Increased functional connectivity of contralesional secondary somatosensory cortex following somatosensory rehabilitation of stroke survivors with impaired touch discrimination.

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Background:

- One in 2 survivors experience impairment in touch sensation after stroke.
- Disruptions in functional connectivity may impact extent of deficits and trajectory of recovery (Carter et al. 2010; Bannister et al. 2015; Goodin et al. 2018).
- Interhemispheric interaction is important in tactile processing, involving primary (S1) and secondary (S2) somatosensory cortex; and is coupled with distinct activation and deactivation patterns.
- Yet the impact of stroke on neural networks that support processing of tactile information associated with treatment-facilitated recovery remains virtually unknown.

Aim:

We aimed to identify changes in whole brain functional connectivity (FC) of somatosensory regions following somatosensory rehabilitation designed to help stroke survivors regain a sense of touch.

Method:

- Participants: first stroke, right hand dominant, impaired touch sensation of the upper limb.
- We investigated resting-state FC of survivors with right (n=15) or left (n=17) hemisphere somatosensory lesions pre and post SENSE therapy, and in comparison to age-and-gender matched healthy controls (HCs, n=15).
- Whole brain FC from 6 regions-of-interest (seeds):
 - primary somatosensory cortex (S1),
 - secondary somatosensory cortex (S2) and
 - thalamus of both hemispheres.
- SENSE Therapy: neuroscience and learning based approach to help survivors discriminate textures, limb position and recognise everyday objects through touch (Carey et al. 2011).

<http://youtu.be/G9V3I30pn68>

Results:

- Survivors with **right hemisphere lesion** showed increased connectivity from contralesional S2 to ipsilesional S1 post- compared to pre-therapy. In addition, prior to SENSE therapy, FC from ipsilesional S1 and thalamus was greater in stroke than HCs in distributed regions; whereas post-therapy FC was greater in stroke than HCs between ipsilesional S1 and ipsilesional thalamus, and with cingulate gyrus.

- In survivors with **left hemisphere lesion**, FC was greater from contralesional S2 to contralesional visual area (Brodmann area 19) post- compared to pre-therapy. Pre-therapy, FC from ipsilesional S1 to contralesional fusiform and cingulate regions was greater in HCs compared to stroke; while post-therapy, FC from ipsilesional thalamus to contralesional S1 was greater in stroke.

Results cont:

Connectivity maps from seeds with connectivity differences:

Healthy – Right S1 seed: Four sig clusters: right S1, right BA 40 (SMG), left BA 6, right BA 37 (fusiform g)

Healthy – Left S1 seed: Five sig clusters: left S1, left BA 39 (angular gyrus), left BA 46, left BA 44, right 13 (insula)

Post SENSE Therapy differences from ipsilesional S1:

R hem stroke > HC: from ipsilesional S1 to L thalamus and R post cingulate gyrus

Post SENSE Therapy differences from S2 seed of contralesional hemisphere:

R hem stroke: Post > Pre in left S1.

L hem stroke: Post > Pre in right BA19

R hem stroke: Post: HC > stroke in right cingulate

L hemi stroke: Post: S > HC in right BA 30; HC > S in left BA 6.

Post SENSE Therapy differences from thalamus seed of ipsilesional hemisphere:

R hem stroke: Post: S > HC in right S1

L hemi stroke: Post: S > HC in right S1

Conclusion:

Changes in functional connectivity of somatosensory network occur following SENSE Therapy. Pre-post changes involved increased connectivity from contralesional S2; to ipsilesional S1 (following right hemisphere lesion) and to contralesional visual area (following left hemisphere lesion). Changes in connectivity from ipsilesional S1 and thalamus and contralesional S2 were also observed relative to healthy controls. These findings support the role of brain networks and functional connectivity in therapy-facilitated recovery post-stroke.

References:

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