The Uninjured Hemisphere in Hemiplegia: Friend for some and Foe for others

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a place of mind

Djavad Mowafaghian CENTRE FOR BRAIN HEALTH

UBC MRI RESEARCH CENTRE

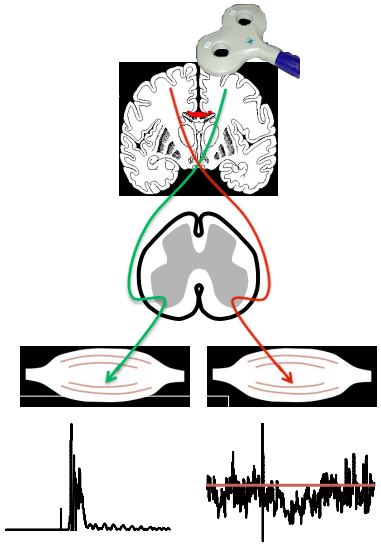
Brain Behaviour Lab

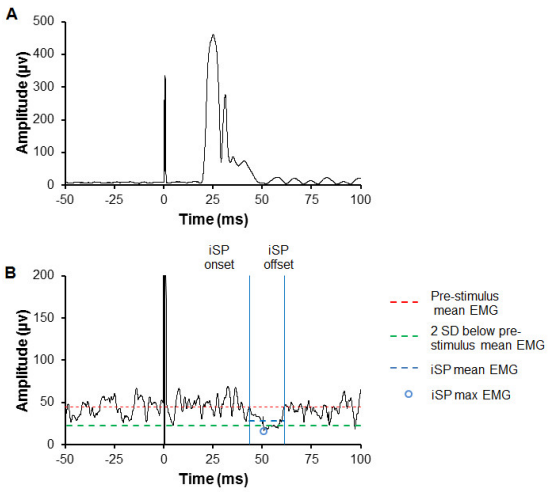
Interhemispheric Interactions after Stroke

Brain Behaviour Lab

- Interactions between the two cerebral hemispheres are changed by stroke
  - Variability from person to person in how these changes manifest
- The cause(s) and functional significance of these shifts is not clear

M1-M1 Interactions: Transcallosal Inhibition

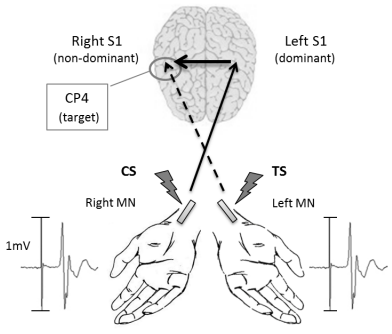


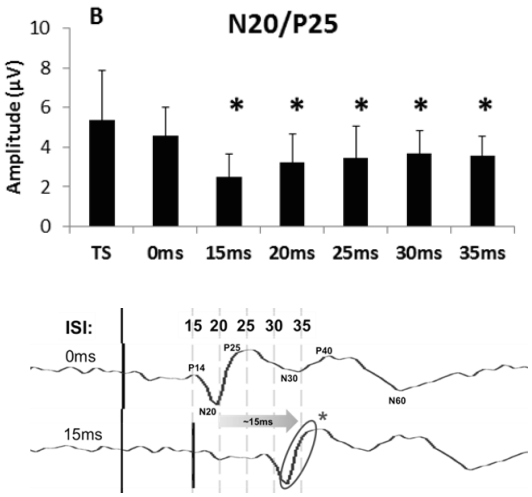


Longer iSP = more TCI

(Mang, et al., 2015)

