

June 2014

MRC

Cognition and
Brain Sciences Unit

MEDICAL RESEARCH COUNCIL COGNITION AND BRAIN SCIENCES UNIT

NEWSLETTER



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Welcome to the CBU

At the Cognition and Brain Sciences Unit (CBU) we study human cognition and the brain. The Unit has about 120 researchers and postgraduate students investigating topics such as attention, emotion, language and memory. We are funded by the Medical Research Council whose aim is to turn scientific knowledge into benefits for health and well-being. For example, we are developing new treatments for depression, improving hearing through cochlear implants, and helping children to overcome memory problems.

With a large collection of scientists engaged in both basic and translational research on the mind and brain, the Unit provides an exceptional training and academic environment that benefits postgraduate students and researchers at all levels.

Most of our work takes place at the Unit's Chaucer Road site, which houses the majority of our staff and our laboratory facilities. A significant part of our research makes use of brain imaging and we have excellent on-site facilities for magnetic resonance imaging (MRI) magnetoencephalography (MEG) and electroencephalography (EEG).

We also have clinical facilities at Addenbrooke's Hospital. The Unit has close links both with the hospital and with Cambridge University.

HAVE YOU CONSIDERED VOLUNTEERING?



If you're reading this it could be because you've already been to the Unit and participated as a volunteer in one of our studies. If so, you've already done more than most people do to help our researchers advance their studies into many of the diseases and conditions that affect us all throughout our lives. At the CBU we would be unable to continue our work without your support - but we still need your help. We ask you to keep spreading the word. Statistics show that our biggest recruitment aid is you, i.e. word of mouth. So, keep telling your friends and family about your experiences of volunteering at the Unit and encourage them to join the Panel.

If you're new to the idea of volunteering for our research please read on...

Our volunteer panel, established over 30 years ago, is a unique resource within the neuroscience community in Cambridge. With several thousand volunteers of all age ranges it is an invaluable pool of volunteers for our researchers – but we always need new people to join. Many of our researchers need to test up to a 100 different people for a particular project without using the same person twice, which is why we need a constant supply of new volunteers.

So, if you've already been to the Unit and participated in a test – why not come again and do another one soon – and you don't even have to wait for us to contact you. You can sign up for studies directly on our online system, and may even be able to find two studies happening at the same time and come with a friend.

If you're reading about us for the first time, or have been thinking of volunteering but 'putting it off' – take action now! Most people find it a rewarding experience and enjoy learning a bit more about 'brain science'. Our researchers will always be happy to explain their study to you and will never expect you do anything you are not happy with.

One valued volunteer who was recently interviewed for a University article was quoted as saying: 'Since I started volunteering 10 or 12 years ago I've become really interested.... one study I did was about early-onset Parkinson's disease. I had to do a series of brain-hand coordination tests and these were repeated while I was in an MRI scanner. In the waiting room I met the wife of a patient and realised that my volunteering was having a real impact on people with diseases like Parkinson's. It really hit home,' she says. Therefore, if you too want to make a difference, make this the year you do something positive for research.

Sign up for studies now using the link below or scan the QR code at the top of the page using your smart phone and a free code reader app :

<http://mrc-cbu.sona-systems.com> or contact our Panel Manager on 01223 355294.



Volunteers are vital to our research 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 or let others know.

Andy Calder 1965-2013

Susan Gathercole, Unit Director

Andy Calder, dearly loved by his family and his many friends and colleagues from all over the world, died unexpectedly on 29th October 2013. Born in Edinburgh in 1965, he was a loving brother to his sisters Kath and Clare and brothers-in-law Gary and Tony, and a devoted uncle to his nieces and nephews.

Andy was known internationally as a leading cognitive neuroscientist. He was a deep thinker, a meticulous experimenter, and an inspiration for those who worked alongside him.

His ground-breaking research led to major new insights into vital social abilities such as how we recognize faces, and how the brain processes and distinguishes between emotions.

After completing a PhD at Durham, Andy joined the MRC Cognition and Brain Sciences Unit at Cambridge (then the Applied Psychology Unit) in 1993, becoming a programme leader in 2000. In addition to his dedicated team in Cambridge, Andy worked closely with many collaborators, bringing to each project excellence in methods and precision in scientific thinking. This led to new discoveries including the brain systems that underlie unusual social abilities in conduct disorder and autism.

The news of his untimely death is devastating for all that knew him. Not yet 50, Andy had a wonderful future as a scientist still ahead of him. His abilities to answer important fundamental questions using rigorous methods will continue to inspire his many collaborators and the broader field of social neuroscience. A passion for overseas exploration made Andy a great travelling companion and a keen guest in the laboratories of his dear friends and fellow scientists, including Gillian Rhodes and Colin Clifford in Australia.

Andy was wonderful company. He was an entertaining house guest with his family every Christmas, and took a keen interest in all his nieces and nephews Clark, Amy, Ava, Rebecca, Cameron, Tim and Eve as they were growing up. He had a passion for film and theatre, and every summer would make the trip home to take full advantage of the Edinburgh Festival. A gifted pianist and singer, Andy was a key figure in pantomimes and productions in Cambridge. He made many lasting friendships with colleagues, who were delighted by his warmth, lightness of spirit, and wit <http://www.mrc-cbu.cam.ac.uk/blog/2013/11/our-friend-and-colleague-andy-calder-1965-2013/>. Andy will be held dearly in the hearts of the many that knew him. He is greatly missed, but his spirit, life and achievements will be celebrated for many years to come.



WELCOME!

Each October we have a new intake of PhD students here at the CBU, coming from all over the world to perform research at the Unit and to gain their PhD from the University of Cambridge. Last October we welcomed nine 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. One of our new MRC-funded students, Alex Kaula, is already well known around the Unit having worked here as a Research Assistant for a year before deciding to do his PhD here too. The new students are already taking part in Unit research and conducting their own experiments, working on diverse topics across the emotion, memory and methods groups.



Julia Gillard



Rebecca Beresford



Lydia Vinals-Castonquay



Julie Ji



Rafael Neto Henriques



Alex Lau Zhu



Erica Bottacin



Connor Quinn



Alex Kaula

GOODBYE!

