# Examining Somatosensory and Motor Reorganization after Stroke using fMRI

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## Introduction

**Brain Plasticity**

- Cortical reorganization can occur
  - Visual system (Dilks et al., 2007)
  - Animal studies (i.e. Merzenich et al., 1984)
  - Amputees (Ramachandran et al., 1992)
  - *Somatosensory system*

## Research Questions

**Main Question**

- How do somatosensory and motor representations in the brain change after stroke?

**Experiment 1: Tactile**

- If somatosensory cortex (S1) is damaged, what brain regions are active during tactile stimulation?

**Experiment 2: Motor**

- If somatosensory processing has reorganized into motor cortex (M1), what brain regions are activated during motor processing?

**Hypotheses -** If somatosensory processing of the affected hand is represented in M1, possible that motor processing of the affected hand will either

- ALSO remain in M1, such that M1 now has two roles: somatosensory + motor processing

**OR**

- Be represented in a different location(s) of the brain, such that M1's role has changed from motor processing → somatosensory processing

## Methods

**Experiment 1: Tactile**

- Task during fMRI
- Blocked design; 4 blocks total in ABAB order
- Each block: 30 seconds brushing on back of ipsilesional or contralesional hand, followed by 30 seconds of rest, 4 times in a row

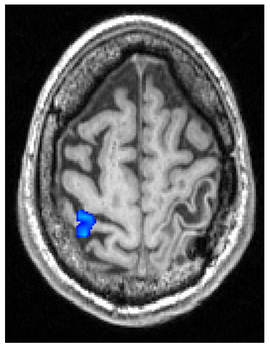
**Experiment 2: Motor**

- Task during fMRI
- Blocked design; 6 blocks total in ABBAAB order
- Each block: 12 seconds of opening and closing ipsilesional or contralesional hand (1.5 seconds to open, 1.5 seconds to close, last 3 seconds were open), followed by 12 seconds of rest, 10 times in a row

**Analyses**

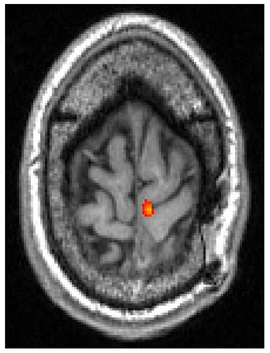
- Used FSL for analyses
- Data modeled with standard GLM (Generalized Linear Models) w/ 6 DOF
- All voxels significant at $p<0.05$ after FDR correction

## Neuroimaging Results

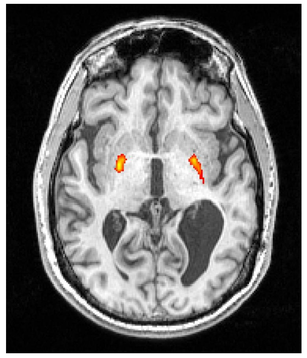


**Experiment 1: Tactile**

Tactile stimulation on **ipsilesional** hand (unaffected side) – rest; Significant activation in **contralateral S1**.



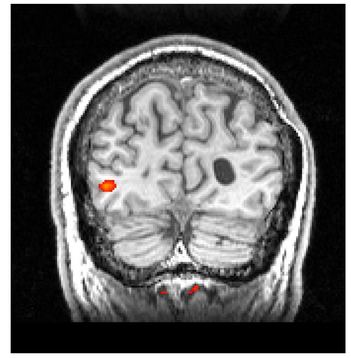
Tactile stimulation on **contralesional** hand (affected side) – rest; Significant activation in **M1**.



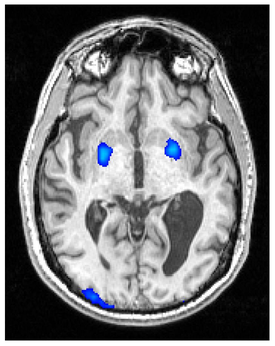
Movement of **contralesional** hand – rest; Significant activation in **bilateral putamen** and **contralateral occipital cortex (MT).**

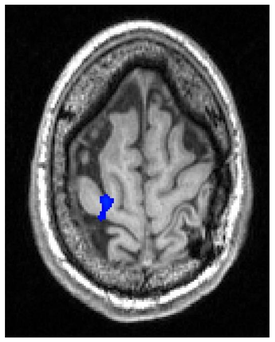
**Experiment 2: Motor**

Movement of **ipsilesional** hand – rest; Significant activation in **bilateral putamen** and **contralateral occipital cortex**.



Movement of **ipsilesional** hand – rest; Significant activation in **motor cortex** (shown) as well as potentially **contralateral somatosensory cortex** and **supplemental motor cortex** (not shown).

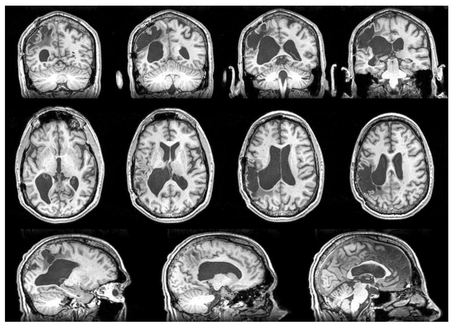




## Case Study

**KR**

- 64 year old male who suffered a stroke
- Left hemisphere lesion affecting most of primary somatosensory cortex (S1)
- No damage to motor cortex (M1)



## Discussion

**Experiment 1: Tactile**

- Tactile stimulation on contralesional hand resulted in significant activation in M1 and not S1
- Since S1 is damaged, representation of tactile stimulation has relocated to M1
- Suggests that tactile stimulation is represented in a new location in the brain after lesion in S1

**Experiment 2: Motor**

- Movement of *either* hand resulted in significant bilateral putamen and contralateral MT activation despite motor cortex being intact
- Putamen is associated with movement control
- MT involved in processing visual motion
- Post-stroke mirror movements have shown to induce bilateral activation in primary sensorimotor cortex (Kim et al., 2003)
- Suggests that motor processing may be largely represented in different locations (putamen and MT) now that tactile stimulation is represented in M1

**Future Research**

- Studying patients with brain damage similar to KR that affects S1 and/or M1, and replicating these experiments
- Psychophysiological interactions (PPI) analyses to determine if brain regions are correlated
- Run functional localizers in MRI scanner to more confidently localize S1 and M1 in brain damaged individuals
- Modeling hemodynamic response function in brain damaged individuals

## References/Acknowledgments

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