S1-S1 Inhibition

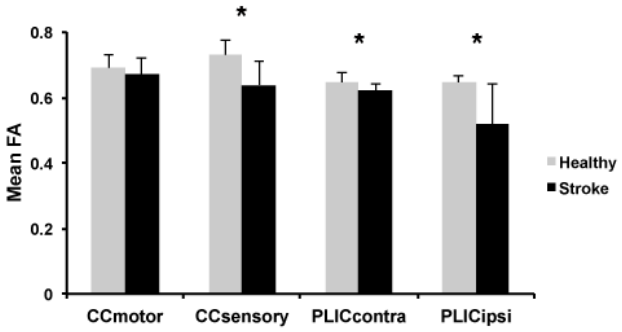


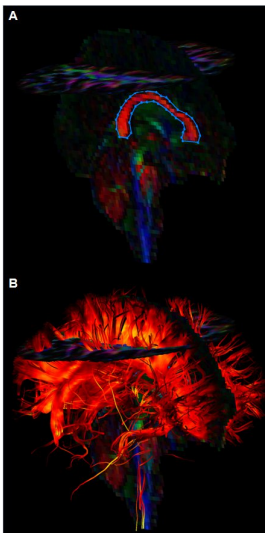


(Brodie et al., 2014)

White matter status after stroke

Widespread loss of white matter in both hemispheres after stroke

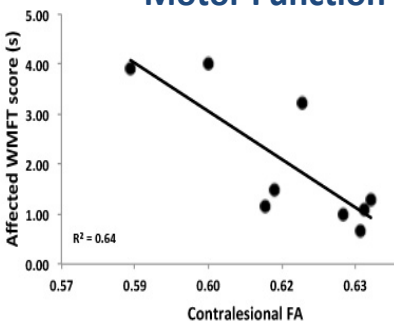




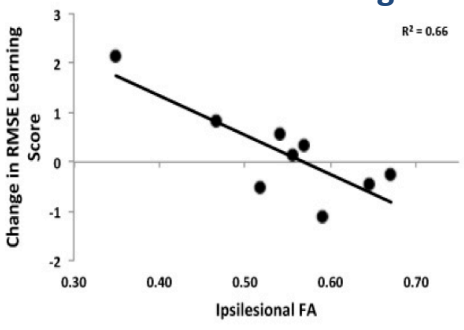
(Borich, Mang & Boyd, 2012; Mang, Borich & Boyd, 2015)

White matter microstructure (FA) relates differently to motor function vs. learning in chronic stroke

Motor Function

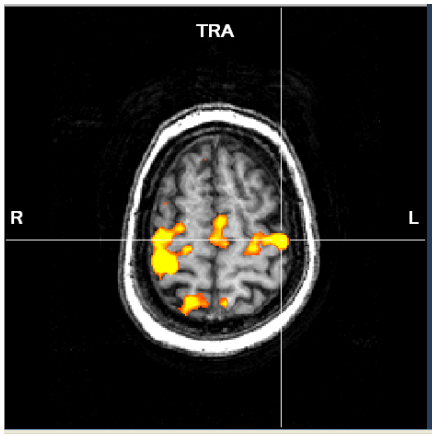


Motor Learning

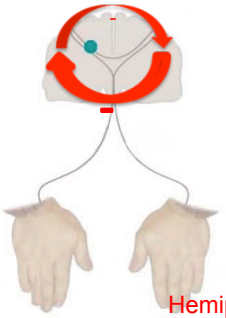


(Borich, Mang & Boyd, 2012; Borich, Brown & Boyd, 2013; Mang, Borich & Boyd, 2015)

Altered M1-M1 inhibition after stroke

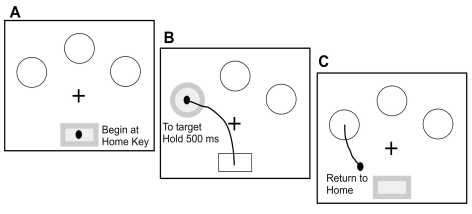


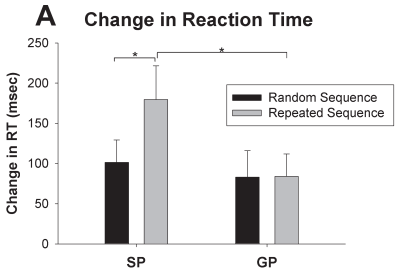
(Boyd et al., 2010)

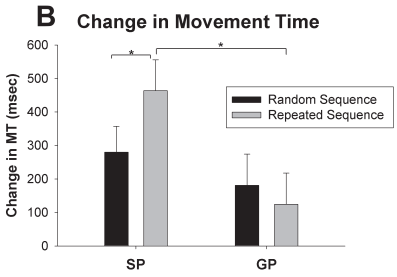


(Figure adapted from Murase et al., 2004)

Can the relationship between the two hemispheres be changed after stroke?