Jo Taylor left the CBU in March 2014 after over 4 years based at the CBU researching the brain systems involved in learning to read. Her research was funded initially by an ESRC/MRC post-doctoral fellowship and latterly by a fellowship from Newnham College. During that time, Jo published an authoritative meta-analysis of the brain systems that allow adults to be so skilled at reading familiar and unfamiliar written words. She also conducted several brain imaging studies of the learning processes that contribute to the development of these skills, and explored how brain responses change with varying degrees of proficiency in reading and other related skills (such as phonological short term memory). Jo has now moved to a research position at Royal Holloway University of London funded by an ESRC grant. She will continue her research on brain systems involved in reading and learning to reading, and continue her ongoing collaborations with CBU colleagues like Matt Davis and Connor Quinn. Jo played a big part in Unit life over her four years and will be sorely missed by all her friends at the CBU.



Jo Taylor

NEWS IN BRIEF

1. Turning words into actions – or not?

The mechanisms, through which our brain turns simple perceptions and acts into complex mental representations and ideas, are still unknown. One important question therefore is whether such complex human activities as language understanding are directly based on simple biological mechanisms controlling movements and perceptions. In an MRC-supported research, a group of scientists, led by former CBU scientist Dr Yuri Shtyrov, have investigated how the brain processes different words. They used magnetoencephalography which registers tiny magnetic fields produced by brain cells as they process information. They found that, even when people are not listening to speech, hearing words (verbs and nouns) related to movements instantaneously activates not only brain areas responsible for sound processing, but also those that control body muscles. For example, hearing the word 'toss' automatically lights up hand-control areas in the brain even when no actual action is done. What's more, they have showed that words compete in the brain and suppress each other – when one word instantly activates its representation, it simultaneously reduces activity in neighbouring representations. Such a suppression is a well-known mechanism that helps control and fine-tune muscle movements and perceptions in an animal brain. The instantaneous character of these activations and deactivations in the brain's so-called "motor system" in response to language, their automatic emergence in the absence of attention and their presence for different types of words suggest that even such a high-level human activity as language comprehension relies on basic biological mechanisms of movement and perception that we share with our animal ancestors. The article describing this research has just been published in *Proceedings of the National Academy of Sciences of the United States of America* (PNAS).



2. Cambridge Science Festival – Science evening at CBU

An entertaining and educational evening of demonstrations and lectures was held at the CBU in March. Our annual science open evening, this year titled "Brains and building blocks" is given as part of the Cambridge Science Festival and featured lectures from three of our leading scientists highlighting our varied research, plus the chance to take part in some of our experiments exploring how the mind and brain work, with time to meet the scientists and students doing the research. Hands on activities were run for the first hour, followed by three short talks. The evening was a great success with some very positive feedback from our audience. "Enthusiasm of lecturers very infectious".



3. CBU part of new UK dementia study

The CBU is proud to be part of the NIHR-MRC Dementia Deep and Frequent Phenotyping feasibility study for the UK Dementia Platform. The world class brain imaging facilities and expertise in magnetoencephalography (MEG) here will be used in partnership with the University of Cambridge Biomedical Research Unit in Dementia to identify brain technologies that can detect changes over months, rather than years. The aim is that these techniques will be used to accelerate clinical trials and the development of new treatments to treat – and prevent – dementia. The CBU's James Rowe is the Cambridge lead for the study, which has six other UK sites.



4. Five CamCAN films now on Youtube

The BBSRC have released 5 short promotional videos about the Cambridge Centre for Ageing and Neuroscience (CamCAN) – a pan-Cambridge project on healthy ageing, funded by the BBSRC, that brings together the MRC CBU, MRC Biostatistics Unit and the University Departments of Psychology, Psychiatry, Engineering and Public Health. This project includes detailed cognitive and neuroimaging profiling of a population-representative cohort of 700 people from 18-88 years of age, and is led by Prof Lorraine Tyler at the Centre for Speech, Language and the Brain in the Department of Psychology.



Prof Rik Henson, one of the MRC CBU Co-Investigators, comments: "Although the 5-year project is only half-way through, and the results not yet fully analysed, the aims and scope of the project are well captured by these engaging vignettes."

The videos can be found here:

<http://youtu.be/msiHdCsUq2s> (Part #1: Cam-CAN project overview)
<http://youtu.be/fexu3VNzY-k> (Part #2: MRI brain imaging)
<http://youtu.be/eq8wHT8qYJs> (Part #3: MEG brain waves)
http://youtu.be/-DhCfxn_XnA (Part #4: Motor learning experiment)
<http://youtu.be/HRSTrioN-EE> (Part #5: Hitchcock emotional movie re-response). Although at present CamCAN is a cross-sectional study, further funding is sought for future longitudinal and interventional extensions.

5. Frontotemporal dementia – funding renewed

We are delighted to report that the Wellcome Trust will renew James Rowe's Senior Research Fellowship in Clinical Science. This prestigious award will support James and his team over the next five years, to develop his highly innovative research program into the causes and treatment of Frontotemporal dementia. The studies bring together the CBU with the University Department of Clinical Neurosciences, to combine magnetoencephalography with network modelling and new drug treatments, in order to restore cognition in this severe type of dementia.



6. How suppressing memories may help

New research shows that, contrary to what was previously assumed, suppressing unwanted memories reduces their influence on behaviour, and sheds light on how this process happens in the brain.

The team at the MRC Cognition and Brain Sciences Unit have examined how suppression affects a memory's unconscious influences in an experiment that focused on suppression of visual memories, as intrusive unwanted memories are often visual in nature. CBU researchers included Pierre Gagnepain, Rik Henson and Michael Anderson.

Michael, pictured above, says "It is now clear that the influence of suppression extends beyond areas of the brain associated with conscious memory. This may contribute to making unwanted visual memories less intrusive over time, and perhaps less vivid and detailed."

The study, part-funded by the Medical Research Council (MRC) and published online in PNAS, challenges the idea that suppressed memories remain fully preserved in the brain's unconscious, allowing them to be inadvertently expressed in someone's behaviour. The results of the study suggest instead that the act of suppressing intrusive memories helps to disrupt traces of the memories in the parts of the brain responsible for sensory processing.



