The involvement of the cerebellum in structural connectome changes in episodic migraine without aura
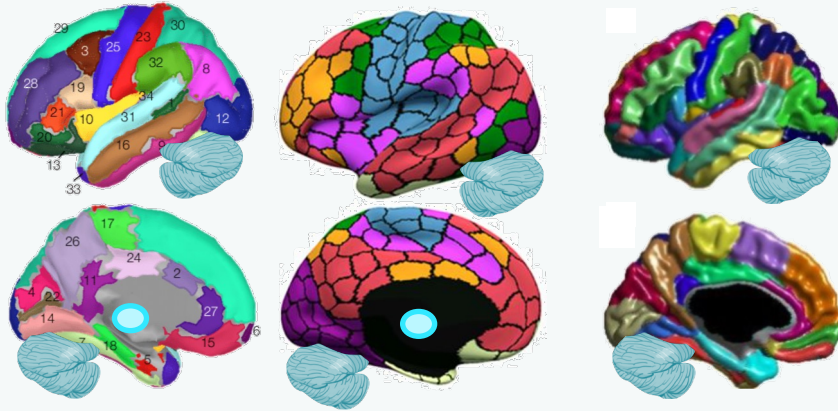
Ana Matoso*, Ana R Fouto, I. Esteves, A. Ruiz-Tagle, Gina Caetano, Nuno A. da Silva, Pedro Vilela, Raquel Gil-Gouveia, and Rita G. Nunes, Patrícia Figueiredo
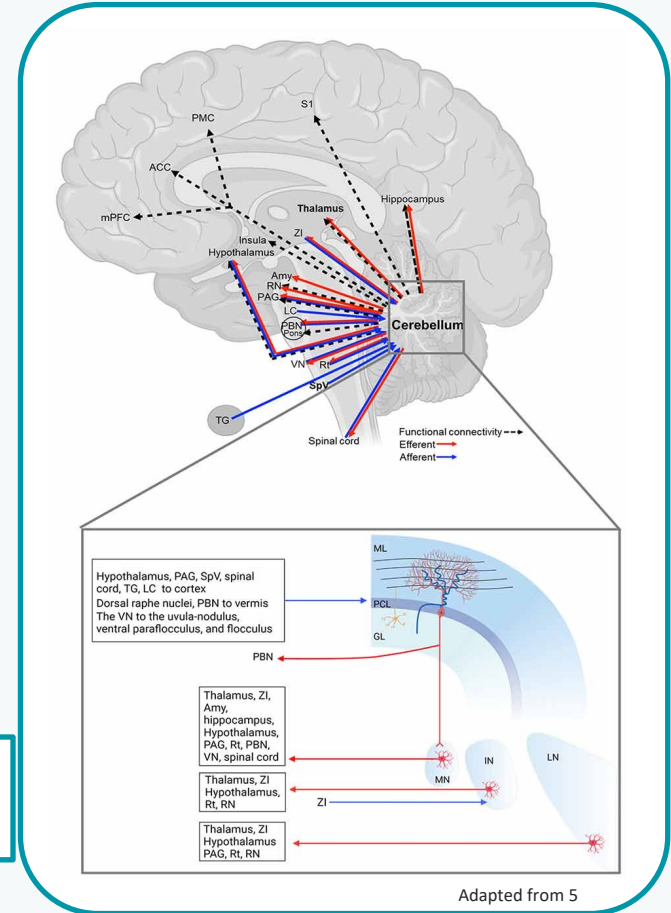
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Motivation

- Migraine ~ 17% of the population worldwide[1]

- Disruptions in functional and structural brain networks[2-4]

- Commonly used atlases: Desikan, Schaeffer, AAL90

Goal: Investigate the structural connectome changes in migraine patients, including cortical, subcortical and cerebellar regions.

