Rewiring the Brain

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“The work of a pianist, speaker, mathematician, thinker etc., is inaccessible for the untrained human, as the acquisition of new abilities requires many years of mental and physical practice. In order to fully understand this complicated phenomenon, it is necessary to admit, in addition to the strengthening of pre-established organic pathways, the establishment of new ones, through ramification and progressive growth of dendritic arborizations and nervous terminals.”

Ramon Y Cajal (1904)
Differences in brain structure reflect different skills and experiences.
Brain structure reflects expertise

Maguire et al, PNAS, 2000
Training affects white matter
Diffusion MRI measures white matter integrity

Diffusion-weighted MR imaging
- Fractional anisotropy (FA)
Training affects white matter

*Bengtsson et al, Nature Neuro, 2005*
Dynamic changes with learning?
Brain changes with learning: functional changes

Floyer-lea and Matthews, J Neurophysiol, 2003
Brain changes with learning: structural changes in grey matter

Draganski et al, Nature, 2004
Dynamic changes in response to brain injury?
Functional changes with rehabilitation post-stroke

Johansen-Berg et al, Brain, 2002
Structural changes with rehabilitation post-stroke

Gauthier et al, Stroke, 2008
What’s happening at the cellular level?
Functional remapping around an experimental stroke in monkeys

Pre-infarct

Post-infarct and training

Nudo et al, Science, 1996
Functional remapping in a remote region

Frost et al, J Neuroscience, 2003
Increased cellular branching after injury and with rehabilitation

Biernaskie & Corbett, J Neurosci, 2001
Rewiring the brain after injury

Dancause et al, J Neurosci, 2006
Can we modify brain plasticity?
Modulating brain plasticity with brain stimulation?

Transcranial Direct Current Stimulation (tDCS)

Effects of tDCS on motor performance in patients post-stroke

Hummel et al., 2005
Conclusions

• The adult brain is capable of considerable plasticity
• This occurs with learning and in response to brain damage
• Techniques are being developed to try to modify brain activity in order to limit the effects of damage or ageing
Acknowledgements

• Paul Matthews
• Charlie Stagg
• Rose Bosnell
• Helen Dawes