7. Swinging at a cocktail party – It's all in the ear

A paper describing how 'Voice Familiarity Aids Speech Perception in the Presence of a Competing Voice' – or how to tune into, or ignore, your loved ones – has recently been published in the journal Psychological Science and covered by a New Scientist article. Bob Carlyon of the CBU who co-authored the paper says "We've shown that it's easier to suppress the voice of your spouse than that of a stranger when listening to a mixture of talkers. But that's no excuse for ignoring your loved one: if you really want to hear that all-important message about taking the bins out later, you can use what you know about your spouse's voice to pick out his or her voice from the crowd".

People often have to listen to someone speak in the presence of competing voices. Much is known about the acoustic cues used to overcome this challenge, but almost nothing is known about the utility of cues derived from experience with particular voices—cues that may be particularly important for older people and others with impaired hearing. Here, we used a version of the coordinate-response-measure procedure to show that people can exploit knowledge of a highly familiar voice (their spouse's) not only to track it better in the presence of an interfering stranger's voice, but also, crucially, to ignore it so as to comprehend a stranger's voice more effectively. Although performance declines with increasing age when the target voice is novel, there is no decline when the target voice belongs to the listener's spouse. This finding indicates that older listeners can exploit their familiarity with a speaker's voice to mitigate the effects of sensory and cognitive decline.



8. Where does the left half of the world go when we doze off?

Researchers from the CBU have discovered a remarkable shift in healthy people's awareness of space as they fall asleep. In the study, published in Nature Scientific Reports, volunteers relaxed in a deck chair with their eyes closed whilst they listened to sounds played on the left and right.

The researchers measured changes in brain activity linked to falling asleep. "When they were awake, the volunteers were equally good in telling whether a tone happened on the right or the left," said Dr Corinne Bareham, the lead author. "When they became drowsy though, they showed a dramatic increase in errors, but only for left tones. On average they wrongly indicated that nearly a quarter of left tones had been on the right. In contrast, they became slightly more accurate with right tones."

The study, conducted at the CBU was spurred by a common problem following stroke called unilateral spatial neglect. Patients with unilateral spatial neglect fail to notice information on one side of space despite in some cases being able to see, hear or feel it normally. They may eat food from only one side of the plate, wash and dress only one side of the body and even have problems in remembering details from one side of well known objects like a clock face or famous landmarks.

"It's a highly debilitating condition," said Dr Tom Manly, a clinical neuropsychologist on the study team, "we are interested in what makes it a persistent problem for some but not all patients, and factors that might help reduce its impact. One thing that we know is that patients who ignore the left tend to have the more severe and longer lasting problems than those that ignore the right. There is also evidence its severity is greater when patients are drowsy". The researchers wanted to find out whether normal brains showed a similar pattern at the extremes of drowsiness. "We predicted a tiny but detectable effect," said Dr. Tristan Bekinschtein, Wellcome Trust Fellow and researcher on altered states of consciousness, "but we were blown away by the scale of what we found". Whilst it is early days the result definitely raises the possibility that what we see after stroke may be an amplification of some bias in our normal awareness of space that is only revealed when we are extremely drowsy, that is changes in consciousness modulate spatial awareness. This would make us think differently about the disorder and possible treatments. Having shown that the pattern is there, the next question is why it is there and that research is ongoing.



AWARDS

Karalyn Patterson elected as Fellow of the Royal Society

Many congratulations to Karalyn Patterson, who has been elected a Fellow of the Royal Society. Karalyn is an international leader in the field of cognitive neuropsychology. She contributed much of her ground-breaking work in the areas of acquired dyslexia and semantic dementia during her 30 years as a programme leader at the MRC Cognition and Brain Sciences Unit (formerly the Applied Psychology Unit). Director Susan Gathercole: "Karalyn is a world-leading scientist whose contributions to cognitive neuropsychology have not only shaped theory in the field but also changed diagnostic practice. Here at the CBU we are very proud of her achievements and delighted that she has been honoured in this way".



2. Tim Dalgleish wins BPS Presidents' Award

Tim Dalgleish, Senior scientist at the CBU, has recently been awarded the British Psychological Society's Presidents' Award for Distinguished Contributions to Psychological Knowledge. The award is given to "a mid-career researcher currently engaged in research of outstanding quality in recognition of exceptional contributions to psychological knowledge". Tim joins several previous winners with CBU connections, including current and previous directors Susan Gathercole and Alan Baddeley.



3. PhD student Phil Gomersall wins poster award for tinnitus research

PhD student Philip Gomersall scooped an award for 'Best poster in the category of tinnitus research' at the Annual British Society of Audiology Conference in September. Phil works with Bob Carlyon in the Hearing, Speech and Language group at CBU and is conducting a part-time PhD that focuses on tinnitus in people who have a cochlear implant. His project focuses on an approach, often referred to as sound therapy, whereby particular sounds are used to alleviate tinnitus distress. As well as being a graduate student here Phil is also an HPC-registered clinical scientist in Audiology and holds a position at Addenbrooke's Hospital, performing diagnostic tests and rehabilitation of individuals with a range of audiovestibular pathologies.



4. PhD student Emma Hill wins poster prize for depression research

PhD student, Emma Hill, has recently been awarded the 2013 British Association for Behavioural and Cognitive Psychotherapies (BABCP) Conference Best Poster Presentation Excellence Award for her poster presentation entitled 'A new decentering and perspective broadening training intervention for recurrent depression'.

As an Excellence Award winner, Emma will be invited to present her work at next year's BABCP Conference in Birmingham, July 2014 and will receive £500 towards registration and attendance. We'd like to congratulate Emma on this achievement.



5. Emily Holmes wins APA award

Emily Holmes was recently awarded an American Psychological Association award for Distinguished Early Career Scientific Contribution to Psychology. It was given for her ground breaking research into the role of imagery in emotions and emotional disorders. The citation states "Emily's pioneering work has revealed that encoding events as

mental images — rather than in verbal form — can enhance both the intensity and the duration of emotional consequences. In her experimental program she has demonstrated how the encoding of emotional information can be modified, with implications for both understanding and treating emotional conditions ranging from post-traumatic stress disorder to depression. Her work exemplifies a rare combination of outstanding scientific acumen, rigorous experimental research and a clear vision of its relevance to the origins and treatment of clinical disorders".



