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# The successfully ageing brain

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# Our brain

If our brains were simple enough for us to understand - we would be too simple to understand them



# Our brain

- We know there are over 10 to the power of 10 neurons (brain cells) in a typical human brain, that can link up in networks
- Each neuron has up to 10,000 neighbours
- Meaning we have 40 quadrillion possible patterns of connections
- If each connection (synapse) has several different possibilities for strength of communication (lets say 10) then we have 10 to the trillionth power of possible electrochemical configurations!



# Our brain

These internal neural networks have the ability to communicate between each other dynamically, to reflect on aspects of their own workings and can link up with other external networks (other brains) to form a community of communicating, interacting brains (aka human society!)



# The historical brain

- The first known brain map was found on an Egyptian Papyrus from 3000 BC
- In medieval times it was thought that various human attributes – such as thinking, or the spirit – resided in the ventricles where cerebro-spinal fluid is produced



# The historical brain

- Early 17<sup>th</sup> Century - Descartes split the mind and body saying the Pineal Gland (as the only non-bilateral structure in the brain) was responsible for consciousness and the soul, whilst the rest of the brain was a “sophisticated receiver”
- This “Cartesian Dualism” is still pervasive in thinking - that is to say the *mind* is something other than the *body* (challenged by “holistic” approach)



# The historical brain

- Early 19<sup>th</sup> Century - Franz Gall invented “Phrenology” – reading the bumps on the skull to evaluate the attributes of man; correlating bumps in different areas with different organs or functions
- Mistaken in thinking that features of the skull are linked with underlying brain tissue but was on the right track in thinking that the brain did have functional regions or zones



# The historical brain

- Early 20<sup>th</sup> C – hierarchical organisations of the brain were identified and models of operation at differing levels – higher cortical function as a distinct human capacity “covered” more animal or basic behaviours from lower levels of the brain.
- These lower, primitive behaviours (reflexes) could be “unmasked” by certain conditions or injuries.





# The historical brain

- Mid 20<sup>th</sup> C – craze for Psychosurgery based on a very mechanistic view of brain. Parts sectioned surgically (particularly certain fibre tracts) for different psychological conditions – very primitively done and with a variable success rate!

*“...nothing to it. I take a sort of medical icepick....bop it through the bones just above the eyeball, push it up into the brain, swiggle it around, cut the brain fibres and that’s it. The patient doesn’t feel a thing” (Travelling surgeon).*



# The historical brain

- Still in 20<sup>th</sup> C – awareness of the chemical nature of brain (*neurotransmitters*) rather than purely structural. Use of psychotropic drugs for mass action effects!
- More research into systems of brain function – computer style modelling with inputs and outputs
- Combination of modular and networking



# Current brains

- Our brains have been in their current form for about 100,000 years
- So we are moderately “successful”!
- We have only recently reached the age (in years) where brain degeneration becomes a feature for significant numbers of people.



# The ageing brain

## Two models of ageing:

- Original – inevitable ongoing neuronal cell death until you die
- New – unless something catastrophic happens (e.g. stroke or trauma), MOST neurons survive until you die



# The ageing brain

Neuroscientific knowledge from imaging studies supports the latter somewhat

- Between the ages of 20 and 90 we lose between 5-10% of the weight of our brain
- There is a reduced surface area
- “Pathologies” appear (tangles and plaques - but we don’t know how important these actually are)



# The ageing brain

Maybe chemical changes are more important than cell death?

- e.g. inflammatory changes
- loss of neurotransmitters like dopamine
- oxidative stress
- vacularity

Genetics are important and for some are linked to inevitable pathology but in many cases need a trigger.....



# The ageing brain

## Secrets for success

What is the evidence for factors that may impact on the rate of change in the brain?

