Title of Project: *Quantifying and measuring cortical reorganisation and excitability with post-stroke Wii-based Movement Therapy: report to the Brain Foundation 2014*

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Aims:

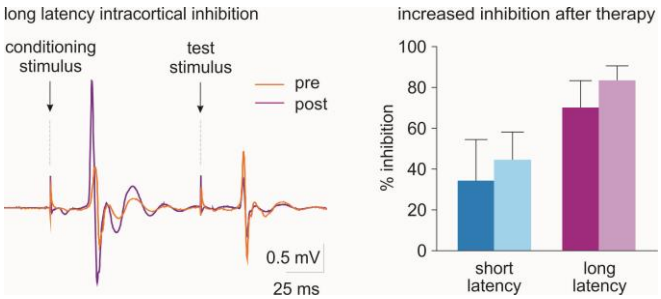
1. To investigate changes in brain excitability of stroke patients after a 14-day protocol of Wii-based Movement Therapy
2. To examine the relationship between excitability changes measured using brain imaging techniques (MRI and MEG) and the neurophysiological technique of transcranial magnetic stimulation (TMS).

Progress:

10 patients were scanned using both magnetic resonance imaging (MRI) and magnetoencephalography (MEG) and completed TMS before and after a 14-day protocol of Wii-based Movement Therapy. Detailed functional assessments were completed before and after therapy and neurophysiological recordings were made during formal therapy sessions at early and late therapy. The functional ability of all patients improved and there was significant transfer to increased independence in activities of daily living. No adverse events were recorded. The study generated a very large dataset and data analysis is ongoing. Due to the complex analyses requiring multiple processes, the final results will not be confirmed until 2015. This study forms the basis for Christine Shiner's PhD thesis to be submitted in 2015.

Preliminary findings:

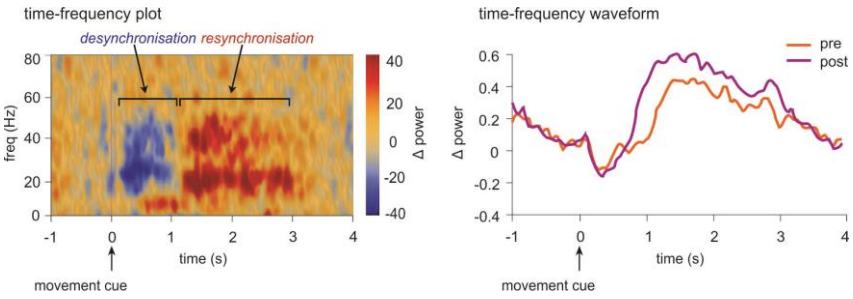
Muscle responses could be elicited from the less-affected in all patients but only in 50% patients on the more-affected side. Inhibition increased in the contralesional motor cortex after therapy and transcallosal inhibition from the ipsilesional to the contralesional cortex was also increased. Changes in the lesioned hemisphere were very small and more variable and there was no change in transcallosal inhibition from the contralesional to the ipsilesional motor cortex. These changes suggest that Wii-based Movement Therapy promotes a rebalancing of the asymmetric interhemispheric inhibition known to develop after stroke.



Changes in cortical inhibition of the non-lesioned hemisphere. Left: male 79 years, 10 months post stroke with increased inhibition after therapy (smaller responses). Right: group data showing a trend towards significantly increased inhibition.

Increased inhibition of the non-lesioned hemisphere reflects a better balance between the hemispheres enabling more controlled use of the more-affected hand after stroke. This change was associated with improved functional use of the more-affected hand and arm in activities of daily living.

Magnetoencephalography (MEG) enables the temporal characteristics of brain activation patterns to be recorded with high resolution. MEG brain scans are co-registered with MRI scans to enable the source of the signal to identified. Our preliminary data suggest that post-stroke movement-related MEG beta-band activity is related to both corticomotor excitability and motor-function on the more-affected side. Cortical beta-band activity was bilaterally affected after stroke even in patients with relatively preserved ipsilesional cortical excitability and less-affected side motor-function.



Single subject MEG data (male 50 years, 8 months post stroke). The panel on the left shows the two phases of brain activation during a simple finger tapping task with the more-affected hand.

The waveforms on the right are an average of 80 trials and clearly demonstrate an increase in both the amount and the rate of brain activation after therapy.

The first two manuscripts are in preparation.

Presentations:

Preliminary results have been presented 5 times (twice internationally, once nationally) with another national meeting presentation in July 2014 (see below). The presentation marked * was an invited symposium.

Data will be included in the following invited symposium presentations by Dr McNulty:
Australasian Winter Brain Research Conference, Queenstown NZ 2014
Smart Strokes Conference, Sydney 2014

Shiner CT, Johnson BW, McNulty PA (2013) Using magnetoencephalography to measure biological change in the brain after post-stroke Wii-based Movement Therapy, preliminary data. *Stroke Society of Australasia. International Journal of Stroke* 8, Suppl 1, 18.

Shiner CT, Johnson BW, McNulty PA (2014) Magnetoencephaolography as a tool to investigate differences in cortical beta-band activity as a function of motor ability after stroke. *Society for Brain Mapping and Therapeutics.*

McNulty PA, Shiner CT, Harris LR, Johnson BW (2014) Using magnetoencephalography (MEG) to measure cortical reorganisation induced by the novel post-stroke rehabilitation strategy Wii-based Movement Therapy. *Society for Brain Mapping and Therapeutics.*

*McNulty PA, Shiner CT (2014) Investigating neuroplasticity post-stroke: contrasting bilateral differences in magnetoencephalography, transcranial magnetic stimulation and functional motor assessments. *Society for Brain Mapping and Therapeutics.*

Shiner CT, Harris LR, McNulty PA (2014) Changes in contralesional and interhemispheric excitability accompany improvements in functional movement ability induced by post-stroke upper-limb therapy. *World Congress for Neurorehabilitation*, Istanbul Turkey.

Shiner CT, Harris LR, McNulty PA (2014) Changes in cortical excitability that contribute to a rebalancing of asymmetric interhemispheric inhibition accompany functional motor improvements promoted by post-stroke therapy. *Stroke Society of Australasia.*

Dr Penelope McNulty with PhD student Christine Shiner