LISTEN VERY CAREFULLY; I WILL SAY THIS ONLY ONCE (WITH SUBTITLES)!

Helen Blank, Matt Davis

Sometimes it can be challenging to understand what other people are saying: when we are at a loud party, meet somebody with an unfamiliar accent, or watch an old film with poor sound quality. In these situations, additional knowledge and expectations about what the other person is going to say improves understanding. For example, we pay more attention to someone's lips at a noisy party, or turn on subtitles when watching an old film or to help with an unfamiliar accent. However, these additional cues only help if visual information matches spoken words. Mismatching information can be misleading and even hinder understanding of speech. Watching a badly dubbed movie is irritating because of this mismatch between lip movements and heard speech.

Helen Blank and Matt Davis at the CBU are interested in how the brain combines written subtitles or lip-read information with incoming speech sounds. To explore this issue, they are using functional magnetic resonance imaging (fMRI) to measure brain activity when listeners use written subtitles to help understand degraded speech. In the MRI scanner, volunteers heard spoken words degraded to sound like they were processed by a cochlear implant – a prosthetic hearing device that provides low fidelity sound to otherwise deaf individuals. The crucial manipulation in the experiment was that written and spoken words could be presented in matching pairs (written SING + spoken “sing”) or mismatching pairs (GAME + “sing”). Participants were more accurate in reporting degraded spoken words in matching pairs showing that they used written words to inform speech perception (despite occasionally hearing highly-confusable pairs like SING + “thing”). Furthermore, brain imaging shows a reduction in brain activity for matching compared to mismatching pairs (see image right).

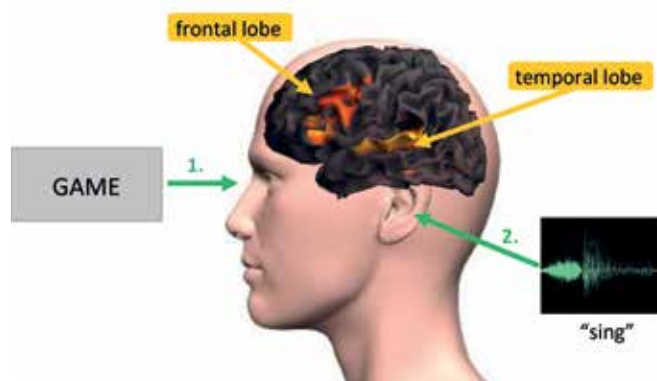
The results so far clearly demonstrate that brain responses in the frontal and temporal lobe combine prior expectations (here from a written word) with incoming speech. However, there are two different mechanisms that could explain decreased activity for matching pairs: First, it could be that matching prior knowledge improves the processing of degraded speech so that expected words are more easily extracted; listeners need no longer consider incorrect interpretations of degraded speech signals. An alternative “predictive coding” theory, however, proposes that the reduction in activity is because the brain ignores sensory input that was predicted in advance; only unexpected, or surprising sensory signals are processed in detail. Currently, we are using complex statistical methods (known as multivariate pattern analysis) to try to differentiate between

these two explanations: testing whether matching pairs lead to more informative patterns of brain activity or whether matching pairs produce less informative activity patterns.

The answer to this question will help us to understand the brain processes responsible for the success or failure of listeners at loud parties, and for understanding how hearing-impaired individuals benefit from lip-reading or TV subtitles in their everyday life.

You can already experience the benefits of matching visual cues when you're next watching TV – just turning on subtitles or paying attention to the actors' facial movements can help you to hear what they are saying even when the volume is turned down low or there's lots of background noise.

But listen very carefully, they will say this only once...



The brain combines information from different sources: Frontal and temporal lobe regions use expectations (e.g. reading the word GAME) to make sense of incoming speech (e.g. hearing the word “sing”). Combining these different pieces of information in this mismatch case (GAME – “sing”) will not be very helpful, and will lead to increased brain activity. However, in our everyday life we frequently use matching information from different sensory sources to improve perception of our environment.

CHILDREN'S RESPONSES TO TRAUMA: HOW A SCIENCE OF HORROR CAN HELP PREVENT YEARS OF MISERY

Richard Meiser-Stedman, Tim Dalgleish
(Programme Leader), Anna McKinnon,
Ben Goodall, Isobel Chadwick

Many researchers at the CBU conduct research into mental health problems. Much of this research has an emphasis on understanding how common health problems (such as anxiety and depression) persist so that we can improve the treatments available for them. One particular group the CBU has a long track record of working with people exposed to extreme trauma. Since the late 1980's researchers at the CBU, together with long-term collaborators at the Institute of Psychiatry, King's College London, have explored how both adults and children respond to events such as the Herald of Free Enterprise disaster, the Bosnian War, and more common traumatic experiences such as road traffic collisions and violence. In particular, studies have addressed how post-traumatic stress disorder (PTSD) manifests itself in people exposed to trauma. PTSD is characterised by highly distressing recollections and nightmares of a traumatic experience, attempts to avoid thoughts or reminders of what occurred and being in a constant state of alertness (with problems sleeping, concentrating and being able to relax), and can cause both tremendous distress and impairment in day-to-day life.

From initial work on how to best assess PTSD and how common a problem it is, our work has focused on children and teenagers, addressing vital issues such how long PTSD may persist in this age group, how cognitive functioning (e.g. memory and attention) may be affected, how families cope with a young person with PTSD and the risk factors for developing PTSD. Crucially we have found that a minority of young people exposed to trauma can go on to experience PTSD lasting many years, which in turn impacts on their wider functioning and development.

Rather than recruiting through the CBU panel, we work closely with hospital Emergency Departments in South London and East Anglia to identify young people exposed to trauma and monitor their progress over the following months. This research effort has helped to identify particular processes by which exposure to trauma can lead to PTSD. Rather than being a result of injury severity, their age or their previous life experiences, our data suggest that young people go on to develop PTSD

when their memories of such experiences are fragmented and dominated by visual information; when their perceptions of themselves and the world are disrupted; and when they engage in certain ways of coping with their experience and their PTSD symptoms.

