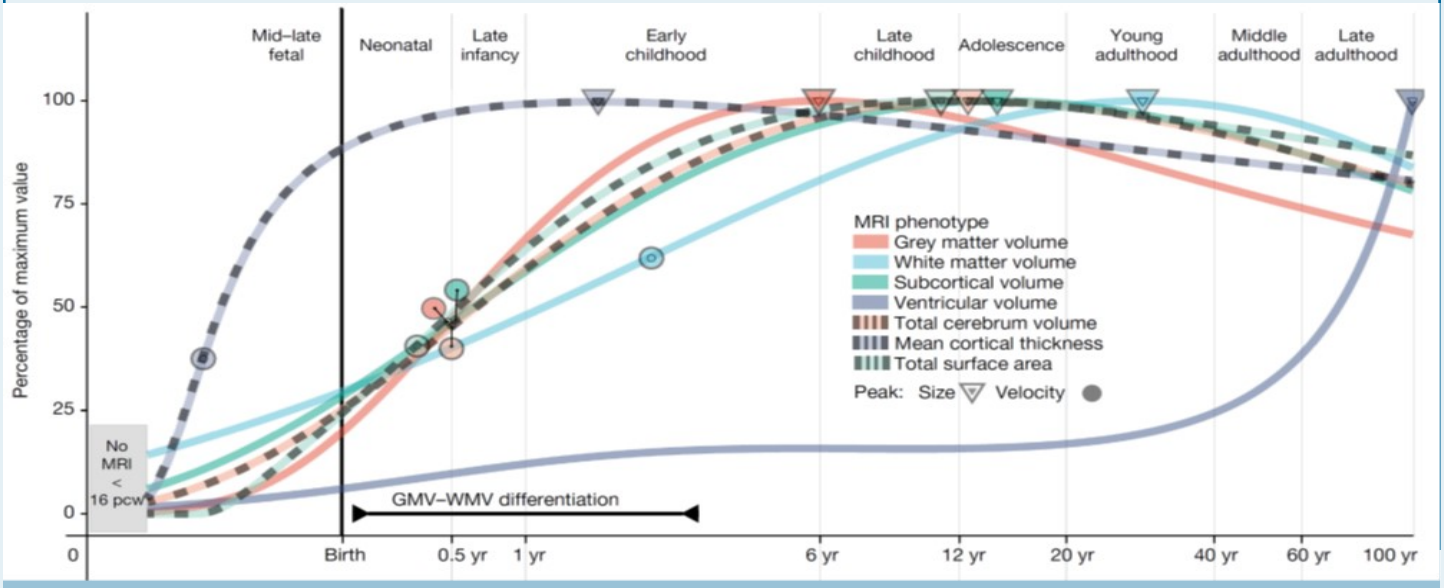
Cam-CAN Newsletter 2022

Brain Growth Charts *Rik Henson*

Standardised growth charts for physical properties like height and weight were first published in the late eighteenth century. They have become vital benchmarks, e.g. for paediatric healthcare. However these charts only exist for a handful of physical properties, and generally only available for the first decade of life. Until now, there have been no analogous growth charts for the brain, even though it is known that the brain undergoes prolonged and complex maturation and senescence across the whole lifespan. Moreover, different properties of the brain, such as gray matter (cell bodies) versus white matter (connections between cells), change at different rates, as do the thickness versus surface area of our highly folded cortex. By combining brain images from CamCAN with those from other cohorts around the world, we were able to publish the first ever standardised brain growth charts across the whole lifespan (example plot below; free, interactive version on https://brainchart.shinyapps.io/brainchart/). These averages were derived from over 100,000 brains in total, ranging from 115 days post-conception to 100 years of age. These brain growth charts will help identify atypical brain development, and neurodegenerative diseases that cause pathological brain changes in the context of normative senescence.

Reference: Bethlehem et al. (2022). Brain charts for the human lifespan. Nature, 604, 7904.



