patient volunteers who had damage to a part of the brain that is not thought to be involved in executive function were both able to do a computer task that involved making some very simple decisions about colour and shape of objects following a set of simple rules, and whether the parts of their brains that were working (and so producing electrical activity that could be recorded by the EEG cap) were the same or different to those in healthy volunteers who had never suffered a brain injury.

In Majorca, over a 3 year period only a handful of patients had been recruited but with the help of our patient and healthy volunteer panels, two researchers were able to visit the CBU and test 31 patients and 24 age and education-matched healthy controls in the space of 3 months. It will take some time to analyse all of the results obtained, but if the brains of those volunteers with damage to the frontal lobes show a pattern of activity that is similar in all of them, and consistently different to the pattern produced by a non-injured brain, then this helps not only in our understanding of how the human brain can recover from an injury (all of our patient volunteers were able to do this decision-making task for instance), but also is showing the EEG could be a valuable tool for assessing brain function in patients.

For this and all our many other research projects we are extremely grateful to our small army of willing patient volunteers.

Witnessing the unexpected: how guns and other weapons influence eyewitness memory

Andrea Greve, Rik Henson and Jonathan Fawcett

Imagine you are on your way to a coffee shop for something to help you make it through the afternoon. While you await your order, a man bursts in holding a hostage and demands that everyone empty their pockets. The atmosphere is tense, but everyone complies and the man is gone in under a minute. The police arrive and ask you to describe what just happened. Would you be able to do so? Though this example may sound like something from a movie, it is in fact what happened in Toronto, Canada, in 1997. What is interesting about the event is that witnesses reported focusing on what the man held in his hands rather than inspecting the robber himself. As a result, they were unable to adequately describe or identify the culprit.

The above case poses a problem for the police and the legal system because eyewitness reports play a crucial role in reconstructing and solving criminal cases. There are few other sources of evidence that are as compelling as someone who was present and able to identify the offender. However, eyewitness reports must be treated with care. Our brains do not function like video recorders capable of storing a precise copy of our experiences. Instead, our memories represent imperfect reconstructions of past events, which are sensitive to both the manner in which they are encoded and the manner under which they are retrieved. In the robber example, it has been proposed that the witnesses experienced difficulty describing the perpetrator because they were subject to what has been called the “weapon focus effect”. This effect occurs when a weapon (e.g., a gun or knife) is present at a crime, which is believed to attract attention away from the person wielding the weapon, resulting in worse memory about the person’s appearance.

Historically, the weapon focus effect was thought to occur because of the threatening nature of weapons. This account is appealing, but recent research has suggested an alternative account, in which the effect should occur for any object that is unexpected in a given context.

For example, it might surprise you to discover that the perpetrator described above did not carry a gun – but rather he robbed the coffee shop using a wild Canada Goose that he had captured and was threatening to choke! Nonetheless, witnesses displayed the classic signs of having been robbed at gunpoint.

We decided to investigate this weapon focus effect more systematically in the laboratory, with the aim to understand how threat and expectation combine to influence eyewitness memory. In our experiment, volunteers were presented with a context in the form of a background scene shown on a computer screen (e.g., tennis court). We then superimposed an image of a person holding an object (e.g., tennis racket) so that this person appeared to be standing within that scene. By combining various scenes and objects, we were able to test eyewitness memory for four conditions, in which the effect of threat and the effect of expectation were contrasted with each other: an expected non-weapon (EN), expected weapon (EW), an unexpected non-weapon (UN) and an unexpected weapon (UW), as shown in figure 1.

The outcome of our study demonstrated that people have more difficulty remembering the identity of a person when that individual was seen holding an object that was unexpected given their surroundings, (i.e., top row in figure 1). Interestingly, memory difficulties were observed for both weapons and unexpected non-weapon objects, with little difference between them.

These results suggest that violating a witness’s expectations is the main cause behind the weapon focus effect, rather than threat per se. It is possible that threat plays a larger role in real-life situations where the witness is likely to experience considerably more stress than in our laboratory setting. Nonetheless, by studying the factors important for an effect in the laboratory, we can create hypotheses to test in future, more realistic experiments.

