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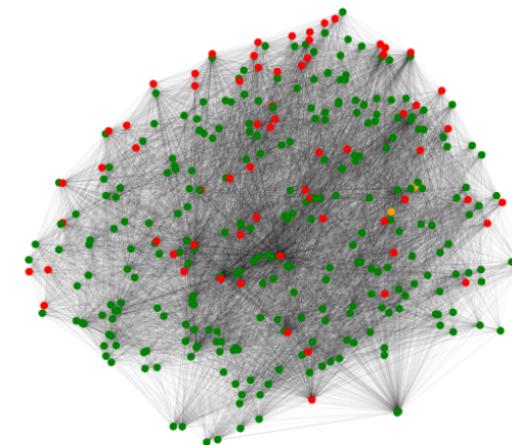
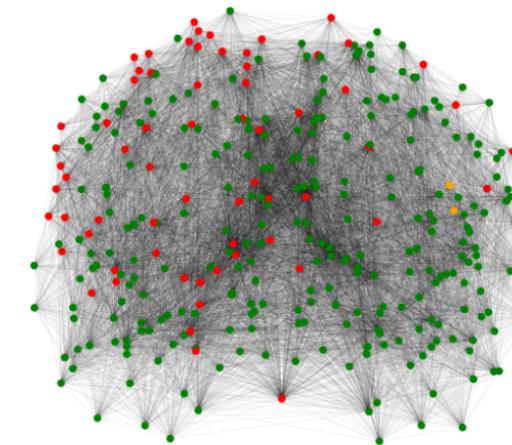
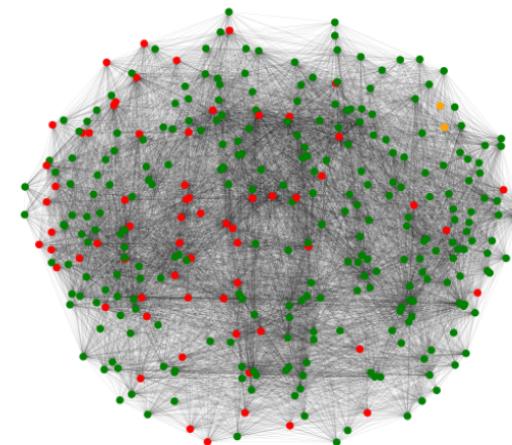
An exploratory study on the brain dysconnectome

