

Your brain on Hitchcock

by Karen Campbell

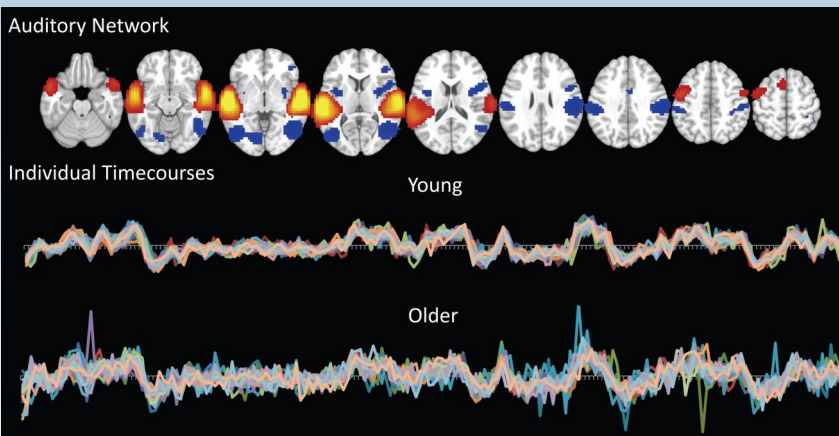
There is nothing quite like watching a film at the cinema. You laugh, and those around you laugh. You gasp, and those around you gasp. You cry (despite your best efforts), and those around you cry. Sharing the experience with others takes movie-watching to a whole new level, one that is difficult to recreate at home, sat alone on the settee.

Amazingly, this shared experience can also be seen at the neural level. When watching the same movie, people's brains respond in much the same way, and the extent of this overlap largely depends on how captivating the movie is. Gripping films pull people (and their brains) in; boring films, on the other hand, allow for lapses of attention and as a result, less synchronization across individuals.



A unique finding coming out of the Cam-CAN study is that this neural synchronization also depends on one's ability to maintain focus on the movie. We used fMRI to measure participants' neural activity while watching an episode of "Alfred Hitchcock Presents". Our results show that neural synchronization was highest in those who are best able to control the focus of their attention, presumably because these people spent less time mind-wandering and more time focusing on the film. We also found that neural synchronization declined with age, such that older adults responded in a much more idiosyncratic fashion than younger adults.

Although responding to the movie in your own way may seem pretty innocuous, perhaps simply the neural equivalent of laughing at the wrong times, our findings suggest that this idiosyncratic responding has serious



The top images show brain regions that respond to auditory stimuli during the movie (yellow and red coloured regions). Below the brains is shown activation of these regions across the 8 minutes of the movie for the 30 youngest and 30 oldest participants (one line per person). Note how the young lines overlap strongly with each other and are well synchronised, while the lines of the older adults are less well synchronised and go up and down at different times.

knock-on effects for memory and understanding. Those individuals who responded to the movie in a different way to others also showed the poorest memory for a recently heard story, suggesting that paying close attention is the first step to being able to remember something.

While synchronization tended to decline with age, there were people of all ages with both good and poor synchronisation to the group. An important question going forward is to figure out how to keep your brain looking young, both in the cinema and elsewhere. Thanks to your participation in Cam-CAN, we should soon have the answer.

To keep up to date with our scientific output visit the 'Publications and Presentations' page of our website at <http://www.cam-can.com/publications>

BBC Radio 4 Frontiers: *Ageing and the Brain* Do mental powers really decline in old age?