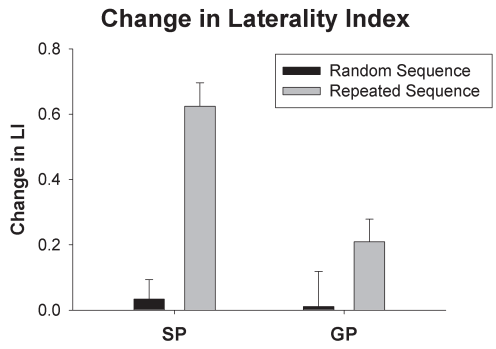


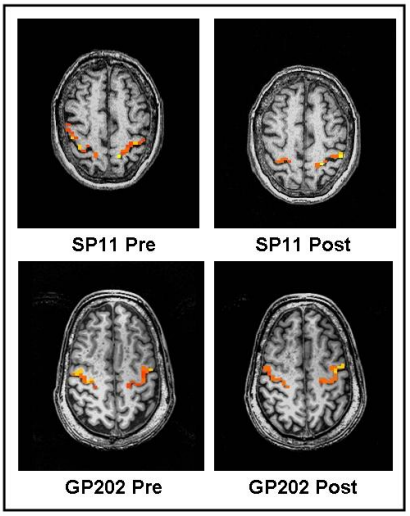




(Boyd et al., 2010)

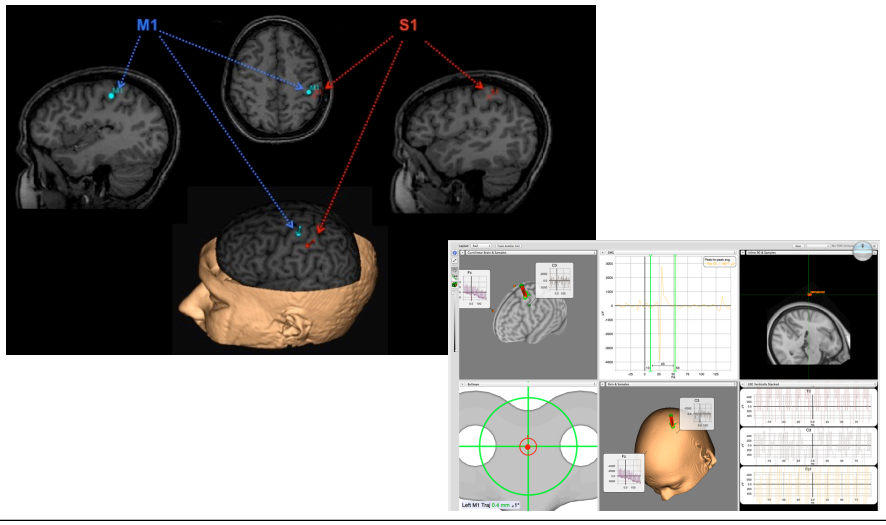
Motor Learning alters patterns of brain activity in both motor cortices