A Medical Research Council (MRC) Fellowship awarded to Richard Meiser-Stedman has allowed for a much closer examination of young people's recovery in the first few weeks and months after a trauma, in an effort to understand how best to intervene early on to prevent the development of chronic PTSD. Our initial findings suggest that while many children and teenagers experience the full range of PTSD symptoms in the first two to three weeks after a trauma, there is a remarkable natural recovery for a large proportion of these youth. As well as highlighting the optimal time to intervene, these findings are a reminder of the powerful mechanisms our brains have for adapting to highly stressful experiences; understanding these recovery mechanisms will help us to target interventions for youth whose recovery is not so smooth. We also looked at whether a psychological (i.e. talking) treatment – that targets the processes our previous research has shown are important in maintaining PTSD – might be a powerful intervention to prevent the development of PTSD at an early stage.

Other on-going research concerns the reactions of young children (aged 3-8 years) to trauma and we are now running the first European clinical trial of a therapy programme for this age group. We are also undertaking preliminary work with youth exposed to multiple traumas, such as domestic violence and abuse. Many of our measures and treatment approaches are now being taken up and used in the UK and internationally. Our goal is to continue to extend our scientific understanding of how children's brains makes sense of horrific experiences, so that our health services can better care for and support the most traumatised young people.



Scientists at the CBU are looking at child trauma to find effective new ways to understand and treat it.

HOW DO WE LEARN NEW INFORMATION AS WE HEALTHILY AGE?

Elisa Cooper & Andrea Greve

Do you know what a numbat* is? If not, then how do you learn this new information? One area of cognition that we are interested in at the CBU is memory, which is important throughout our lives. Investigations in the Memory and Perception group have studied different types of learning that might support memory in younger and older healthy adults.

We know that 'explicit encoding' is one type of learning that we use to store new information. For example, we might try to memorise our shopping list before a trip to the supermarket; this is an intentional attempt to learn. The brain's medial temporal lobe, including a structure called the hippocampus, is traditionally thought to support the initial learning of information. In addition to an explicit encoding type of learning, we are interested in whether another mechanism might also support memory.

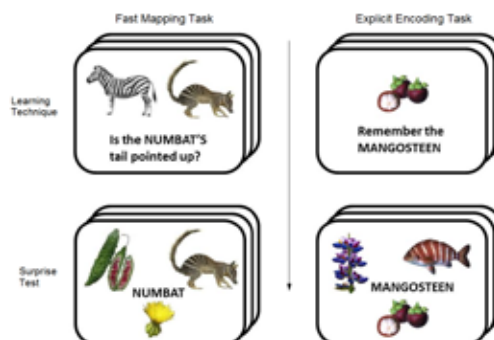
'Fast mapping' might be another mechanism that assists learning. Fast Mapping relies on implicit learning that occurs through making inferences about the new item and relating information about it to existing knowledge. For example, when food shopping on holiday in Australia, we might see a new fruit that we've never encountered before, and we might hear locals use an unfamiliar word when we are in the fruit and veg section of the shop. We soon deduce that this new word names the exotic fruit.

Young children, for example, suddenly and rapidly link a great number of names to the correct objects or animals and are thought to do so by using this same fast mapping mechanism. Interestingly, recently published research reports that adult amnesic individuals, who we know struggle to learn new information through traditional explicit encoding, were able to successfully learn new information using fast mapping. This work suggests that fast mapping might be a type of learning that could bypass brain structures traditionally involved in memory, such as the hippocampus.

We were interested in learning during healthy aging, a time when the hippocampus is thought to get slightly smaller and people anecdotally report that their explicit memory gets worse. We wondered whether learning information using the same fast mapping task, as reported in the adult amnesic study, might be helpful to improve memory in healthy older age. We therefore invited younger and older members of our CBU volunteer panel to take part in a study that investigated this.

Our results told us a number of things about memory in healthy adulthood, and about the two learning mechanisms, explicit encoding and fast mapping, as captured by our tasks. We learned that both older and younger healthy adults are better at learning new information when they explicitly try to remember it, as opposed to the more difficult fast mapping task. We also confirmed objectively and quantitatively that in healthy aging there is some measureable healthy memory decline that can be considered completely normal.

Most importantly, we found no evidence that we benefit from using a different type of learning technique in different stages of healthy adulthood, as we found no support that this particular fast mapping task provides benefits above and beyond traditional explicit encoding in older adults.



Our study had a younger group and a older group of healthy volunteers, who did not initially know that we were conducting a memory-based experiment. Each group performed two tasks; a task with an implicit fast mapping learning technique, using inference and similar-item context, and a task with an explicit encoding procedure, using intentional learning. After each learning phase a surprise memory test was completed.

We also had structural brain scans for our participants that provided us with information about the grey-matter volume in various brain regions. We confirmed that there is some small normal hippocampal shrinkage associated with healthy aging, and that these two factors, age and size of hippocampus, are also related to how well our volunteers did on the memory tests.

To summarise, our results suggest even though our brain's memory structures may slightly change as we age, we likely still use similar mechanisms and brain structures to learn what a numbat is, regardless of whether we are in older or younger adulthood. Though neither of our healthy groups showed a benefit of the fast mapping learning task, a fast mapping brain mechanism might be used in childhood or be of benefit to people who have memory problems. Due to the possible important therapeutic potential of a fast mapping mechanism, we continue to investigate this type of learning in people who have serious memory problems, such as people with amnesia.

We want to thank the CBU panel members that have volunteered to take part, including, but not limited to, the project discussed here. Without your participation we wouldn't be able to carry out our research.

This short piece is based on our published research. If you'd like to know more, then our journal article is publically available online at:

<http://www.sciencedirect.com/science/article/pii/S0028393214001596>

*A numbat is a marsupial anteater that is found in Australia; it has four legs, a striped back, and a tail. A picture of a numbat is included in the image above.

THE CAMBRIDGE COGNITIVE NEUROSCIENCE RESEARCH PANEL

Sharon Erzinciloglu

Cambridge 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.

So, why did we develop a clinical panel? Here 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, memory and so on 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.



An image of a brain with stroke damage.

Since 1995, we have recruited over 460 patient volunteers. Most have stayed on the Panel for about 10 years. Currently we have about 250 active members from all across East Anglia. Many have had a number of different brain scans to help us understand exactly which part of the brain has been injured. Over the years they have taken part in a variety of studies, ranging from those that involved pen-and-paper tasks or simple computer-based tests to intervention studies testing out specific new rehabilitation therapies. And for all this we are extremely grateful to our small army of willing patient volunteers.