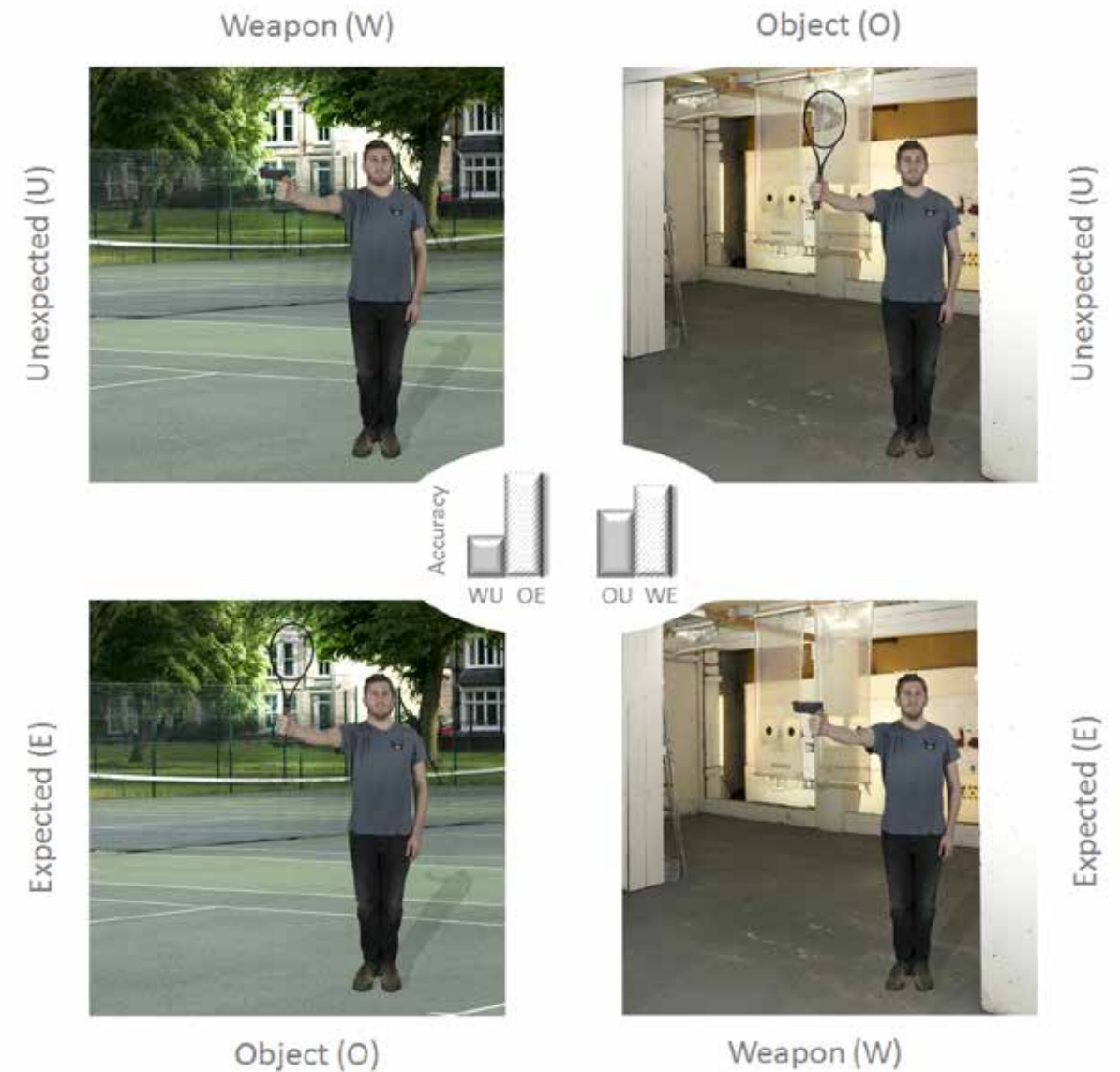


Figure 1. This figure shows example images from our laboratory-based experiment testing both the type of object (weapon, non-weapon) and whether they were expected given the context (expected, unexpected). Many previous experiments include only the weapon-unexpected (WU) and non-weapon-expected (NE) conditions, and it is this comparison that represents the often reported weapon focus effect. We, however, have designed the experiment to separate the role of expectation from the role of threat induced by weapons. With this in mind, the inlaid plot shows the typical findings from such an experiment: an object that is unexpected (WU and NU) results in worse memory for the appearance of the person holding that object, than an object that is expected given the context (WE and NE).