Adapted from 5

1. Hoffmann, Journal of Cerebral Blood Flow and Metabolism, 2019. 2. Silvestro et al, The Journal of Headache and Pain, 2021. 3. Planchuelo-Gomez et al, Cephalgia, 2020. 4. Li et al Brain Imaging and Behaviour, 2017. 5. Wang et al, Frontiers in Systems Neuroscience, 2022
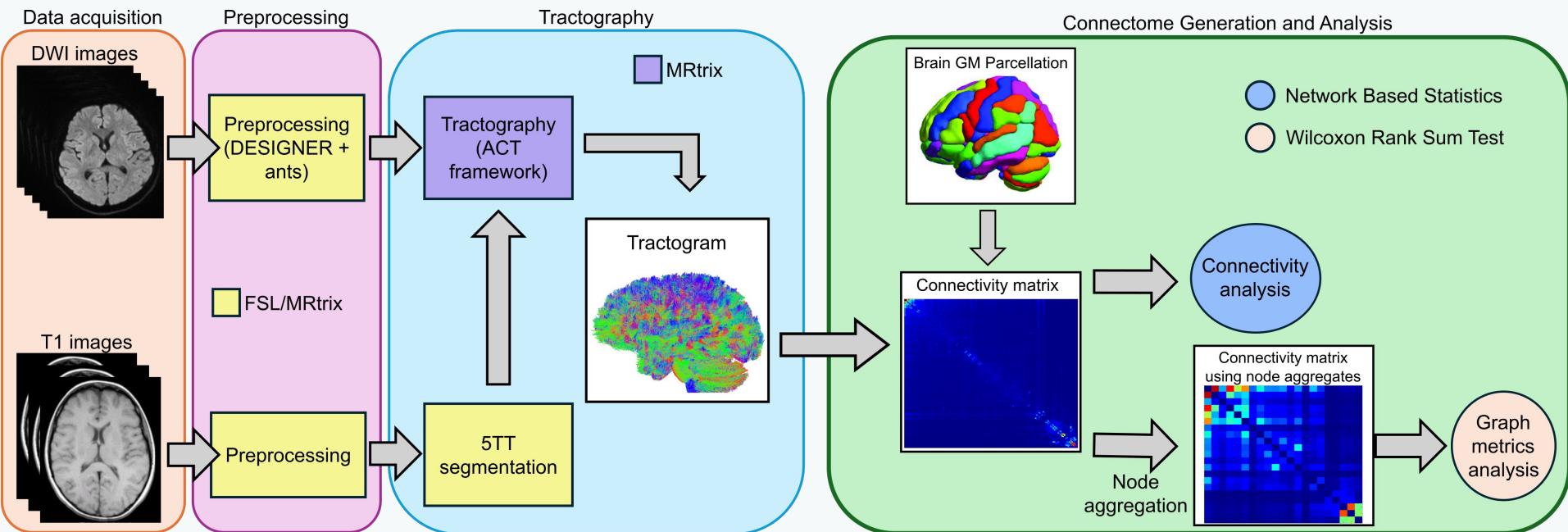
Methods

- 15 Healthy Controls

- 14 Migraine Patients (interictal phase)

Parcellations:

- Schaefer + Subcortical + Cerebellum

- AAL116

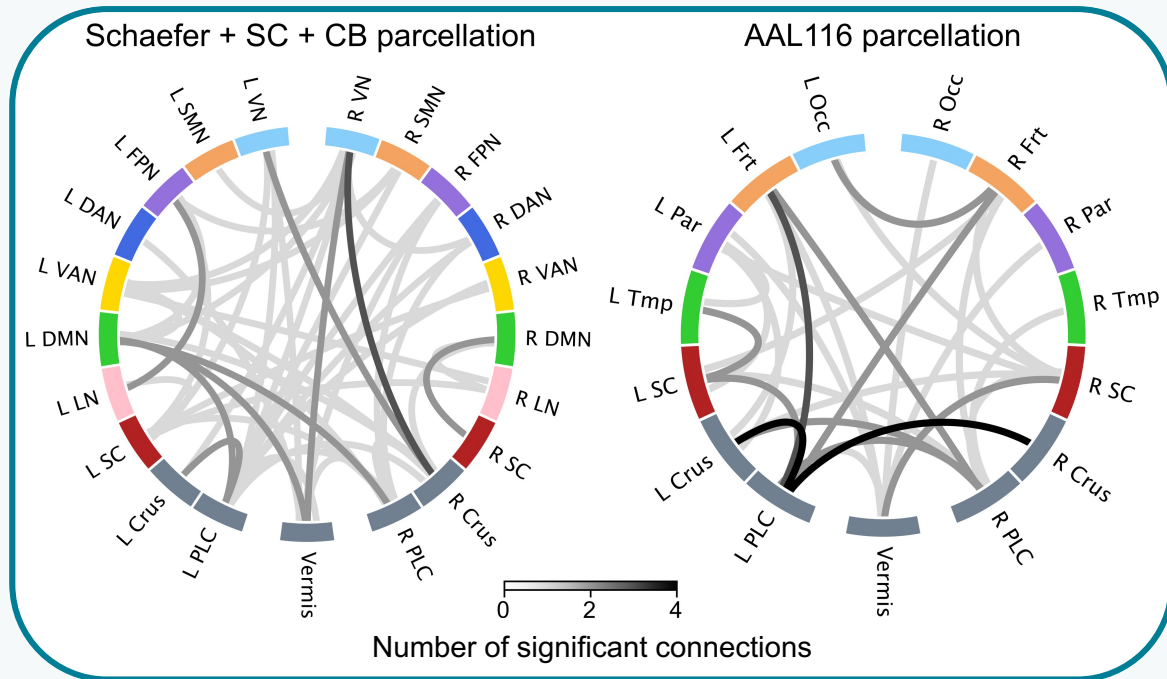# Results - Connectivity

Increased connectivity:

➢ Left Crus - Left PLC

➢ Occipital/Visual - Vermis

➢ Cerebellum - Frontal and Parietal

➢ Similar patterns across parcellations

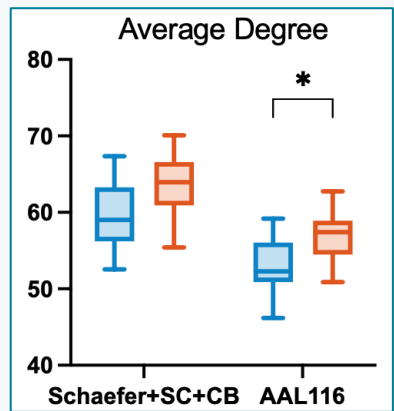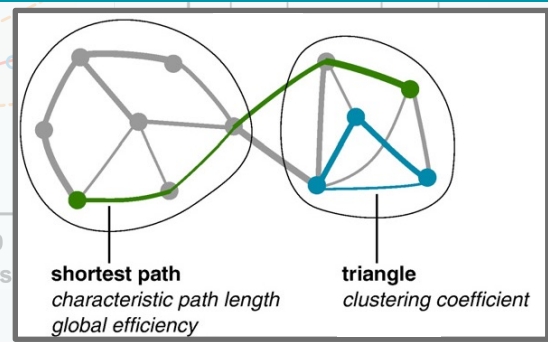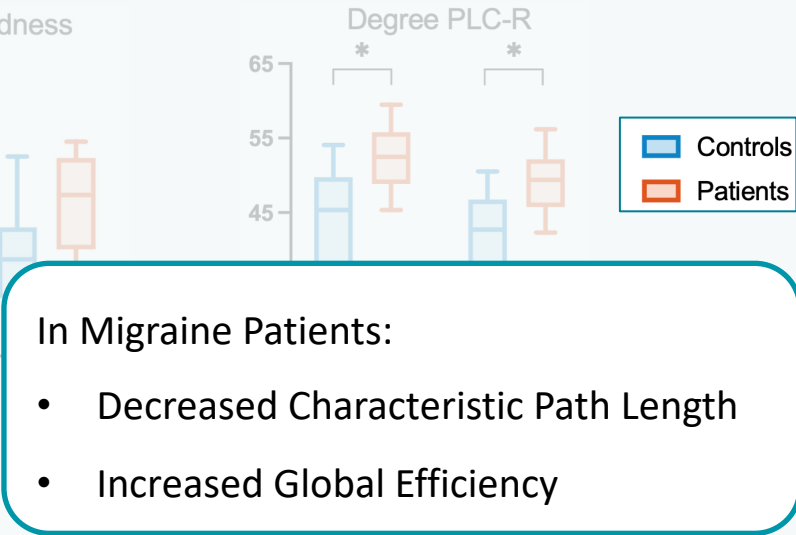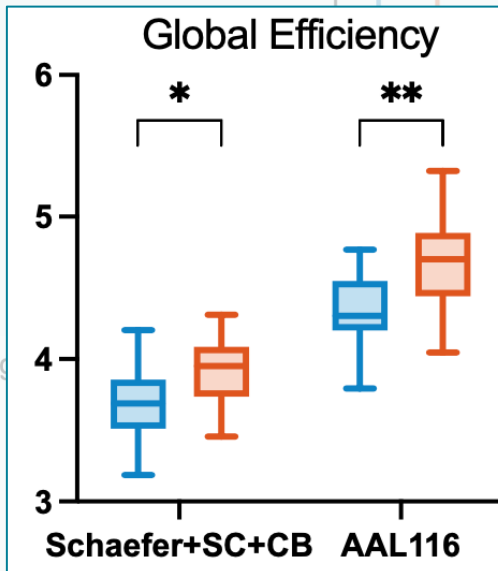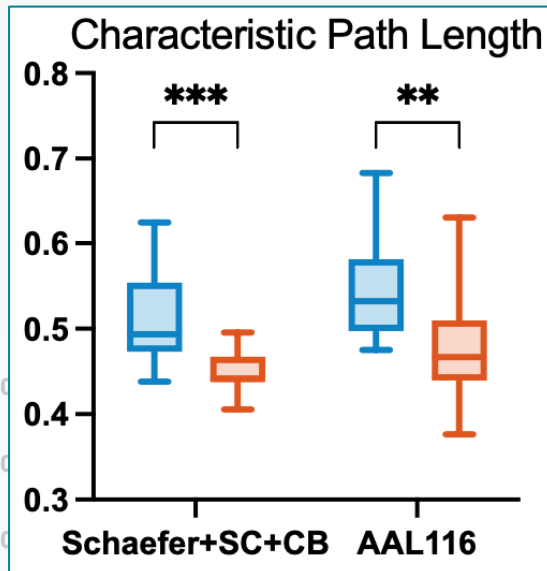Migraine Patients > Healthy Patients
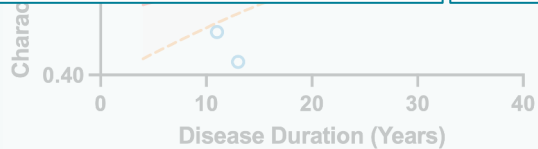
Schaefer + SC + CB parcellation   AAL116 parcellation