Cam-CAN participated in the BBC Radio 4 Frontiers programme which was broadcast on 11 June 2014. During the programme on 'Ageing and the Brain', Geoff Watts investigated the latest thinking about our brain power in old age. He met researchers, including Professor Lorraine K Tyler from Cam-CAN, who argue that society has overly negative views of the mental abilities of the elderly - a dismal and fatalistic outlook which is not backed up by recent discoveries and theories. Missed the show? You can listen again using the BBC Radio player at:

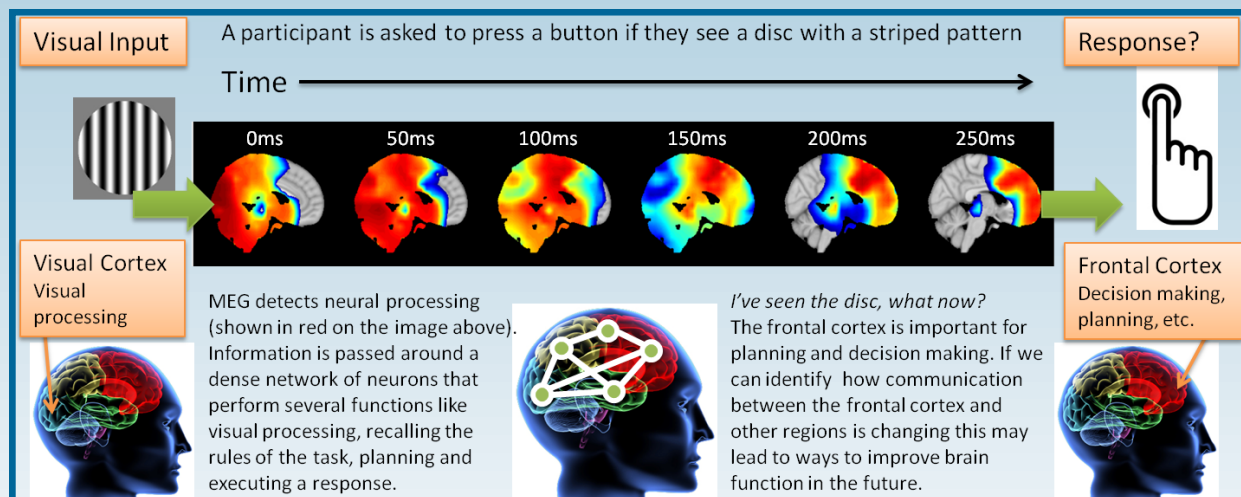
<http://www.bbc.co.uk/podcasts/series/frontiers>



Neural communication uncovered with MEG

by Darren Price

Magnetoencephalography (MEG) is a non-invasive imaging technique for observing extremely weak magnetic fields that result from electrical impulses in neurons of the outermost layer of the brain, the *cerebral cortex*. In the cerebral cortex, information is passed between neurons via electrical and chemical signalling. These tiny electric currents generate magnetic fields that can be detected by the MEG sensors. We know from years of biological and cognitive investigations that different regions of the brain perform different functions, but these regions do not work on their own; rather they are part of complex brain-wide networks, often with many regions working together on a single task. Communication between neurons is therefore very important for keeping the whole brain in a healthy state. MEG is a useful tool because it is a direct measurement of the electromagnetic fields generated during neuronal communication. What's more, thousands of measurements can be taken every second to produce very precise recordings of brain activity. For example, the image below shows neural processing travelling from the visual cortex to the frontal cortex over a time period of around $\frac{1}{4}$ of a second.



Investigations are currently under way at Cam-CAN to uncover connectivity patterns across the whole brain and how these might change with age. We know that neuronal communication is affected in neurodegenerative disorders such as Parkinson's disease, but we are interested in whether and how communication and integration of brain regions is affected in healthy ageing. Not all change is necessarily bad, so an understanding of what amounts to healthy ageing of the brain may allow us to identify unhealthy changes early and lead to advances in the treatment of clinical disorders. Your participation has provided us with a great deal of valuable data that we can now analyse using techniques similar to those above. Our future newsletters will keep you up-to-date on what we find.



It doesn't all go together when it goes

by Rogier Kievit

Twenty years ago, renowned ageing scientist Patrick Rabbitt asked about ageing “Does it all go together when it goes?”. Increasingly, we know that the answer is ‘no’ -although some abilities do decline with age, others, such vocabulary and general knowledge, are preserved or even improve well into old age.