CALM: Centre for Attention, Learning and Memory

Frankie Woolgar, Joni Holmes and Sally Butterfield



In 2014, a research clinic for children with problems in the areas of attention, learning and/or memory was opened at the MRC Cognition and Brain Sciences Unit (CBU). The clinic is located in the Centre for Attention, Learning and Memory (CALM), a family-friendly developmental research facility based at the CBU. Research conducted in the CALM clinic aims to increase our understanding of the cognitive, brain and genetic causes of children's learning difficulties. By understanding more about the causes of learning difficulties we aim to develop better diagnostic tools and interventions for children who are struggling at school.

Education and health professionals refer children to the clinic. When the clinic first opened we took referrals for children struggling in attention, learning and / or memory. At the moment we are only taking referrals for children who have received support from speech and language therapists, or who have a diagnosis of ADHD or OCD.

What happens on your first CALM visit?

- 1 Children complete a variety of tests to measure their attention, learning and memory abilities. Their parents / carers complete a set of questionnaires about the child's behaviour and mental health
- 2 Families are invited to join a research panel to take part in future studies
- 3 Children are asked to provide a saliva sample so we can look at the genetic bases of learning problems
- 4 Children are invited back for a brain scan using an MRI scanner, which is like a giant camera
- 5 To help the children decide whether they would like to come back for a real brain scan, they are given the opportunity to lie in a pretend MRI scanner on their first visit to CALM to get an idea about what it will be like in the real scanner
- 6 A report summarising the child's strengths and weaknesses is sent to the referrer within three weeks of the assessment. This helps to guide the support that the referrer is providing for the child

How many children have been to CALM?

<h1>450</h1> <p>children with problems in attention, learning and / or memory have been to the clinic.</p>	<h1>80%</h1> <p>have agreed to come back for an MRI brain scan, and 175 children have already had a brain scan.</p>	<h1>90%</h1> <p>of the families who have visited CALM have signed up to the developmental research panel to take part in future studies at the CBU.</p>
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We asked some of the people who used CALM what they think of it...

The researchers:

Why do you like working in the CALM clinic?

- “ Not only is it stimulating to work with a variety of children it is also satisfying that our research serves a dual purpose: to collect data to understand the issues related to learning, but also to provide more detailed information for professionals working with families in the community. ”
- “ I think the CALM clinic is special because it bridges a gap between researchers and professionals, and provides not only a research assessment unit, but also an information hub and training centre through outreach meetings and workshops. ”

The parents and carers:

Did you find the report helpful?

- “ I have seen an improvement in his performance from his recent school report... Everyone at CALM did a really good job in talking with my son. ”

What do you think of the CALM clinic and your experience here?

- “ I just think it is wonderful that this centre is here... ”
- “ The information sheets explained it all... It's very thorough... I wouldn't change anything. ”

The children:

What would you say to another child who was deciding whether to have a brain scan?

- “ ...No point in getting worried. The fun part is watching the movie. ”
- “ Go in the brain scan. Don't be scared. Have a good time! ”
- “ You should have a brain scan, You don't need to be worried. ”
- “ It's a good experience. The slight problem is you have to keep still. ”

What did you think of the assessment?

- “ I loved all the challenges. They were good! It pushed you on, to have a go. Thank you for helping me. I have improved. ”
- “ It was fun; the tester was very nice and clever! ”

More information

If you would like to find out more about CALM, or would like to refer a child, please visit our website: www.calm.mrc-cbu.cam.ac.uk

Helping stroke patients re-build “me”

Polly Peers

Stroke can have a devastating impact on sufferers and their families. In a moment lives can be changed, indeed people can be changed, such that they no longer recognise themselves. As one of our patients put it, “I woke up and I was me but I was not me, I did not know myself or what I was capable of any more”.

Stroke is the leading cause of long-term disability in the UK and the cost to health services and society as a whole is thought to be around £9 billion per year. NHS physiotherapists, speech and language therapists and occupational therapists work hard to help patients regain movement, improve swallowing and speech and work towards functional goals such as shopping or cooking. However there are few proven interventions to help alleviate patients’ cognitive problems. These silent difficulties, though less overtly obvious than paralysis or difficulty with speaking, can have major impacts on patients ability to function, their social interactions, their mood and their understanding of themselves.