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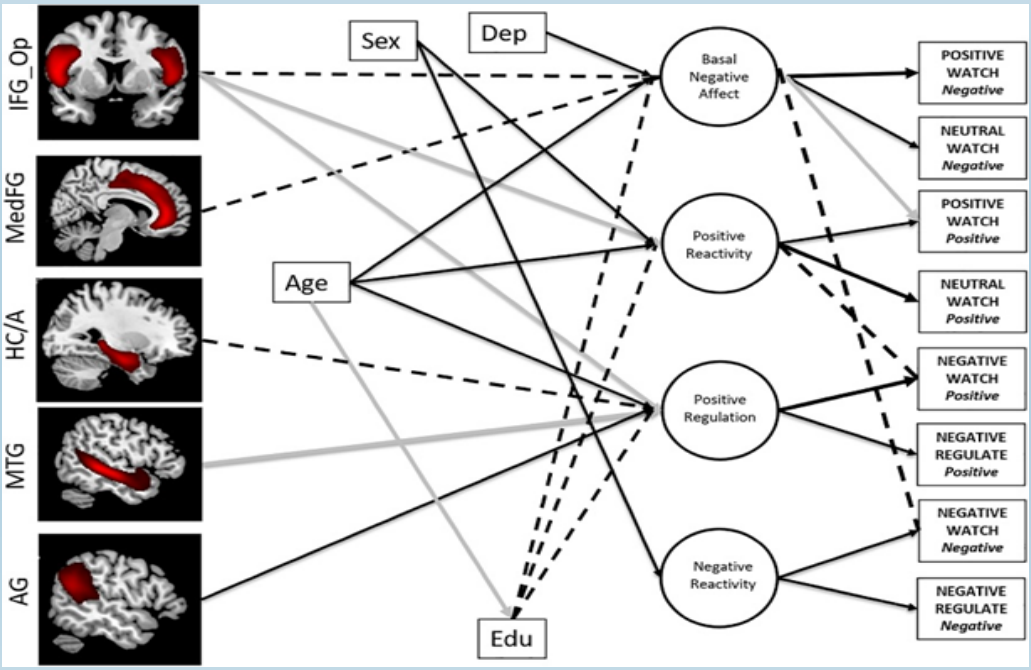
Why do we get happier as we get older?

Jason Stretton

There is a lot of research that suggests that getting older is associated with a paradoxical increase in well-being and improved emotion regulation despite widespread cognitive decline and gray matter volume loss in brain regions that serve emotion regulation. In other words, we tend to *feel* happier the older we get and can control our emotions better in spite of our aging brains and body. There are two main competing theories that attempt to explain this. The first, called 'socioemotional selectivity theory', suggests that feeling happier as we get older is a result of being aware of the limited time we have left, therefore we choose to surround ourselves with a smaller group of trusted friends and family to help keep the good times rolling. The second, the 'aging brain model', suggests that the amygdala, a region traditionally thought of as crucial for processing negative emotions, begins to degrade as we get older and therefore we are less responsive to negativity as we age. We tested the theories behind this emotion/aging paradox with an emotion regulation task and structural MRI brain data. We show that positivity does increase across the life span and that different brain structures influence this relationship with increasing age, but not specifically the amygdala. Importantly, several brain-behaviour relationships remained unaffected by age and could represent neural markers to explore the paradox of increased well-being in old age in future studies. The results support the predictions of socioemotional selectivity theory of improved emotion regulation in older age and help our understanding of well-being in older age.



Stretton J, Schweizer S, Dalgleish T. Age-Related Enhancements in Positive Emotionality across The Life Span: Structural Equation Modeling of Brain and Behavior. J Neurosci. 2022 Apr 20;42(16):3461-3472.

Bilateral brain activation is not compensatory

Rik Henson

The part of our brain that controls movement of our body is called "motor cortex". The brain consists of two hemispheres – the left and right "hemispheres" – each with its own motor cortex (shown by beige regions on pictures of brain below). The side of brain that "dominates" control of movement is opposite to the side of the limb being moved. So when for example people move a finger on their right hand, there is increased brain activity in the left motor cortex (we say activation is "contralateral" to the side of the limb). However, as we grow older, this asymmetry decreases, such that activation of the contralateral motor cortex decreases with age, while activation of the "ipsilateral" (same sided) motor cortex increases with age (see graphs below). One suggestion is that the ipsilateral age-related increases reflect "recruitment" of the non-dominant hemisphere to help with the control of the movement; compensating for the dominant motor cortex becoming less effective in older age. However, using measurements of brain activity while CamCAN volunteers pressed a key with their right index finger whenever they saw a pattern or heard a tone, we found no relationship between activity in ipsilateral (non-dominant) motor cortex and various behavioural measures of performance (like reaction time). Our data suggest that the increased activity in ipsilateral motor cortex is not compensatory, but a consequence of some other age-related process, such as reduced inhibition of the non-dominant hemisphere by the dominant hemisphere.