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NTDS Final presentation

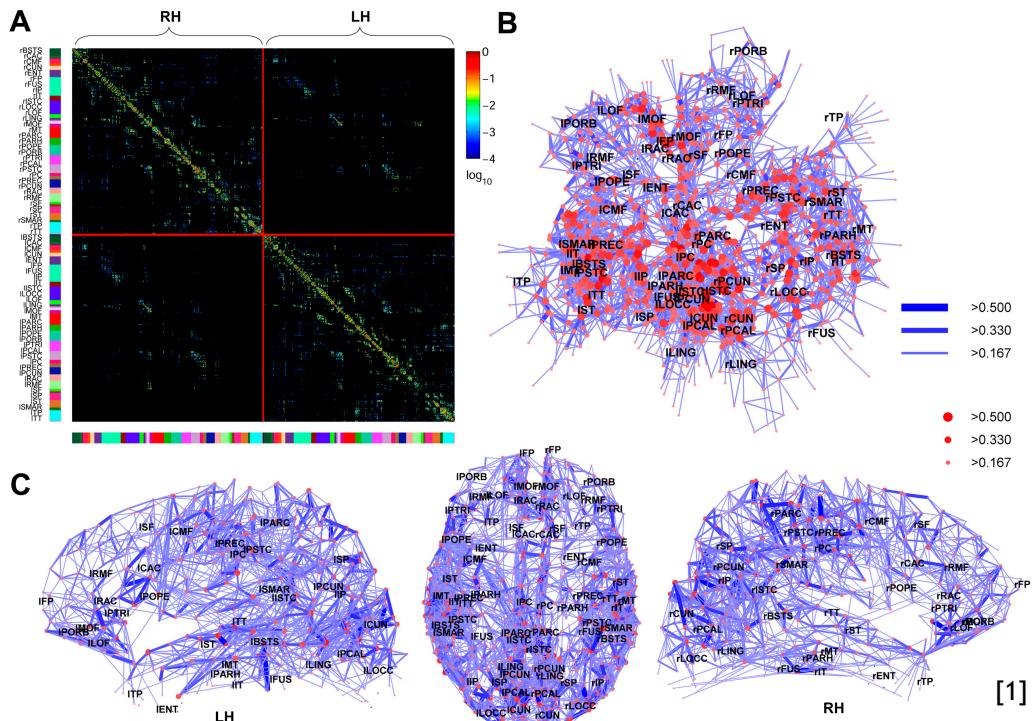
22nd January, 2018



Agenda

1. Background and dataset
2. Research questions
3. Methods
4. Results
5. Discussion
6. Conclusion and future steps

The human brain connectome and dysconnectome

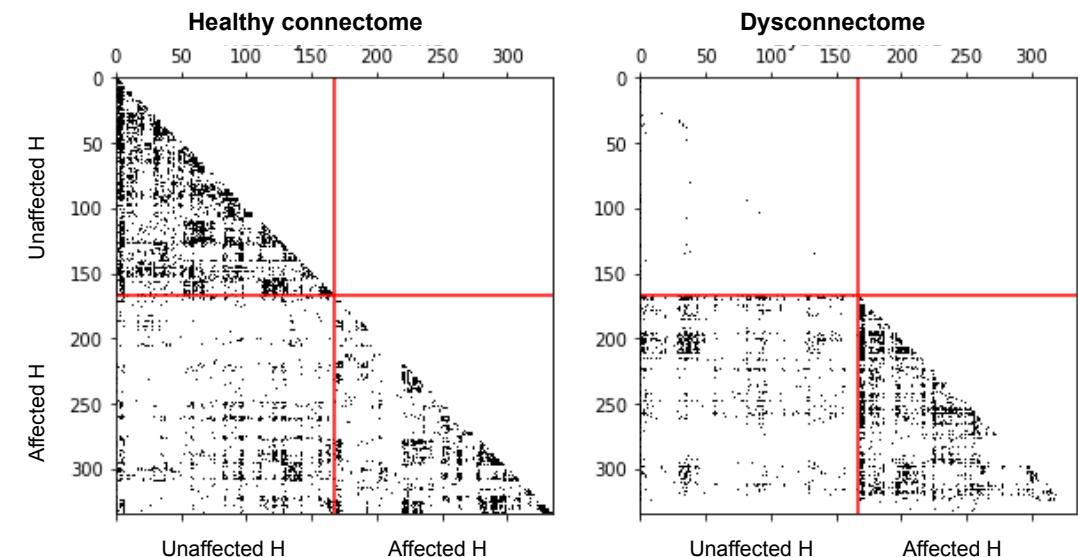


Human brain as a graph:

- Nodes: brain regions
 - Edges: white matter tracts
- Symmetric adjacency matrix with no self-connections

After stroke – focal-lesioned graph

- Lost connections
- Some nodes no more functional
- 2 new graphs:
 - Healthy connectome (Graph without lesion)
 - Dysconnectome (Graph of lesion)



Dataset

62 stroke patients with motor deficits

2 time points for brain graphs:

- Acute: 3 weeks after stroke
- Chronic: 3 months after stroke

Fugl-Meyer Assessment (FMA) [1] score

Group division to motor improvement (*fitters* and *non-fitters*)

Group division according to lesion location

Lesion Location	No. subjects	% of fitters
Striatum Capsula	16	65
Corona radiata	12	50
Peri-insular	3	0
Pons	13	70
Other location	19	42

[1] Fugl-Meyer et al., 1975. Scandinavian journal of rehabilitation medicine

[2,4,5] Siegel et al., 2016. Pnas

[3] Human Connectome Project

[6] Hagmann et al., 2008 Plos Biology

Processing to Connectome (full) and Dysconnectome

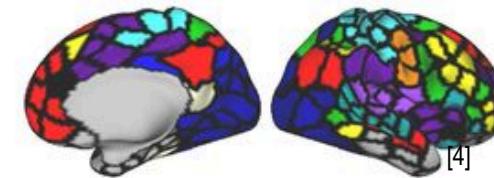
Magnetic Resonance Imagining



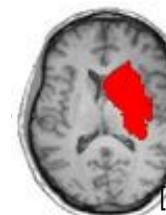
T1 image



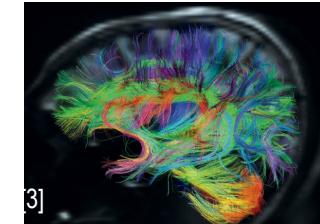
Tractography



Parcellation in 333 ROI



Lesion mask



Connectome

(wt = mean Fractional Anisotropy)



Dysconnectome
(wt = % of fibre tract in lesion)

Research questions

Characterization of the brain lesion at a network-level

- From **dysconnectome** to **clinical outcome**
- Does a **damaged subnetwork** affect the **global topological brain organization**?

