University of South Australia

Neuroplasticity: the buzz word in Neuroscience

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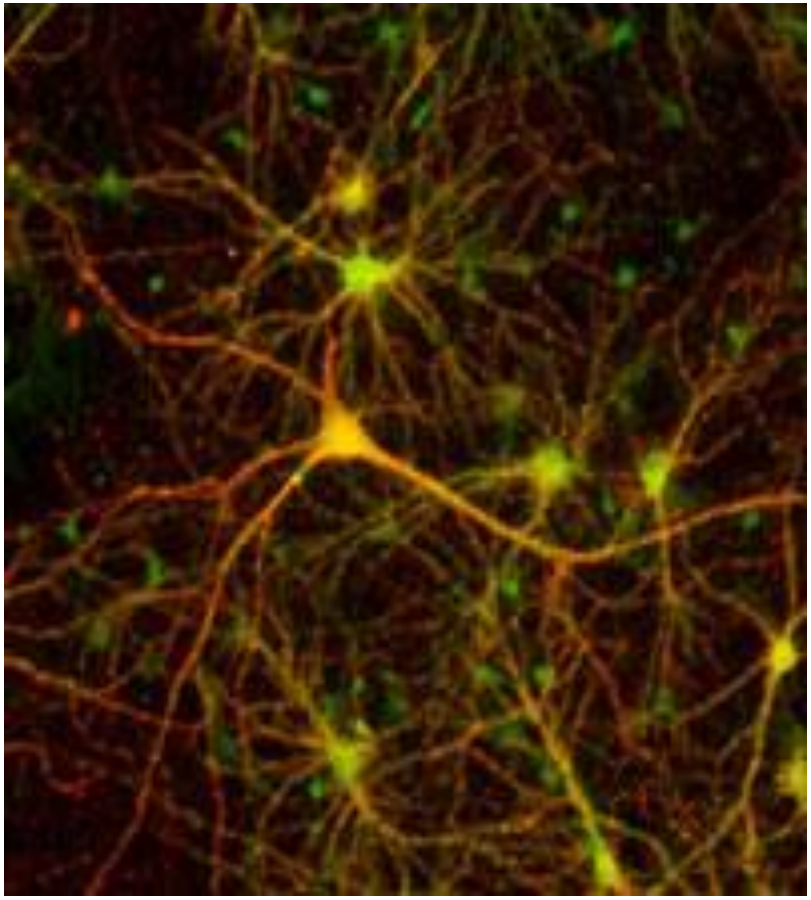
Our brain

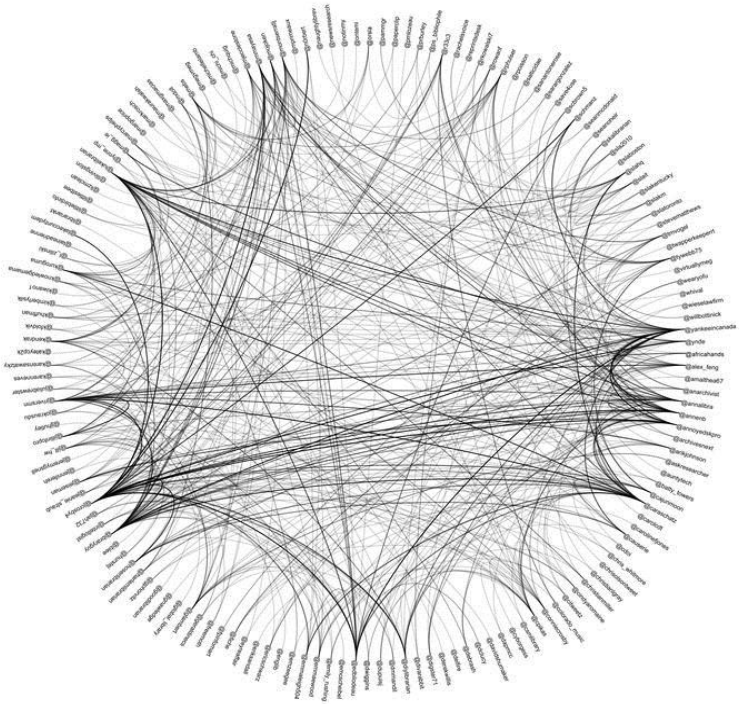
If our brains were simple enough for us to understand - we would be too simple to understand them

Our brain

- 10^{10} neurons (brain cells) in a typical human brain, linking up in networks
- with up to 10,000 neighbours
- meaning 40 quadrillion possible patterns of connections.
- If each connection (synapse) has several different strengths of communication (lets say 10) then…we have 10 to the trillionth power of possible electrochemical configurations!



