Can the brain rewire itself?

Dr Charlotte Stagg
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Outline

- How is the structure of the brain relevant to recovery?
- What happens to the brain after a stroke?
- How does natural recovery happen?
- What can we do that might help that recovery?
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Structure of a neuron (brain cell)

- Grey Matter
- White Matter
- Cell body
- Axon
- Muscles
White matter - pathways out of the brain
Grey matter – generates information
Structure of the brain

- **Grey Matter**
- **White Matter**
Functional MRI – non-invasive human imaging
Functional MRI - the basis of the BOLD Response

BOLD = Blood Oxygen Level Dependent signal

At rest
Baseline

Task

Active
Activation state

Difference

↑ Blood flow
↑ Oxy:deoxy Hb
↓ Magnetic susceptibility
↑ MR signal
Motor Network

- Cerebellum
- Primary Motor Cortex
- Supplementary Motor Area
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After a stroke the paths out of the brain become blocked
Real life experience...

- Click here to view the film clip ‘Real life experience’: [https://www.youtube.com/watch?v=6fuKMKWRAmk](https://www.youtube.com/watch?v=6fuKMKWRAmk)
Real life experience...

Click here to view the film clip ‘Real life experience’: https://www.youtube.com/watch?v=Zybxq96HIrk
But .... New paths can form
Recovery can and does happen

Click here to view the film clip ‘Recovery can and does happen’: https://www.youtube.com/watch?v=l2ASoedQa2M
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The more you do the better

Click here to view the film clip ‘The more you do the better’: https://www.youtube.com/watch?v=5v2VUNfSgAo
More of the brain is active when moving after a stroke

Controls

Post stroke

FMRIB
Oxford Centre for Functional MRI of the Brain
Much of the brain is activated to move the stroke-affected hand.
Targets in stroke neurorehabilitation - “rebalancing” the two sides of the brain

Ward & Cohen 2004
Recovery-related brain changes; sub-acute stages: 2-26 weeks

Across a group of chronic stroke survivors, reductions of activity in these regions were associated with improvements in clinical scores

Ward et al, Brain, 2003
Longitudinal study: Increased activity in the brain after rehabilitation

Pre

Post

Johansen-Berg et al, Brain, 2002
Brain Plasticity

Skill Learning

Rehabilitation
Learning to juggle (as a model for recovery!)

(Scholtz et al., 2009)
Increased Grey Matter after learning

(Scholtz et al., 2009)
What does the increase in Grey Matter represent?

Axon sprouting
Increase in White Matter Organisation

(Scholtz et al., 2009)
What does the increase in White Matter Organisation represent?
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Recovery can and does happen

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Summary

• The more you do the better you will get.

• It is NEVER too late to improve (though things will slow down)

• The brain is able to change and adapt all the time

• New potential therapies are beginning to be developed that may help

• The more we understand about recovery the better those potential therapies will be
A last word to Jan....

Click here to view the film clip ‘A last word to Jan’: https://www.youtube.com/watch?v=U-xMOSTpEPQ
Transcranial Direct Current Stimulation (tDCS)
Repeated sessions may lead to long term motor improvements in patients

Baseline Session: Including clinical measures and TMS

MRI session

Intervention: tDCS (anodal or sham) and motor training

Follow-up sessions: Repetition of clinical measures

Daily motor training consists of simple, standardised exercises

Repeated sessions may lead to long term motor improvements in patients.
People who made greater improvements also had greater increases in brain activity.
People who made greater improvements also had greater increases in Grey Matter