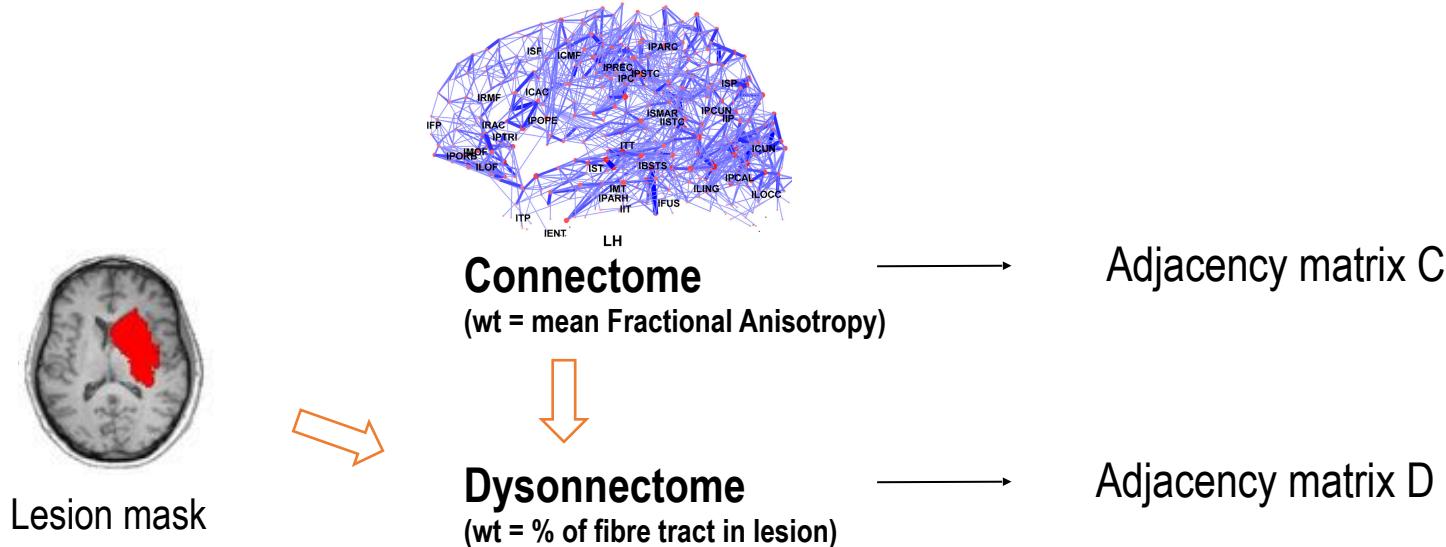
Longitudinal study

- Can we make inferences on **brain reorganization** and related clinical improvements from the acute to the chronic phase in stroke patients?

The dysconnectome

Novel method to describe clinical deficits through network theory:

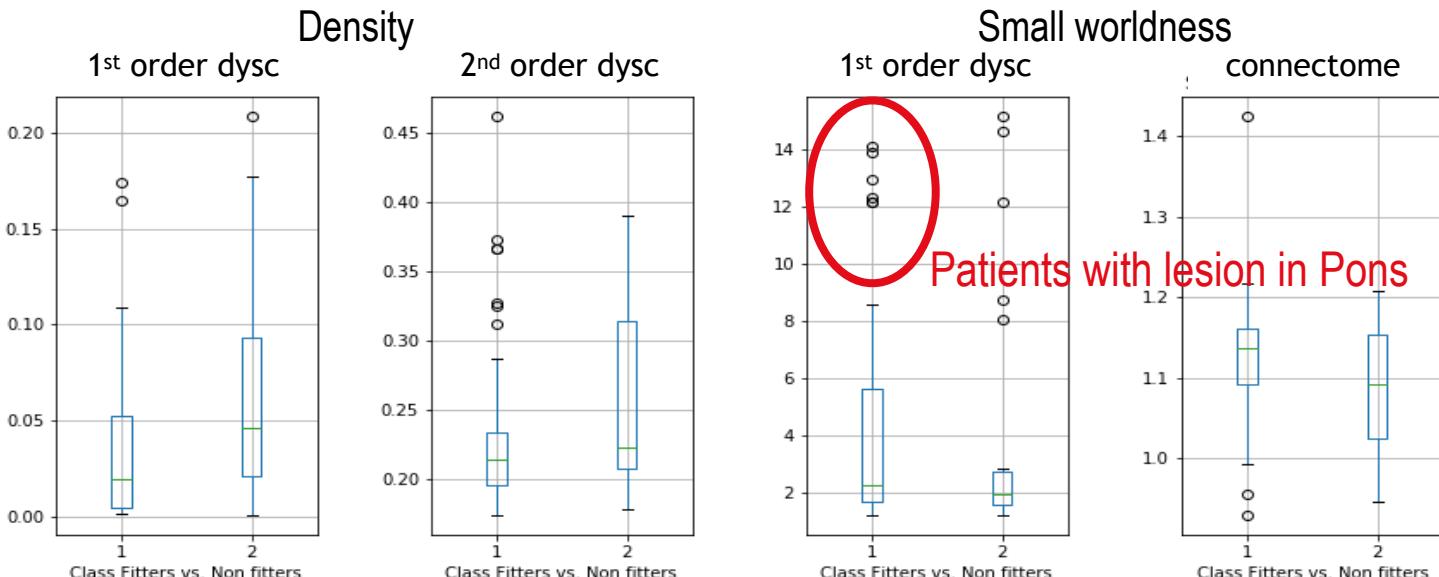
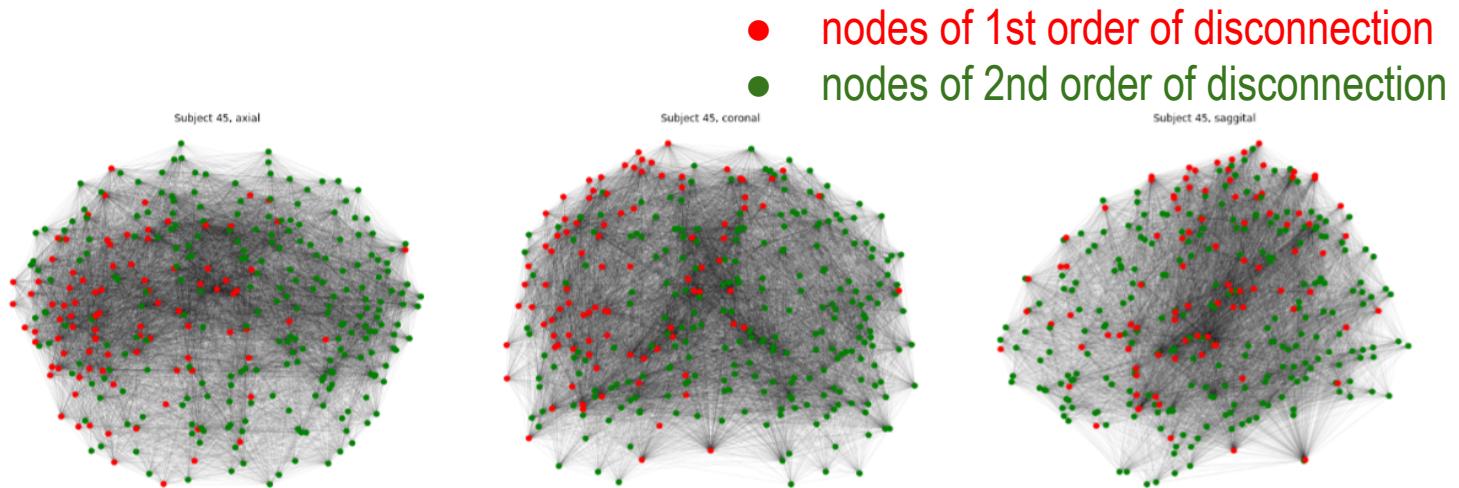
- Dysconnectome of higher orders
- Topological properties of the dysconnectome



The dysconnectome and its orders

kOrderDysconnectome algorithm

- «lesioned edges» in k steps
- «lesioned adjacent nodes» in k steps

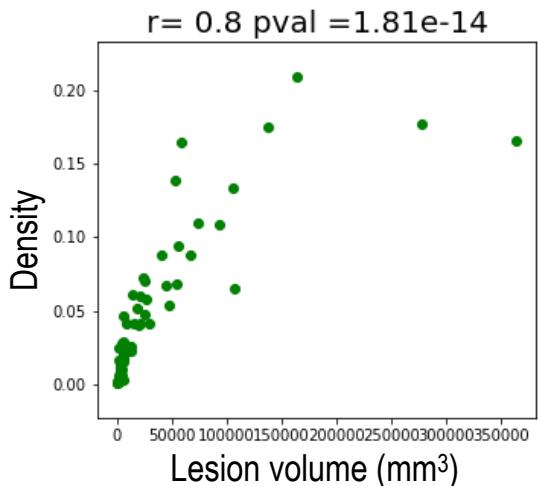


Non Fitters: less improvement than predicted by the proportional recovery model of Prabhakaran.