Our brain



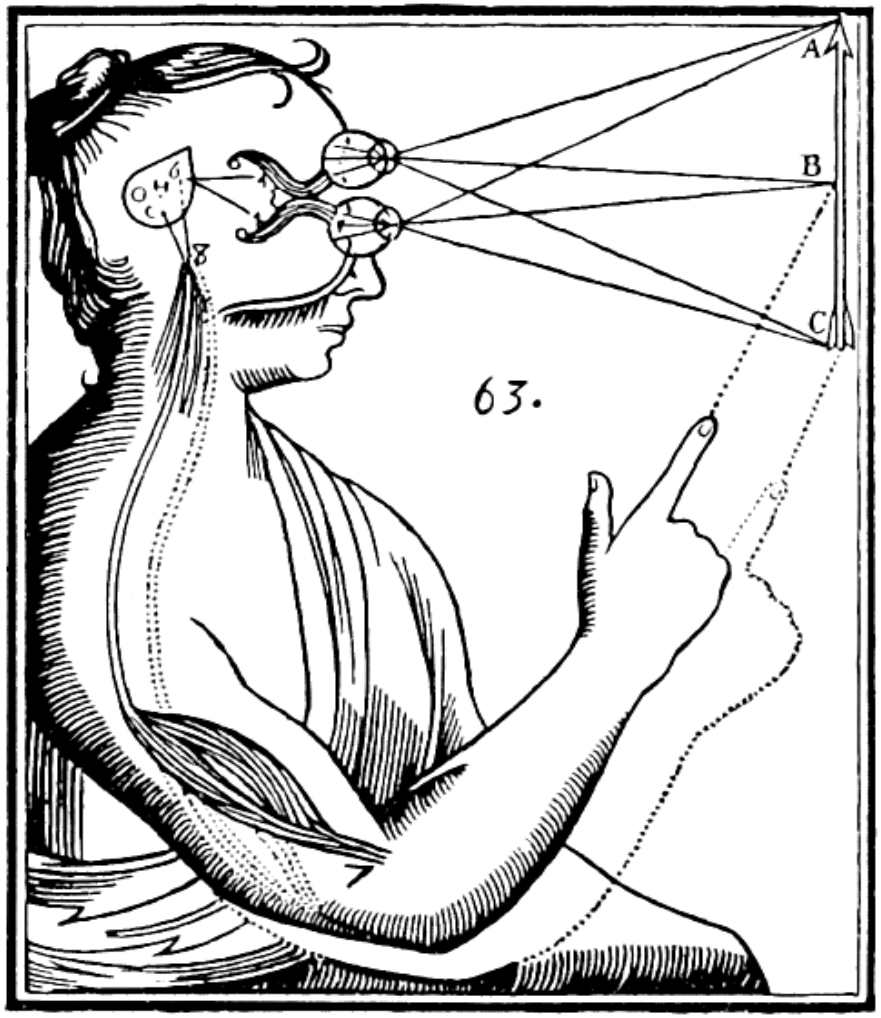
These internal neural networks have the ability to communicate between each other dynamically, to reflect on aspects of their own workings and can link up with other external networks (other brains) to form a community of communicating, interacting brains (aka human society!)

The historical brain

- The first known description of the brain 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 17th C- Descartes split the mind and body
- Pineal Gland responsible for consciousness and the soul; rest of the brain 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)