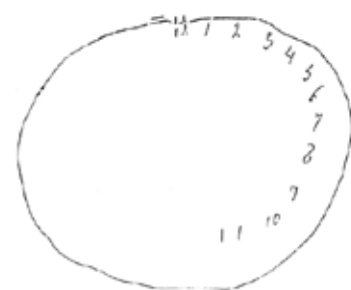
As an outsider it is hard to imagine what it must be like to have an attentional problem that means that you just don’t “see” anything on the left hand side of space, meaning you only eat half the food from your plate or even only dress one side of your body. Equally it is hard to conceive that someone who previously had a responsible job running a large team of people has such difficulties with organisation that they still have their Christmas tree up in May. Lack of resource and knowledge mean many of these people never receive a cognitive assessment to understand their profile of the cognitive difficulties, let alone help to overcome them. The central aim of the rehabilitation group, led by Dr Tom Manly here at the CBU, has been to translate scientific theory into practical and cost effective technologies to assess and treat cognitive difficulties following brain injury.

A collaboration between Tom and colleagues at Oxford University has led to the development of the OCS-bridge, a comprehensive, yet relatively quick, set of computerised tests designed to be carried out by a nurse or other healthcare professional at the bedside.

On completion of the tests the healthcare professional can download a report detailing the patient’s cognitive profile. Whilst, historically, a full cognitive assessment would have to be carried out by a clinical psychologist over many hours, using many different tests, it is hoped that the new battery will be quicker, simpler and easier to administer by a wider range of health professionals. This would give more patients access to a cognitive evaluation which could help them and their care team understand their difficulties and needs.

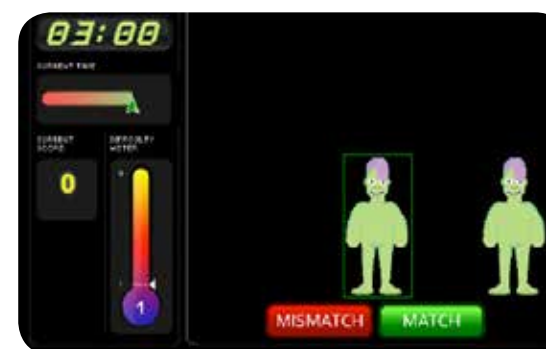
Over the past 4 years, the group has been focussed on the second of the rehabilitation group’s aims, intervention. Previous work from both our group and others around the world has shown that problems with attention are commonplace following stroke, and that patients with attentional difficulties are more likely to have poor outcomes and have a greater reliance on public services. So a treatment that could help people overcome their attentional impairments could significantly impact on patients functioning, quality of life and use of services.

One important component of attention is selective attention (the ability to direct processing resources to objects that are important to the current goal). If for example you are looking for a friend in a crowd, the ability to selectively attend allows you to focus your efforts on people with features that are most like those of your friend, be it their height, hair colour, or body shape etc. Our current research aims to see whether we can use computer tasks to train this skill in patients who have had a stroke, and whether such training is beneficial.



The effects of a stroke can be intriguing, here a patient was asked to draw a clock face, his difficulty with attention to the left side of space meant that he placed all the numbers on the right side. Difficulties such as this have major impacts on patients’ everyday life.

We wished to compare the selective attention training, with training of another attentionally demanding cognitive function, working memory, (the ability to store and manipulate information over short periods of time). Within the CBU many researchers have used working memory training with children, allowing us to benefit from their expertise, however moving to patients with stroke has its unique challenges.



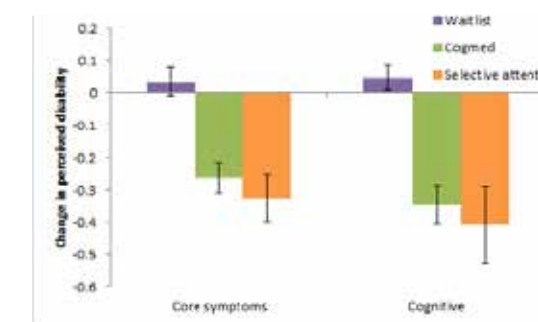
Are these two aliens exactly the same? We have developed games like tasks to help patients practise their attentional skills.

Previous work by researchers from the CBU and elsewhere suggests that in order for cognitive training to be successful, the training must adapt to the individual’s ability allowing them always to work at their own limit. With help from colleagues at Imperial College, London, we have developed two sets of short training tasks (one focussed on selective attention and the other on working memory) that can be “played” by patients over the internet at home.

Before patients start training we carry out a comprehensive cognitive assessment and disability rating (taking 3-4 hours) in their own home. Following the assessment patients are requested to either complete 20 sessions of selective attention training, 20 sessions of working memory training, or wait to complete training at a later date.