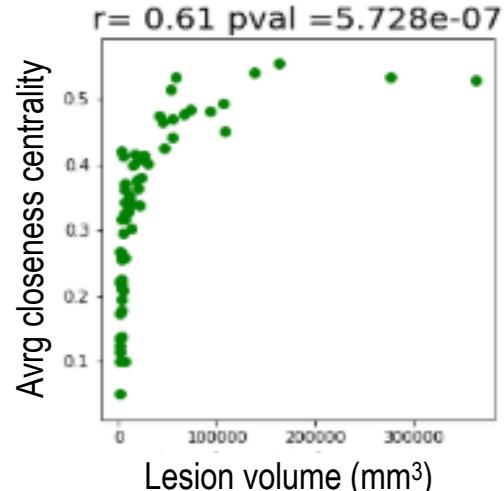
From the dysconnectome to clinical score

IMPORTANCE OF THE LESION VOLUME

Dysconnectome density

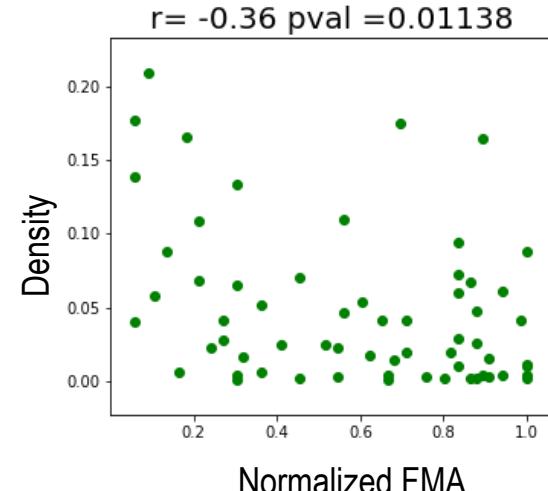


Dysconnectome average closeness centrality

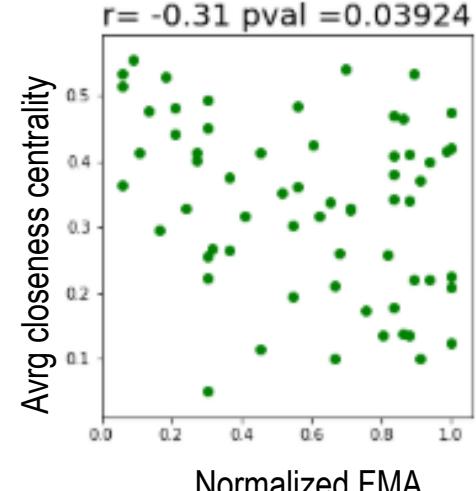


CORRELATION WITH CLINICAL SCORE

Dysconnectome Density



Dysconnectome Average closeness centrality



Positive correlations

Larger lesion volume

- more affected edges
- the nodes are more central