One set of tasks that generally decline as we age is known as ‘executive functions’. These skills comprise abilities such as being able to plan, reason your way through a problem, focus your attention and keep your eye on the ‘bigger picture’. These skills are especially important for healthy ageing, as they are closely related to the ability to live independently, continue to work and sort your own finances.

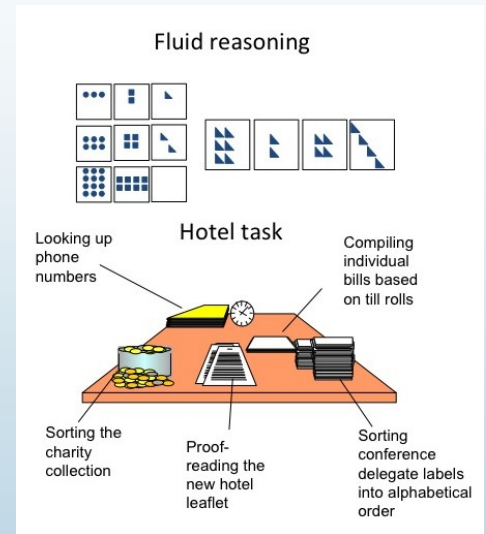
To understand how executive functions change with age, Cam-CAN focused on two different tasks: ‘fluid reasoning’ and ‘multitasking’. Fluid reasoning refers to the ability to solve abstract puzzles that don’t require any specific knowledge, such as the ability to complete a pattern (see top part of the figure at right). The second task we looked at is multitasking, using the so-called ‘Hotel’ task (see bottom part of the figure at right). For this, we used a mock hotel setting, and asked people to perform a series of different tasks as if they were hotel managers. Using this task, we hope to measure how well people keep the ‘bigger picture’ in mind, and are able to juggle their responsibilities by spreading their time equally across all the various hotel manager duties.

In our analyses we consider results from these tasks alone and in comparison to MRI brain-imaging data collected from the same participants. This will help us figure out not only which abilities decline as people grow older, but what about the changing brain causes the change in ability. We focused on the frontal lobe region of the brain as we know these regions are particularly important for these types of tasks, and these regions also change relatively rapidly with age.

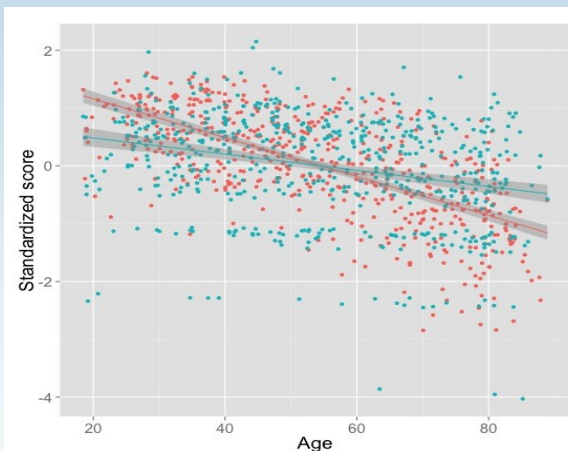
Our analysis so far has yielded several findings. First, grey matter in different parts of the frontal lobe age at different rates, suggesting that even within the frontal lobe, the brain does not all “go together” during ageing. Secondly, we found that although fluid reasoning ability declined with age, the ability to multitask was mostly preserved in our older participants (see figure below) - this suggests that not all executive functions decline with age. Moreover, we know we can improve multitasking performance with some simple additional cues, such as ringing a bell that reminds people of the overall goal. We hope that understanding how we can improve performance on laboratory tasks will ultimately lead to tools and strategies for helping older people perform day to day activities necessary for living independently.

Additionally, we found that different types of brain tissue (white matter and grey matter) played complementary roles in supporting these abilities. In particular, good fluid reasoning performance in old age was supported by preserved white matter **or** preserved grey matter. Understanding the different paths for supporting performance is important for identifying a range of potential interventions. For example, we know that different types of exercise have different effects on grey and white matter: Improving coordination and motor skills seems to have the greatest impact on white matter health, whereas prolonged cardiovascular training yields the most benefit for grey matter health. Understanding this interplay better will hopefully help us devise interventions that can stave off the effects of age on neural health and cognitive performance.