Reference: Knights, E., Morcom, A. & Henson, R.N. (2021). Does Hemispheric Asymmetry Reduction in Older Adults (HAROLD) in motor cortex reflect compensation? Journal of Neuroscience, 41, 9361–9373.
Tak, Y.W., Knights E., Henson, R. & Zeidman, P. (2021). Ageing and the Ipsilateral M1 BOLD Response: A Connectivity Study. Brain Sciences, 11, 1130.

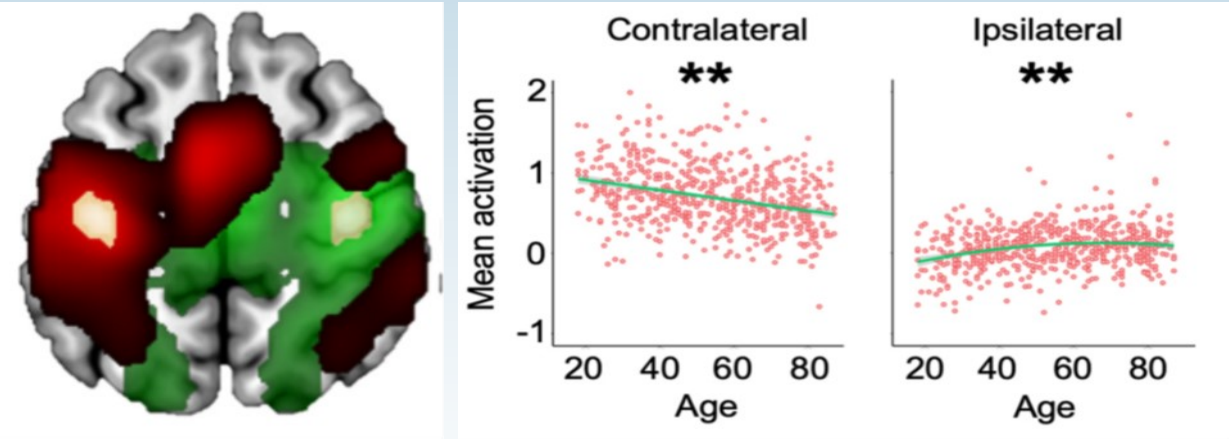


Figure: Horizontal section through the top of the brain showing the left and right motor cortex in beige. The red regions are generally active in all people when they press with their right index finger; the green regions are those more active in older people. Activity in the contralateral (left) motor cortex decreases with age, whereas that in the ipsilateral (right) motor cortex increases with age.