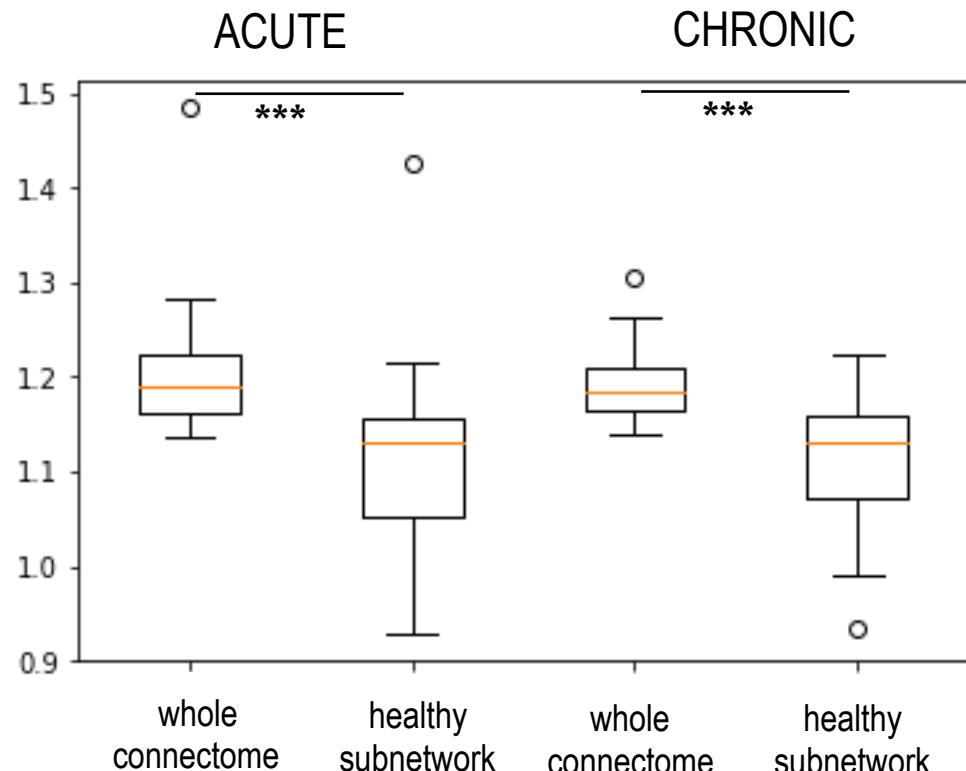
Negative correlations

Greater motor impairment

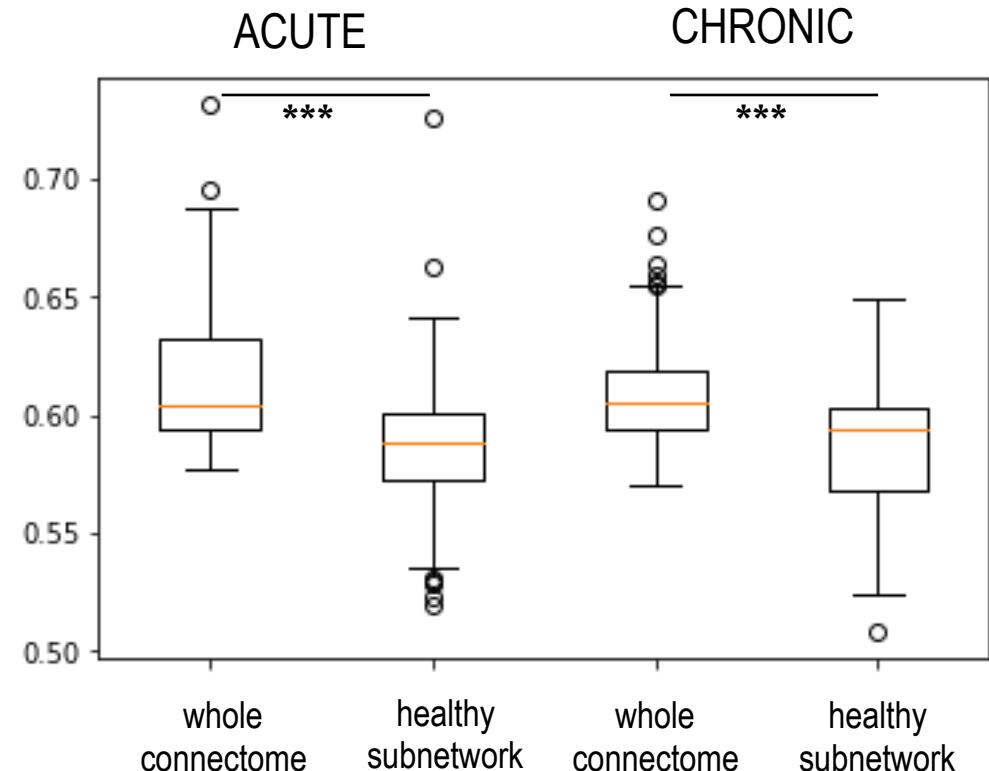


The lesion impact on the healthy connectome

SMALLWORLD INDEX

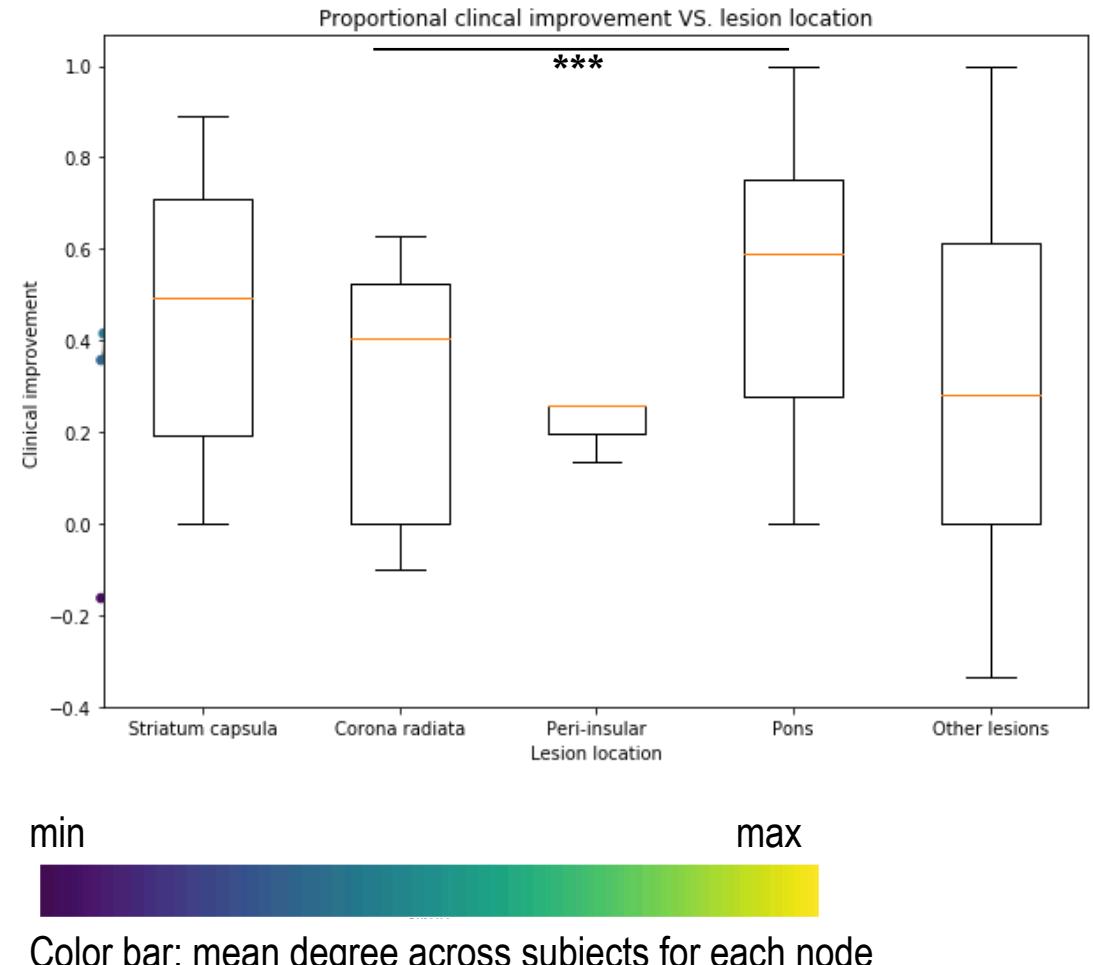


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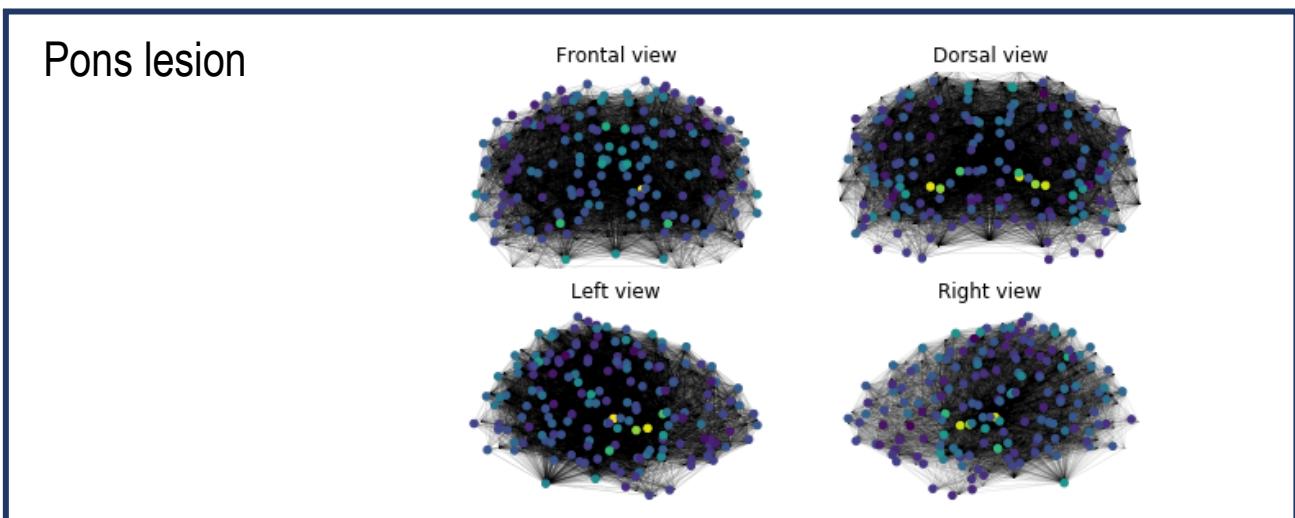
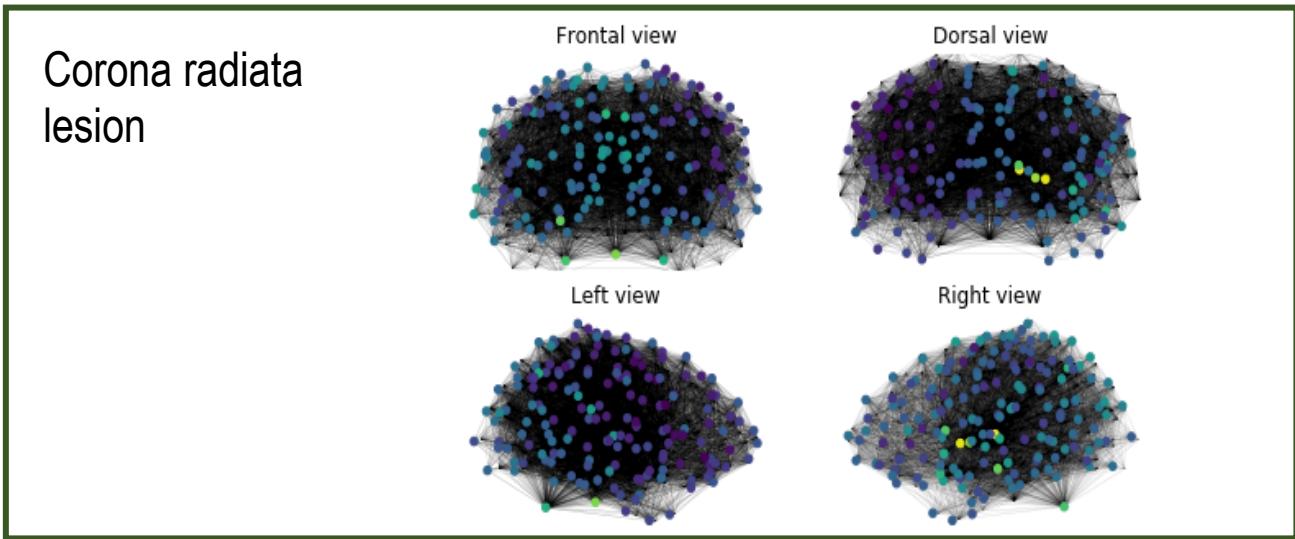


nodes in the lesion are central nodes

The lesion impact on the hubs



Healthy Subnetwork (full connectome – dysconnectome)



Discussion on longitudinal study

No significant changes were found between the acute and chronic phases

Hypothesis

- Three months might be too short to observe significant modifications in the white matter
 - **Functional connectivity might be an alternative** to investigate brain reorganisation
 - Correlation have already been found in the literature **between clinical scores and hubs of functional networks** with brain with lesions [1]

[1] Gratton et al., 2012 J Cogn Neuroscience

Conclusion and future steps

Main finding

- ✓ Correlation between structural properties (density, closeness centrality) of the dysconnectome and motor clinical score (FMA)

Future steps:

- Separate the hubs into 'Hubs of subnetworks' and 'connectors' (Hubs connecting subnetworks) [1]
- Deeper investigation on subjects with lesion in the Pons
- From brain connectome/dysconnectome to patients classification and recovery prediction

[1] Crossley et al., 2014 Brain

Questions & Answers