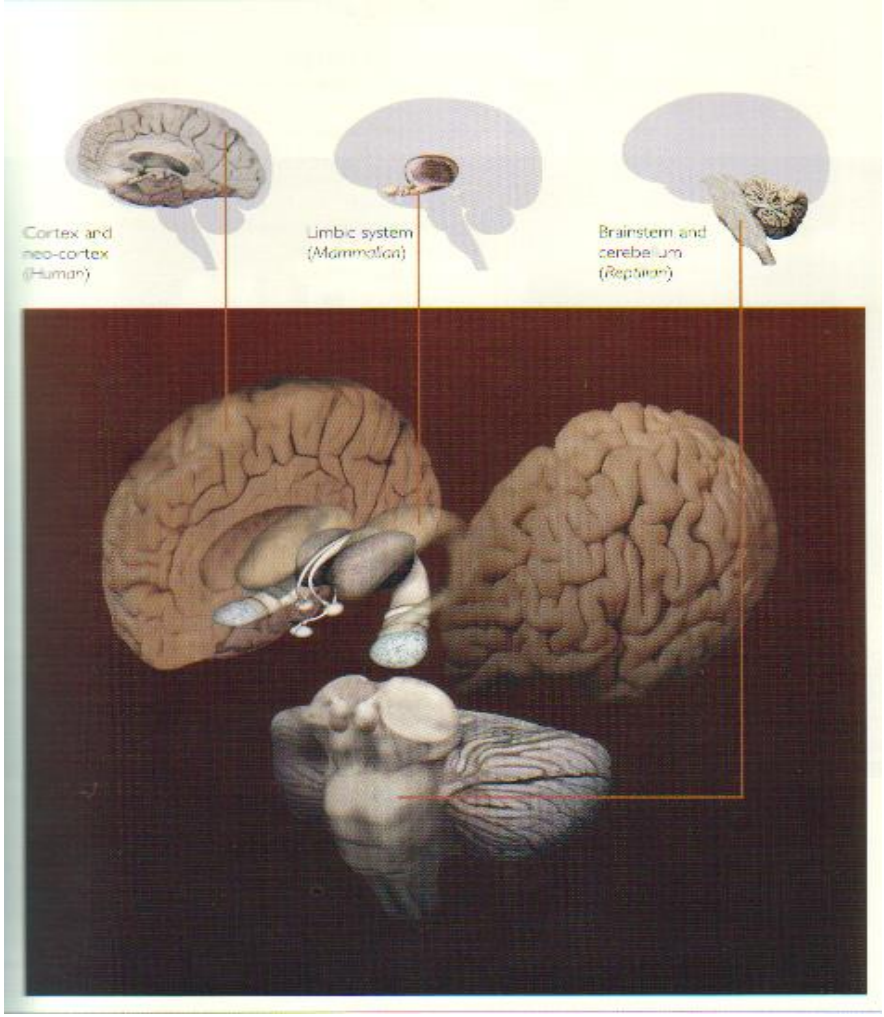
http://en.wikipedia.org/wiki/File:Descartes_mind_and_body.gif

The historical brain

- Early 19th C - Franz Gall invented "Phrenology" – reading the bumps on the skull to evaluate the attributes of man;
- Mistaken that features of the skull link with underlying brain tissue but on the right track in thinking that the brain did have functional regions or zones

http://serendip.brynmawr.edu/Mind/Images/13.GIF

The historical brain



Carter R: Mapping the mind. Weidenfeld and Nicholson, (1998) p 33

- Early 20th C – hierarchical organisations of the brain – 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
- Human > mammalian > reptilian