A few concepts:

- Neuroplasticity of the brain
- Cognitive reserve

# Neuroplasticity of the brain

- Previously thought neurons don't regenerate.....
- “The brain **can** change itself”
- Now known that this process of neuroplasticity underpins not only all learning but also operates after injury
- We need to know about this process and how we can manipulate it positively





# Neuroplasticity of the brain

- The physiology involves many intricate processes whereby
  - synapses (the connections between brain cells) can resume lost function;
  - synapses can become hyper-effective;
  - silent or unused synapses can become unmasked;
  - previously redundant circuitry can subserve lost function;
  - collateral sprouting from adjacent cells can occur and so on.
- Functional areas can be re-organised (driven by increased input and output) and competition for synapses between adjacent areas can occur
- Neurotransmitter release can be altered (by activity)



# Neuroplasticity of the brain

- It is present throughout life, though does decrease with age i.e. newborn baby has the most plastic potential, though the older person has arguably clearer connections (experience)
- Stimulated by activity AND by environment – is driven by demand and lost by disuse

***“Use it or lose it”***

- Triggered best when related to well associated connections e.g. other networks
- Novel actions that require choice (focus attention and make decisions) involve more brain activity than routine actions

***“Use it to improve it”***



# Cognitive reserve

- an *antidote* to the impact of dementia?
- Stems from the idea that people can have similar pathology in the brain but some “cope” better cognitively (are more *resilient*) and therefore show less impairment than others
- More profound for late-onset dementia than early-onset
- Related to childhood intelligence; educational attainment; adult occupational and social life

Richards M, Sacker A (2003). Lifetime antecedents of cognitive reserve. *J Clin Exp Neuropsychol*. 25(5):614-24



# More secrets of the successful brain

Lifestyle factors have been associated with the rate of change in the ageing brain

- Maintaining a lower weight
- Avoiding (managing) chronic conditions like diabetes, hypertension, cardiovascular disease
- Quit smoking
- Adequate rest - 8 hours sleep per night
- Balance stress - not too much and not too little
- Maintain social and friendship networks



# More secrets of the successful brain

## Lifestyle factors continued

- Exercise e.g.
  - **walking** rapidly for 45min, 3x per week was associated with a 30-40% risk reduction for dementia (for review: Butler et al. 2004)
  - similar findings for **gardening** (Fabrigoule et al, 1995: Simons et al. 2006)
  - and for **dancing** (Verghese et al. 2003)
  - Needs to be regular, enjoyable and moderately taxing



# More secrets of the successful brain

## Lifestyle factors continued

- Adequate ***nutrition and hydration***: fish, lean meat, fruit and vegetables, dairy, wholegrain cereal, nuts and legumes, water; ***special treats e.g. alcohol in moderation.***

*Dietary Guidelines for Australians - A Guide to Healthy Eating*

[http://www.nhmrc.gov.au/\\_files\\_nhmrc/publications/attachments/n31.pdf](http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/n31.pdf)



# More secrets of the successful brain

## Lifestyle factors continued

- **“Generativity”** – finding meaning in activities for the benefit of others – volunteering (e.g. Carlson et al 2000)
- **Positivity** – the impact of fear and therefore avoidance is immense (falls literature)
- **Mental stimulation:** regular and high levels of reading, games, puzzles, crosswords, complex tasks, visiting museum all have positive effects for cognition and lowered risk for AD (many studies)



# More secrets of the successful brain

## Brain exercises

- No brain training product has been shown to decrease the development of dementia as yet
- BUT some have shown benefits for specific skills such as mental speed, attention, memory and problem solving
- The exercises are task-specific i.e.

***what you train is what you gain***



# More secrets of the successful brain

## Brain exercises – checklist for products:

- Is it based on scientific *research*?
- *Structured*?
- Does it clearly target specific *tasks*?
- Does it have different exercises (*multi-domain*)?
- Does it offer increasing *challenge*?
- With quality *feedback*?
- Is it easy to use and *fun*?

(adapted from UNSW – Brain and Ageing Research Program website)

[http://psych.med.unsw.edu.au/psychweb.nsf/resources/Att2/\\$file/brain+training+consumer+flyer+May+2010.pdf](http://psych.med.unsw.edu.au/psychweb.nsf/resources/Att2/$file/brain+training+consumer+flyer+May+2010.pdf)

# Summary

So you can teach an old dog new tricks.  
(and it will be good for him/her!)

Success comes with

- Attitude and motivation
  - Meaning (purpose)
- Practice and feedback
  - Environment



Challenge  
attitude  
meaning  
environment  
fun  
healthy  
Stimulating  
Contemplation  
contemplation  
giving  
good-food  
active  
networks  
Learn