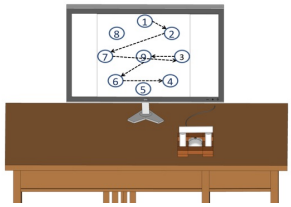


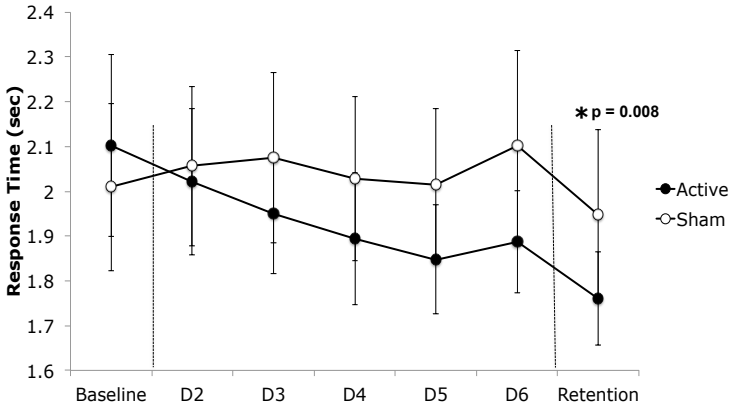
(Boyd et al., 2010)

Using rTMS to probe intercortical relationships: What and where to stimulate?



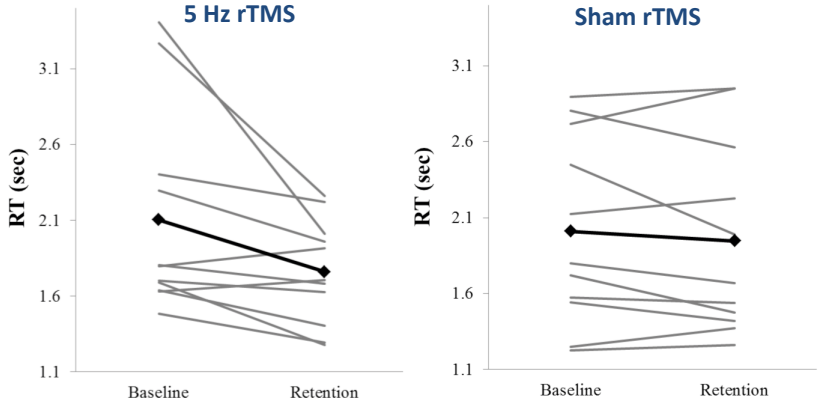
5 Hz rTMS over ipsilesional sensory cortex paired with practice facilitates motor learning





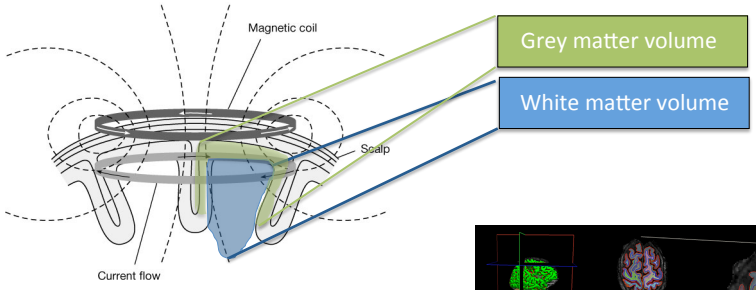
(Brodie, Meehan, Borich, Cheung, & Boyd, 2014)

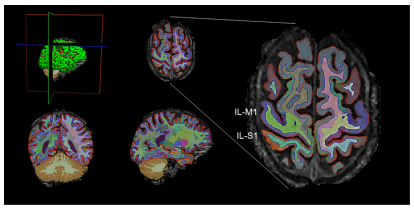
High degree of variability in response



(Brodie, Meehan, Borich, Cheung, & Boyd, 2014)

Is the effectiveness of 5Hz rTMS over ipsilesional S1 related to structural integrity?