CAN SOMETHING OF WHICH YOU ARE UNAWARE CHANGE YOUR MIND?

Tom Manly

Can something of which you are unaware change your mind? It has long been known that events that lie outside of conscious awareness can influence our brains and behaviour. For example, people may be entirely unaware that the word "APPLE" has been briefly flashed on a screen and yet become faster at identifying a picture of an apple shown shortly afterwards. Until recently, it was thought that this effect (called 'subliminal' or unconscious priming) could speed up our identification of things but not influence our decisions. However, at least in certain circumstances, it seems that it can. In our recent study we showed volunteers a pair of words on the computer screen. For example;

CAR BEAUTY

Just before the words appeared, we gave a clearly visible instruction about which one of two different judgments they should make. For example, a hexagon meant decide whether the two words each had the same number of syllables and a triangle meant decide whether both words described something that was concrete (like a car that you can touch) or abstract (like beauty, justice and so on). The volunteers had to press one button for 'yes' or another for 'no' as quickly as possible. What we didn't tell them (until afterwards) was that just before the triangle or hexagon, we presented one of two other shapes for about 8 milliseconds (0.008 seconds), so fast that many people would be unaware that anything had been shown. The question was whether, over repeated presentations, the brain (if not its owner) would come to learn the relationships and get into 'syllable mode' or 'concrete/abstract mode' based only on the subliminal shape. We tested this by then changing the task so that each subliminal shape now occurred for half of the time in the syllable task and half the time in the concrete/abstract task. If the brain had got into 'syllable mode' due to the subliminal shape, but then received the conscious instruction to make a concrete/abstract decision, we would expect our volunteers to be slower than if the prime and conscious instruction were both giving a consistent message. This was exactly the case.

We then asked our volunteers to try a new task. Once again they saw two words on the screen like:

TABLE STABLE

They were again asked to do one of two tasks, this time indicated by a high or a low tone presented just before the words. A low tone meant decide whether the words rhymed or not. A high tone meant decide if they were from the same common category (e.g. both fruits, both items of furniture etc.). Just before the tones we again presented the unconscious shapes that had previously been associated with syllable counting and concrete/abstract decisions.

The question now was whether the subliminal shape that had been linked with syllable counting would also help the rhyme judgment because it got volunteers into 'sounding out the word mode' and the subliminal shape that had been linked with concrete/abstract judgments would help with the semantic task because it got volunteers into 'thinking about a word's meaning mode'. This is what we observed – those volunteers that showed the priming effect in the syllable/concrete task carried it over to the new test. This was interesting because it meant the subliminal shape's ability to 'change the volunteers' minds' was not highly specific to the particular task but generalized to other tasks that required common cognitive processes.

But hang on! We are claiming that the effect was unconscious but what if our volunteers had actually been able to see the brief shapes? To test this, at the end of the session we showed each volunteer the shapes that had been presented unconsciously. We then presented these shapes again many times just as they had been in the experiment and asked the volunteers to tell us which was which. Overall they were just as likely to say the wrong shape as the correct one suggesting that they couldn't see the shapes at all and were just guessing.



A participant taking part in the experiment.

One particularly intriguing aspect of the study is, why did participants continue to be influenced by the subliminal shapes when they were no longer of any use in performing the task? Remember, in the later parts of the study you were as likely to get the 'sound out the word' shape before the word meaning task where it was likely to be actively unhelpful. Surely it would be better to ignore it? To examine this we went back to look at volunteers' accuracy in identifying the subliminal shapes at the end of the test. It turned out that, whilst on average it looked like the group was just guessing, within this some individuals were performing better at spotting the subliminal shapes. It might be expected that those who were best able to 'see' the primes would be most influenced by them. In fact it was completely the other way around. Those who could see the primes best were better able to ignore them when they were no longer useful. It seems, perhaps paradoxically, that we find it more difficult to ignore something of which we are unaware.

Like many studies that we conduct, this experiment was designed to tell us something new about the ways in which our brains work. It also was useful in thinking about potential applications of subliminal instructions in cognitive rehabilitation, for example, after a brain injury; if an individual has difficulty getting into a particular 'mode', could this be helped by unconscious cues that are detected by the brain, but, by being unconscious, do not distract from the task at hand? If we had only seen the effects of the unconscious shapes on the first part of the test, they might be of limited therapeutic value. The fact that the effect transferred from one task to another ('generalised') is promising in this respect however, much more work is needed in understanding the effect and its possible uses.

The study was conducted by Tom Manly, Jessica Fish, Sarah Griffiths, Meike Molenveld at the CBU, and Fanzhi Zhou and Greg Davis of Cambridge University's Department of Psychology. As always, the research was only possible due to the generous help of volunteers.

CBU OPEN DAY

JUNE 2013

To mark the centenary of the Medical Research Council being founded many of the MRC units and institutes around the country ran public events to raise awareness of our work and showcase how the public money that funds us is being spent.

The CBU event was a public Open Day, held here in Chaucer Road in June last year. It was free to attend, family friendly and suitable for all ages. We had three different lectures, given by our leading scientists and repeated morning and afternoon; open lab tours of our MRI, MEG, Developmental and Hearing lab facilities, including chances to try all the equipment; a wide selection of hands-on experiments and displays, covering the work of the four main research groups, positioned throughout the building, and all manned by the scientists involved in the research; a display showing the history of the Unit and our achievements, plus some of our archive equipment and experiments, with i-Pads showing archive film footage of the Unit from the 50s and 60s; a children's activity tent in the garden, with a wide range of brain and mind-themed games and experiments, plus a brain-and mind-themed treasure hunt in the garden with small prizes. And of course, also in our beautiful garden, a large tea tent with

seating and tables, serving hot and cold drinks, cakes and biscuits. We were giving away free refreshments but asked for donations to two charities reflecting our own whole-life approach, AgeUK and East Anglian Children's Hospice, and we were delighted to raise over £200 for these excellent causes.

250 members of the public attended the Open Day, a great turn-out especially given some atrocious early weather and several competing events in Cambridge that day. The ages of attendees ranged from babies to octogenarians, we had many family groups and at least one school group of 10 pupils and two teachers. Visitors commented particularly on being delighted with the 'open access to the vast range of research being undertaken in the unit'.