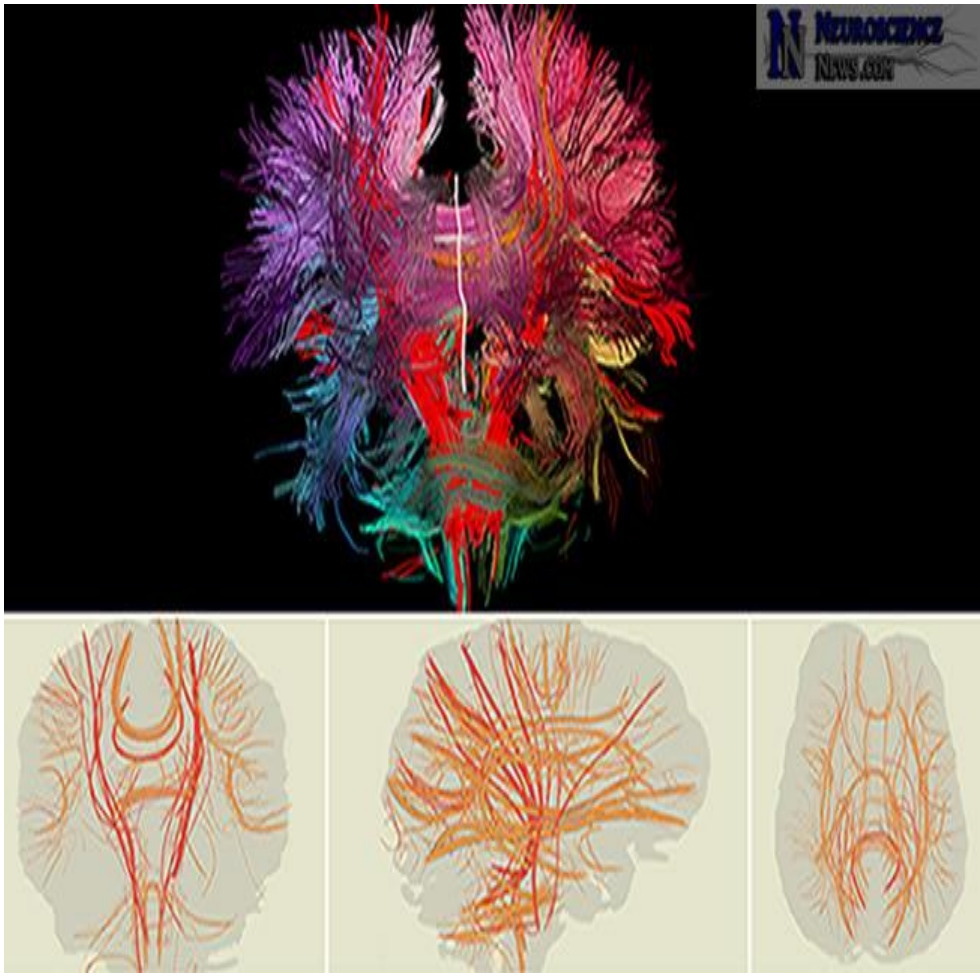
The historical brain

- Mid 20th 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).

Current brain

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

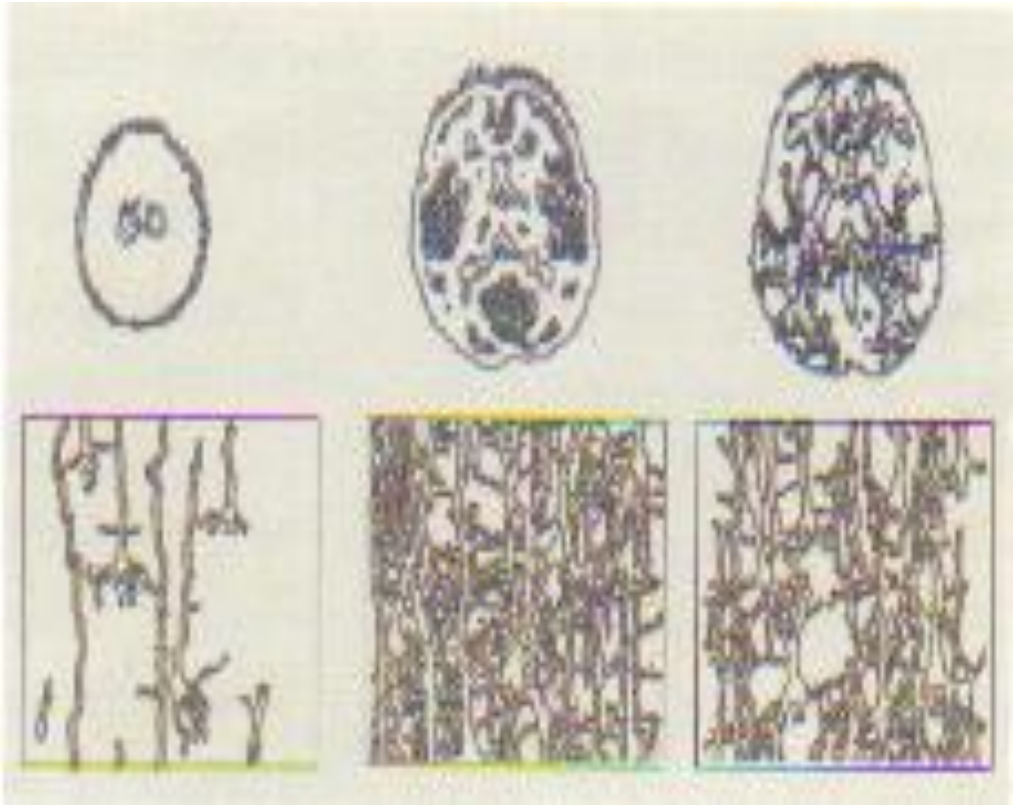


Current brains

- 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.