The "Neural Shift" of Sleep Quality and Cognitive Aging

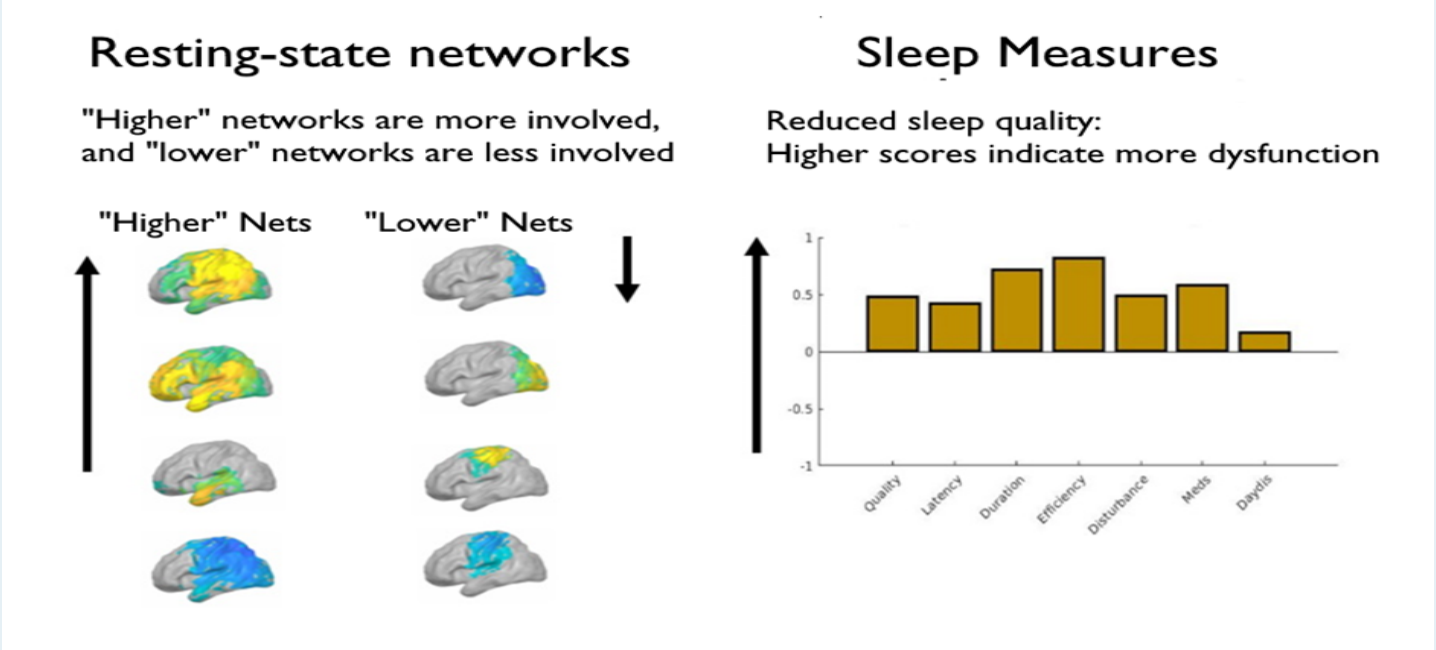
Roni Tibon

Even when we're not doing anything, our brains remain active. Groups of brain regions that are co-activated while we sit back and relax are termed "resting state networks". These networks are short lived (remain stable for a few hundred milliseconds), and so there is constant switching between different resting state networks such that some networks are "visited" by our brains more often than others.

Previously, we found that the brains of older adults pay more visits to networks that are involved in "higher" cognitive processes, such as reasoning, memory, and decision making, but fewer visits to brain networks that are involved in sensory processing. We also found that this ***age-related shift*** from "lower" to "higher" brain networks is related to reduced performance in cognitive tasks.

In the current study, we asked whether this shift is also related to sleep quality. Previous studies showed that sleep quality changes dramatically from young to old age. As we get older, our sleep often becomes more fragmented and less efficient. But how are these changes related to the brain?

We found that the same age-related shift from "higher" to "lower" brain networks that was associated with reduced performance in cognitive tasks, was also related to poor sleep quality. This suggests that the dynamics of our resting state brain networks might play an important role in our ability to get a good night sleep!



Reference: Tibon, R., & Tsvetanov, K. A. (2021). The "Neural Shift" of Sleep Quality and Cognitive Aging: A Resting-State MEG Study of Transient Neural Dynamics. Frontiers in aging neuroscience, 13. https://www.frontiersin.org/articles/10.3389/fnagi.2021.746236/full

Next Testing Round!

It is important to note that from Roni Tibon's study, we cannot tell whether the neural shift is the cause or the effect of poor sleep quality. To answer this, we would need to measure brain activity and sleep quality of the same person in two different time points. Earlier this year we contacted eligible volunteers from CamCAN 700 (who were tested 2011-2013) to ask whether they would be willing, in principle, to return for further testing. We were very grateful to receive replies from over 200 people who said that they would be happy to participate in our research again. This new phase (CC2) of the CamCAN project will allow us to get longitudinal data (i.e. from 2 time points) for many of the tests we have conducted, so we are delighted that now we have finally received confirmation of funding and ethical approval. We can now plan to start testing early next year so will be in contact then with those who previously expressed an interest. They will be invited to join this latest phase and we envisage that everyone who is interested will have received an invite by Autumn 2024.

Please do keep in touch

If your contact details have changed, or you do not want to participate in further studies, please let us know via:

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