Together, our results suggest that even within the domain of executive functioning the pattern of age-related change is complex and multifaceted. And, perhaps more importantly, many older people can run a hotel just as well as the younger generation!



Cam-CAN executive function tasks. Top: An example of the Fluid reasoning task. Bottom: The ‘Hotel’ task showing the five actions to be multitasked.



While Fluid Reasoning performance (red line) tends to decline with age, Multitasking (blue line) does not. Note that while average performance is shown with red and blue lines, individuals (shown with dots) show a range of performance at every age, with some older adults performing as well as younger adults.

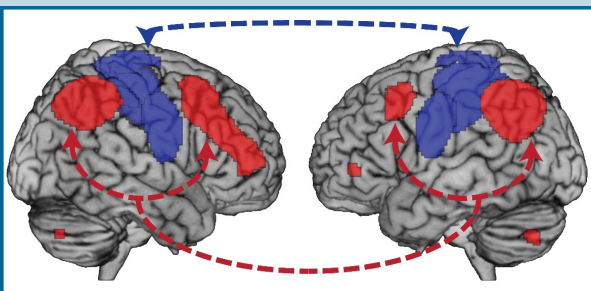


Networks in the ageing brain

by Linda Geerligs

In our day-to-day lives, we use many different cognitive functions such as memory, attention and language. Over the last decade or so, research has shown that these cognitive functions are the result of interactions or communication between different brain networks distributed throughout the brain. Brain regions within each network communicate strongly with each other, but less with brain regions outside of their network. Each of these networks is involved in different functions. For example, the “fronto-parietal control network” enables us to track the goals of the task that we are engaged in and enables us to determine strategies and make decisions about the future. Another example is the “somato-motor network”, which is involved in our sense of touch, and planning and executing movements. The location of these networks in the brain is illustrated in the figure.

Cam-CAN has investigated how these networks change as people age. For some networks, such as the fronto-parietal control network, we observed that the communication between brain areas within the same network was reduced in older compared to younger adults. In contrast, communication between some of the brain regions in different networks increased with age. Most research leads to new questions, and this study is no exception. Following these interesting findings, we will use the Cam-CAN data better understand how these changes in communication between brain regions are related to cognitive function of older adults. Also, we will study possible causes of these changes. Hopefully, the results of this research will offer clues for future interventions to maintain cognitive health in the ageing population. Thank you for your participation, which has made this all possible.



This figure shows a side view of the right and left sides of a model of the human brain. Two brain networks are shown in colour. In red the fronto-parietal control network and in blue the somato-motor network. Note that brain regions working together in a network are not necessarily next to each other.

Cam-CAN team updates

New faces on the team



Post-doctoral researchers: Four new expert researchers, (from top) Darren Price, David Samu, Matthias Treder, and Abdur Mustafa, have been warmly welcomed to the project in the last year. They join our existing team of five post-docs to develop methods, analyse and interpret the data collected at all stages of the project. Their specialist areas of interest are outlined on their profiles on our website www.cam-can.com/people/.



Research Assistant: Andrew Gadie joined the team in March 2014 to help with the final stages of data collection this year.

We're very pleased that the two Research Assistants who left us this spring, David Troy and Stanimira Georgieva, have gone on to exciting new projects. David has started a PhD in Psychology at the University of Bristol, and Stani is conducting research on attention and consciousness states in the Queensland Brain Institute, Australia. Since the last edition of the newsletter our post-doc Simon Davis has got married and moved back to his native USA. He continues to be involved in the project as an affiliated researcher.

Thank you for taking part and please do keep in touch...

We are very grateful for your participation in the Cam-CAN project and for the time you have generously given us. Your contribution to our research is invaluable - we really couldn't do it without you! We hope that you are interested in future stages of the research and are willing to continue your participation.

So that we can keep in touch, please let us know if you have recently changed your contact details or if you have any questions about the research. You can contact us on:

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Thank you