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

- 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)

Neural brain connectivity map_Big postbit_1801

Neuroplasticity of the brain

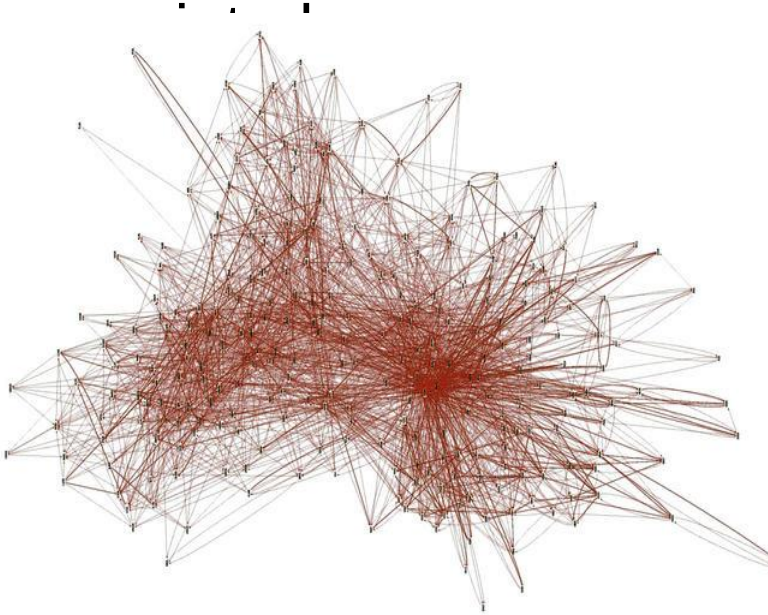
- It is present throughout life, though does decrease with age (offset by the older brain being more efficient: myelinated)
- Stimulated by **activity** AND by **enriched environment** – is driven by demand and lost by disuse

"Use it or lose it"

- Triggered best when related to well connections e.g. other networks
- Novel actions that require choice

(focus attention and make decisions involve more brain activity than routine actions

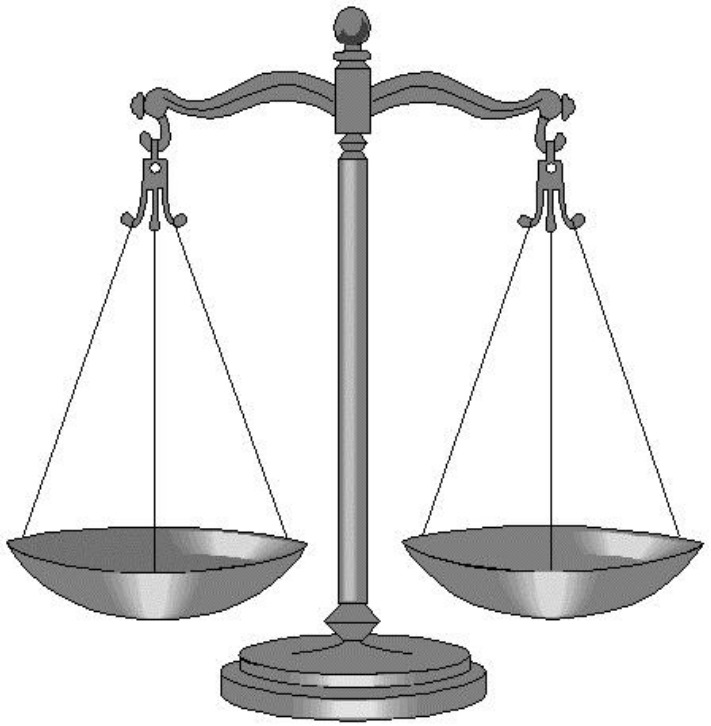
"Use it to improve it"



Implications for a positively changing brain

Lifestyle factors have been associated with a healthy 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