They are supported through this training by the research team. Finally follow-up cognitive and disability assessments are completed at the end of the training period and again after three months.

Such studies are very time consuming, tracking down suitable patients, driving round East Anglia with a mobile lab in bags and suitcases, and drinking many, many, cups of tea! Despite this, an initial pilot study with 23 patients was completed in 2014. This showed promising results. Not only did we see significant improvements in attention tasks following attention training and a corresponding improvement in working memory performance following memory training, but most importantly to us, we found that completing either type of training led to significant reductions in self-reported disability. So not only did training have the potential to improve patients cognitive abilities but it also impacted on their everyday functioning. On the basis of these preliminary findings we received a grant from the Stroke Association to complete a larger scale study involving 99 patients which is currently on-going.



Data from our study shows that not only does training improve cognitive performance, but also perceived disability. Patients waiting for training do not show such improvements.

Whilst this type of research is incredibly time consuming and does not necessarily lead to hundreds of publications in leading academic journals, it is still important. The unique environment at the CBU makes this kind of translation of basic science into interventions that have the potential to improve patient’s lives, possible. Additionally, working closely with the patients and understanding their difficulties helps us to better understand cognitive processes, how they can be affected by brain injury, and gives us clues as to how we may improve our interventions in the future.

Bionic ears and auditory illusions

Alan Archer-Boyd

In the hearing group, we focus on two broad interlinked areas of research: pitch perception and cochlear implants.

What is a cochlear implant?

Cochlear implants (CIs) are biomedical devices that have proven extremely successful in restoring hearing to profoundly hearing-impaired listeners worldwide. However there is still a large variability in CI listeners' abilities to understand speech, especially in noisy backgrounds, and our research aims to understand and improve the listening experience for CI users.

CIs work by picking up sound using a microphone placed on the outside of the ear and converting the sound to electrical signals. These are sent to a line (or array) of 12 to 22 electrodes placed along the length of the inner ear (a snail shell-like structure called the cochlea) to stimulate the nerve (the auditory nerve) directly, bypassing the acoustic parts of the outer and middle ear. The cochlea is sensitive to high frequency sounds at its base, and low frequency, bass sounds at its apex, meaning that the electrodes can be approximately matched with a range of frequencies, going from high to low along the cochlea. The listener learns to interpret the electrical stimulation of the nerve fibres in the cochlea as sounds, partially restoring hearing.

That's the theory. In reality, there are a myriad of factors that may affect a cochlear implantee's hearing performance, from the way sounds are converted into electrical signals inside the CI, to the placement of the electrodes relative to the nerves in the cochlea, damage to the nerves themselves and finally the abilities of the CI user to adapt to the new signals.

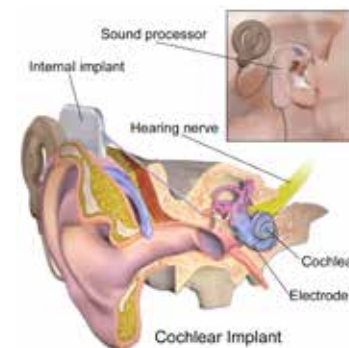


Illustration of a cochlear implant

Stripey sounds

Just as there are a number of factors that can affect CI user performance, there are many possible methods for improving it, including new ways to process the sound and better ways to fine-tune devices to individual users. However, existing hearing tests may not demonstrate a benefit, due in part to listeners learning and being biased to the sound-processing and stimulation method that they have become acclimatized to over a period of months. We have developed a new test that overcomes these limitations, and called it "STRIPES" (Spectrotemporal ripple for investigating processor effectiveness). It requires listeners to detect a series of tones going up in pitch versus a series of tones going down in pitch. By increasing the overlap in time between the tones, it becomes harder for the listeners to hear tones going up or down. These sounds are sufficiently different from speech to remove any bias the listener may have, while the task requires similar skills to deciphering the vowels and consonants in speech. With the ability to rapidly show the beneficial or detrimental effects of a new method of sound processing or stimulation, the STRIPES will speed up the period of tuning and acclimatization that can take many CI users several months.



A volunteer participating in one of the hearing group studies.