All attendees received an MRC centenary canvas bag filled with MRC and CBU goodies - pen, ruler, keyring, postcards, newsletters and a handout for the day with introduction and timetable for the talks plus a map of the site showing the different facilities and how they are used, and where each exhibit could be found. Our very well received talks were given by Sue



Sally Butterfield explaining the different regions of the brain using one of the make-your-own brain hats given out to children (and some adults) on the day.

Gathercole, Director on 'Memory and its failures', Bob Carlyon, Deputy Director on 'Cocktail parties, cochlear implants, and the brain' and Tom Manly, Senior Scientist on 'The curious case of the missing left'. Each lecture was well attended, with up to 50 people each time, and visitors were very generous in their praise for the speakers and their talks, calling them 'excellent', 'fascinating' and remarking how good it was to have 'enthusiastic professionals talking about their specialist areas'.

Feedback from the many completed visitor comment cards was overwhelmingly positive, our favourite quote being "I can think of no way in which it could have been done any better". One person noted that their highlight was "Meeting people who were enthusiastic about their subject and doing it for the sake of understanding rather than commercial gain".

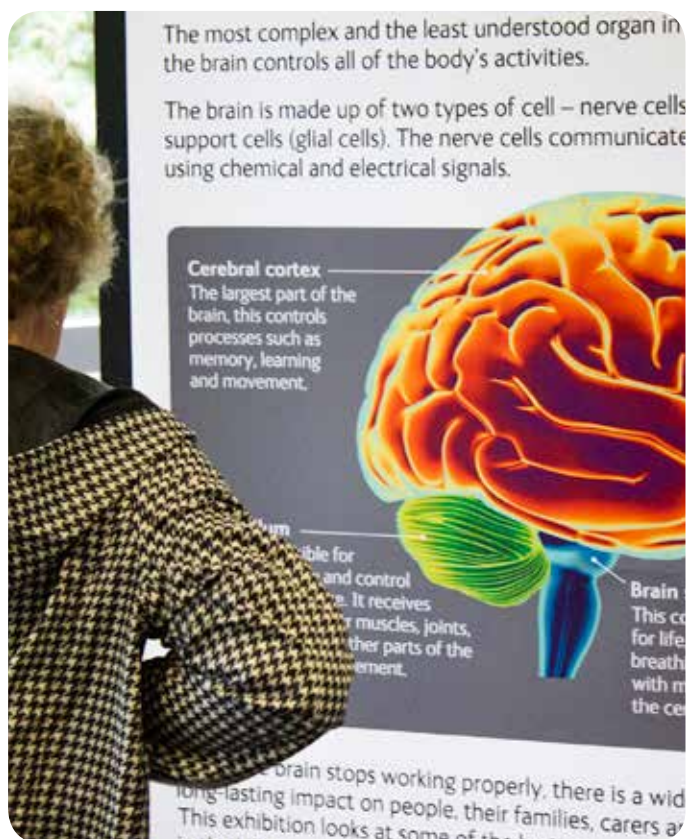
It was a hugely positive experience for the staff and students taking part too, with over 70 of us manning the displays and demonstrations, acting as stewards and even serving the tea. One student noted "Everyone who came into our room that day was full of praise about how good the day was and they were all so enthusiastic", and another member of staff later said "That was great, we should have one every year". Something we are thinking very hard about now!



One of the exhibits on display for the public to try. This one showcased many of the behavioural studies going on at the CBU.



Popular talks were given throughout the day, this one by Bob Carlyon



A member of the public learning about the brain from the display board.



Posters on display throughout the Unit were accompanied by scientists explaining what they had been researching.

THE BRAINS BEHIND THE BRAINS - BEHIND THE SCENES OF WORLD-LEADING BRAIN RESEARCH

Olaf Hauk

The tools we are using to trick our brains into revealing their mysteries are in themselves technological marvels, and running this technology requires a highly skilled training and support team.

Every theory is only as good as the evidence it is based on. At the CBU, our brain science is mostly based on data from two types of technology: Functional Magnetic Resonance Imaging (fMRI), and electro- and magnetoencephalography (EEG/MEG). fMRI can detect the brain areas that consume more or less oxygen while the brain is engaged in specific kinds of processes. EEG and MEG measure the small electric and magnetic responses of the brain while it is processing information. Both methods make use of top-notch technology that you won't get from the DIY store: for example, both of them need liquid helium to cool down parts of the equipment to superconducting level at about minus 270 degree Celsius. This needs to be done in order to create very strong magnetic fields as in the case of fMRI, or in order to measure the tiny magnetic fields of the brain as for MEG.

Maintaining these machines requires a team of specialised scientists and technical support staff. The CBU employs two physicists, Marta Correia and Olaf Hauk, who are running the MRI and MEG scanners, respectively. Both scanners are in use for up to 10 hours every day. The smooth operating of these machines is guaranteed by a group of fMRI radiographers: Steve Eldridge, Karen Kabakulu, and head radiographer Helen Lloyd, and MEG operators: Clare Cook, Lucy McGregor and Maarten van Casteren. Every so often it happens that a researcher needs a very particular type of equipment, and the existing kit just won't do and you can't order anything like this on the internet. Most researchers require their participants to respond to questions such as "Is this a word you know?" by button press using their fingers – but some researchers may decide that they should do this with their feet, and require a suitable foot pedal. Because fMRI creates strong magnetic fields and MEG measures tiny magnetic fields, we cannot just use any metallic or electrical equipment in those labs. It may distort the measurement, or even damage the equipment. Therefore, we often have to look for special solutions to create "scanner-friendly" equipment.

Or there is a ghost somewhere in the machine playing with spanners. Who do you call? The technical department! Our ghost busters David Hayes, Simon Strangeways, Mark Townsend and technical group manager Gary Chandler are always at hand with screwdrivers, voltmeters or oscilloscopes to make sure problems are solved sometimes even before they occur. They also make sure that our equipment runs according to our very high health & safety standards.