http://www.living-intentionally.com/wp-content/uploads/2011/03/scales.jpg

Implications for a positively changing brain

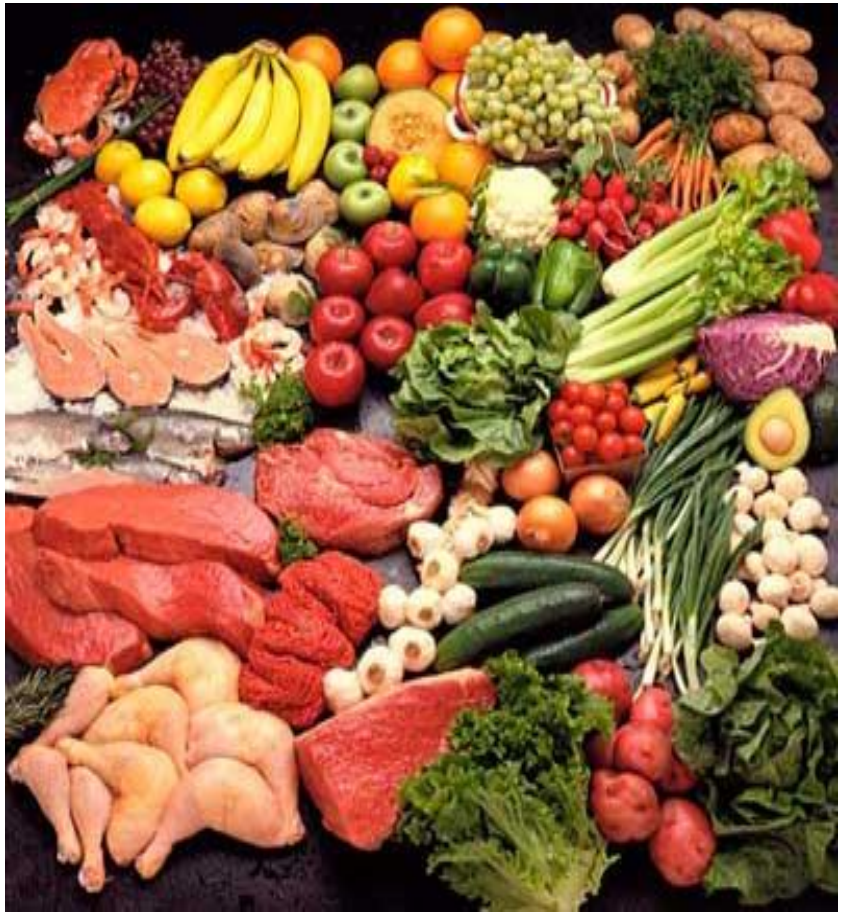
Exercise e.g.

- ***walking*** rapidly for 45min, 3x per week was associated with a 30-40% risk reduction for dementia (for review: Butler et al. 2004)

http://www.bariatriccookery.com/category/exercise

- 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

Implications for a positively changing brain



Lifestyle factors continued

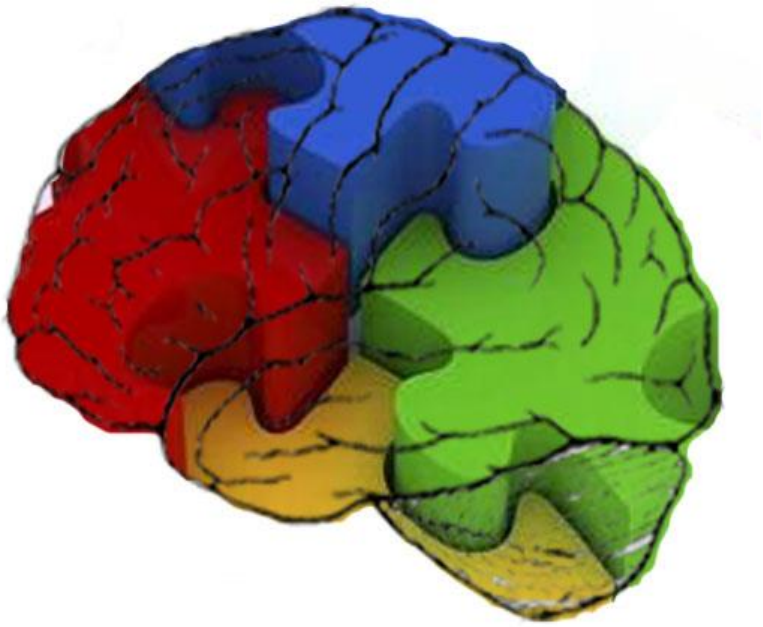
- Adequate ***nutrition and hydration:*** fish, lean meat, fruit and vegetables, dairy, wholegrain cereal, nuts and legumes, water; *special treats e.g. alcohol in moderation.*

Dietary Guidelines for Australians - A Guide to Healthy Eating
http://www.nhmrc.gov.au/_files_nhmrc/publications/attachments/n31.pdf

Implications for a positively changing brain

- ***"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 and balance 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)



http://www.alzheimersreadingroom.com/2010/01/preschoolers-join-alzheimers-fight-with.html

Implications for a positively changing brain

Brain exercises

- Brain training products: some have shown benefits for specific skills such as mental speed, attention, memory and problem solving
- None have been shown to decrease the development of dementia as yet
- The exercises are task-specific i.e.

what you train is what you gain

http://www.muscle-fitness-tips.net/how-to-exercise.html

Summary

Neuroplasticity means the brain can change for the positive at any age

So you can teach an old dog new tricks

This comes with

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


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