Clever Maths

Often the problem may not lie in the sound processing, but in the positioning of an electrode in relation to the nerves that it is trying to stimulate. We investigate these electrode "exceptions" using both listening experiments and analysis of physiological measurements. We have focussed on two important types of exception: "dead regions" – an area on the cochlea with very few nerve endings, meaning that no amount of stimulation in this area will produce sufficient activity to be detected, and "cross-turn stimulation" – an electrode stimulating the wrong part of the cochlea. We measure the response of the nerve fibres in the cochlea to electrical stimulation by each electrode. These responses are known as "evoked compound action potentials" and in practice they are both difficult to measure and often misinterpreted. By taking this difficulty into consideration and applying some "clever maths," we've been able to predict the position of previously undetected electrode "exceptions" in a few CI users. Our goal is to further refine the program (named PECAP) to ultimately develop a clinical tool for improving individualized CI fitting.

A more medicinal approach

Finally, it may be that a CI user's device is working perfectly well, and the interface between the electrode and the nerve fibres is as good as it can be, but the accuracy with which signals pass from the ear to the brain is impaired, possibly due to the effects of long periods of deafness on the ability of the brain to process new sounds. The hearing group is involved in the first CI user trials of a new drug from Autifony. The drug may improve the delivery and accuracy of electrical signals received at the auditory nerve to the brain. This reduces the damage that may have occurred during a long period without stimulation of the nerve, such as in the period of profound hearing impairment before being implanted with a CI. So far, the improvements have been seen only in animal studies. In collaboration with hospitals in Manchester, Birmingham, London and Cambridge, newly implanted CI users will either be given the drug or a placebo, and a number of listening tests will be administered that are sensitive to improvements in the performance of the auditory nerve.

Auditory after-effects

The hearing group has made many contributions to our understanding of how pitch is encoded in the human auditory system. Most recently, the phenomenon of "Zwicker tones" has been investigated. To produce a Zwicker tone (named after the discoverer, Eberhard Zwicker, in 1964), noise similar to the static sound produced by an out-of-tune radio is played with a narrow range of frequencies removed. After listening for a few seconds, the noise is abruptly stopped, and most listeners hear a tone at a frequency within the range removed from the noise, which gradually decays over a few seconds. Musically trained listeners were able to make musical interval matches for both normal tones and Zwicker tones as the reference sound. This suggests that the perception of pitch to an auditory after-effect like a Zwicker tone - where no tone is actually being played to the listener - is similar to the normal perception of pitch in the presence of a tone. This has implications for our understanding of processes underlying pitch perception.

We'd like to thank all of our volunteer listeners, both those with normal hearing and our cohort of cochlear-implant users. Without their patient hours in our listening booths, our theories would be little more than guesses.



Social event held at the CBU for cochlear implant users

Additional information:

The hearing group comprises deputy director Bob Carlyon, senior investigator scientists John Deeks and Hedwig Gockel, postdoctoral researchers Stefano Cosentino and Alan Archer-Boyd, PhD student Phil Gomersall and research assistant Francois Guerit. We hold close ties with the audiology department (Emmeline Center) at Addenbrooke's and collaborate internationally with research groups from Seattle to Melbourne.

STRIPES is funded by cochlear-implant manufacturer Advanced Bionics. PECAP is funded by the UK charity Action on Hearing Loss. The drug trial research is funded by Autifony.

Ways you can volunteer

Get involved in cutting-edge research looking at the most complex computer in the Universe – your brain!

Our research is dependent on keen volunteers who contribute to our studies by completing computerised experiments and taking part in various types of brain scanning studies in our Unit near to the centre of Cambridge. Increasingly we also use on-line tasks that you can complete at home. We are always in need of new volunteers, and are able to compensate you financially for your time.

To find out more about taking part in our research studies, and to sign up as a new volunteer, please visit our website using the link provided below.

www.mrc-cbu.cam.ac.uk/take-part

You can also get in touch with us by phone (01223) 505610 or email: panel.office@mrc-cbu.cam.ac.uk



Bio Resource

The NIHR Cambridge BioResource (CBR) is a panel of around 16,000 volunteers, both with and without health conditions, who are willing to be invited to take part in research studies investigating the links between genes, the environment, health and disease. Volunteers who join the Cambridge BioResource donate their DNA via a blood or saliva sample which is used together with other information, such as gender and ethnicity, to match them to specific research studies.

Volunteers are free to choose which studies they would like to take part in, allowing the CBR to provide researchers with groups of participants, tailor-made to the research study.

We are always looking for new volunteers to join the panel. Interested? Please get in touch!

Email: cbr@bioresource.nihr.ac.uk
 Tel: 01223 769215 or visit our website for more information www.cambridgebioresource.org.uk

Events of 2016



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