Our big machines turn brain activation into numbers – a large number of numbers. The size of a single fMRI or MEG data file can be in the range of several Gigabytes (up to a thousand pictures on your phone). It requires strong electronic teeth to crunch such an amount of numbers. The electronic brain of the CBU is a high-performance computing cluster, consisting of just below 1000 "cores", each of which have more computing power than your average PC. The cluster is used by about 100 users at any one time, making use of dozens of different software packages and analysing hundreds of data sets. Such a computing network needs to be properly set-up and well maintained. If you are proud that you can do your tax return using Excel, then imagine what it must be like to run a novel analysis on dozens of data sets with software almost no one else has used before – there are lots of troubles to shoot. Luckily, there is a team of professional trouble-snipers available in the IT department, consisting of Henry Fullah, Howard Gyton, Russell Thompson and the head of the IT group Rob Anthony.

So you've got big data and big computers – now what? Computers will obediently do what you tell them to do, but unfortunately they won't tell you whether what you are doing is right – rubbish in, rubbish out. The field of cognitive neuroscience is constantly evolving, with new methods emerging almost by the day. In an interdisciplinary research environment such as the CBU, nobody comes with exactly the right IT or methods skills for what they are planning to do. It is therefore essential to provide an up-to-date training programme, facilitate communication among researchers from different disciplines, and offer tailor-made methods support. We have recently started a new training programme, aimed at PhD students and young post-docs, that provides a hands-on introduction into state-of-the-art neuroimaging methods and data analysis. The programme is coordinated by the Head of Methods, Olaf Hauk, in collaboration with Marta Correia, Tibor Auer, Peter Watson and other CBU scientists. At the end of any laborious data analysis, the moment of truth comes with the big question: "Is it statistically significant?" The graveyard of good intentions is littered with the murder victims of statistics – it's better to know your enemy and the usual suspects. Our local statistics crime scene investigator is Peter Watson, who provides lectures on statistics for cognitive scientists, and offers advice to individual researchers.

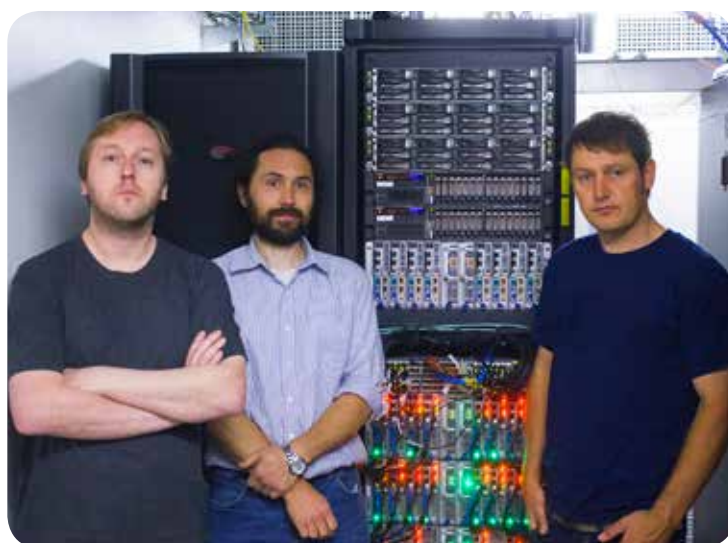
So, if you need ghost busters, trouble-snipers or crime scene investigators for your science project – you now know who to call!



Left to right: Radiographers Helen and Karen next to the MRI scanner, Maartan and Clare in the MEG lab and Steve in the MRI control room.



Left to right: Simon, Gary (sitting) & Mark, David (standing) in the garden.



Left to right: IT team Howard, Russell and Rob in the server room.



Left to right: The Methods group consisting of Tibor, Marta, Olaf and Peter.

THE CENTRE FOR ATTENTION, LEARNING AND MEMORY (CALM) IS OPEN AND RECRUITING CHILDREN NOW!



centre for attention, learning and memory

Francesca Woolgar & Joni Holmes

CALM is new family-friendly research facility housed in its own building on the Chaucer Road site. Funded by the Medical Research Council, research in CALM investigates the cognitive and brain processes involved in attending, learning and remembering. An important part of this research aims to understand the causes and consequences of childhood problems in these areas and how to overcome them.

Who works there and what do they do?

Several scientists at the Cognition and Brain Sciences Unit who are interested in children's development work together through CALM. See the team members below.



Dr Sam Wass, manages the Baby Lab in CALM, and expert in infant attention.



Dr Joni Holmes, CALM manager, and expert in working memory, learning and cognitive training.



Dr Tom Manly, expert in attention and rehabilitation after brain injury.



Dr Duncan Astle, expert in the brain basis of attention and working memory in childhood.



Professor Susan Gathercole, world leader in working memory and language.



Francesca Woolgar day-to-day manager of the CALM clinic.



Outside the CALM building.



The CALM waiting area (toys included).

What happens at in CALM?

The Centre houses a baby lab that studies the development of attention in infancy and a research clinic for children aged 5 to 18 years who are experiencing difficulties in aspects of learning. The baby lab –is developing ways to measure and train infants' abilities pay attention and concentrate. Babies aged 11 to 13 months are currently being recruited.

If you have a baby who you would like to take part in this research please email: Baby@mrc-cbu.cam.ac.uk.

The research clinic – CALM's research clinic aims to understand the cognitive, brain and genetic bases of specific learning difficulties in childhood. Children with problems paying attention, remembering information over short periods of time, reading, maths or language are referred to the clinic by professionals working in children services. These include Special Needs Co-ordinators, speech and language therapists, child psychiatrists, educational and clinical psychologists. Children who are referred complete assessments of core cognitive skills such as attention and memory with Francesca. They are also invited to give a saliva sample and to have a brain scan. These are optional. Children and their families can see what it feels and sounds like to have a brain scan in the mock scanner before deciding whether to come back for the real thing later in the year. Using the information gathered through CALM, we aim to develop new interventions to help children overcome their problems.

If you are a professional working with children and would like to find out more about how to refer a child to the clinic, please email: [Francesca Woolgar: francesca.woolgar@mrc-cbu.cam.ac.uk](mailto:Francesca.Woolgar@mrc-cbu.cam.ac.uk).



A child completing an assessment in the research clinic.

For more information If you have any questions about CALM, or would like more information please contact us at:

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One of our baby volunteers taking part in an eye tracking experiment.



Join our
research
now!