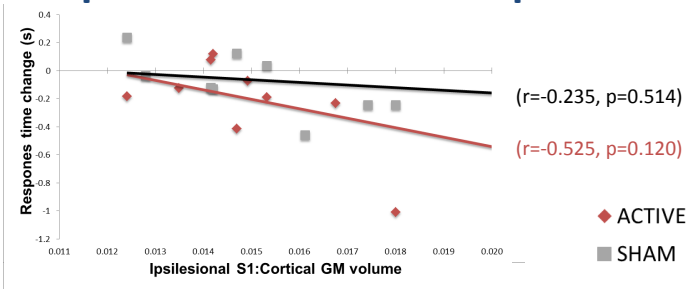


Pre & Postcentral gyri to Cortex ratio
= (Segmented Gyral volume) / (Total cortical volume)

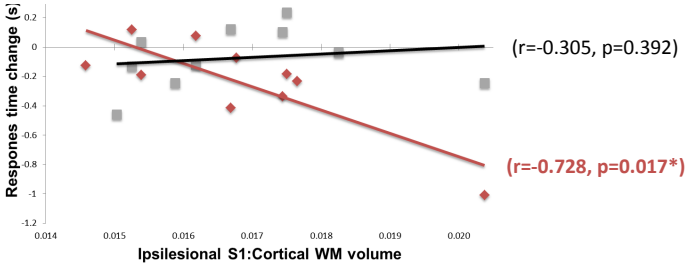
(Brodie, Borich & Boyd, 2014)

Sensory Cortex White Matter Volume is related to response to 5 Hz rTMS + practice

(A) Grey Matter

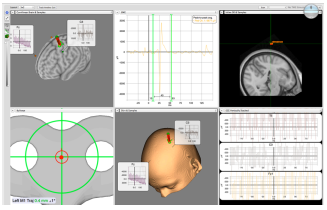


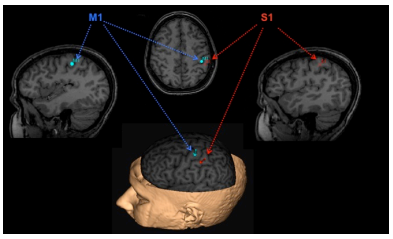
(B) White Matter

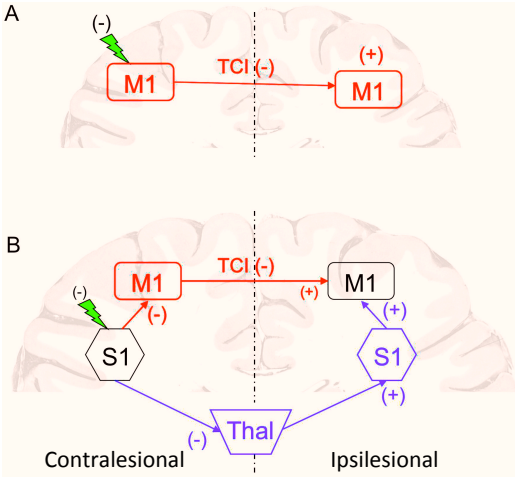


(Brodie, Borich & Boyd, 2014)

Using rTMS to probe intercortical relationships: What and where to stimulate?







Combining data from both hemispheres and the callosum explains the most variability in function in chronic stroke

Brain Behaviour Lab

Hierarchical regression model statistics.

	Predictors	*F* statistic	*p*-Value	R^2
WMFT rate				
Model 1	Age, PSD, L.vol	0.83	0.50	0.16
Model 2	1 + L-CST FA	4.14	0.03	0.58*
Model 3	2 + CCI tract FA	4.53	0.02	0.67*
Model 4	3 + NL-iSP$_{mean}$	4.08	0.03	0.71*
FM score				
Model 1	Age, PSD, L.vol	1.05	0.41	0.19
Model 2	1 + L-CST FA	5.10	0.01	0.63*
Model 3	2 + CCI tract FA	6.57	0.01	0.75*
Model 4	3 + NL-iSP$_{mean}$	8.44	<0.01	0.84*

(Mang, Brodie, Borich, Auriet & Boyd, 2015)

Final Thoughts…

- Contralesional cortex is a foe for some but a friend to others
  - Severity / residual integrity
- A highly integrated network likely supports motor recovery after stoke
  - Structural, functional, physiological
- Best models for the network are not yet known
- May require individual or personalized stimulation or treatment approaches to positively shape this network to promote recovery
  - A one sized fits all approach will not work