Number of significant connections
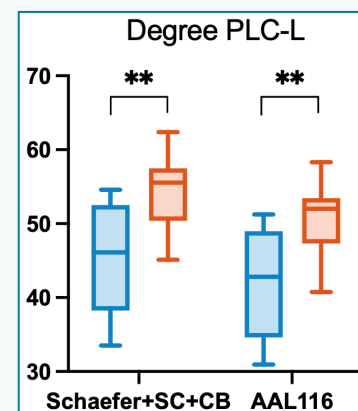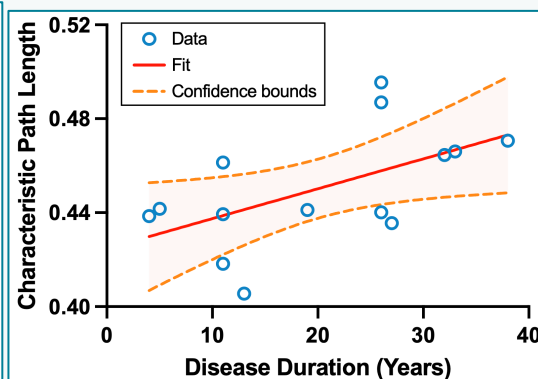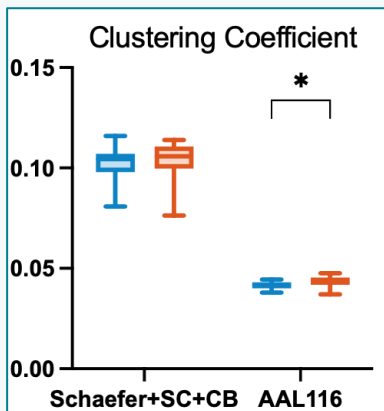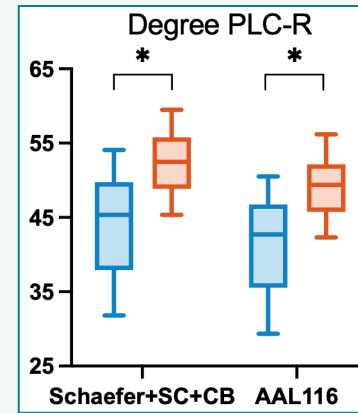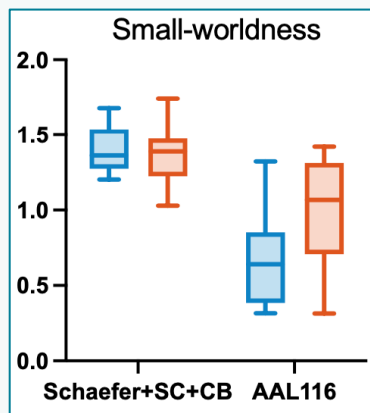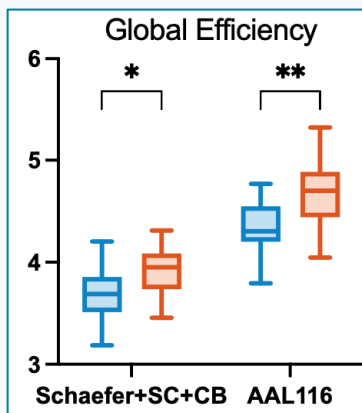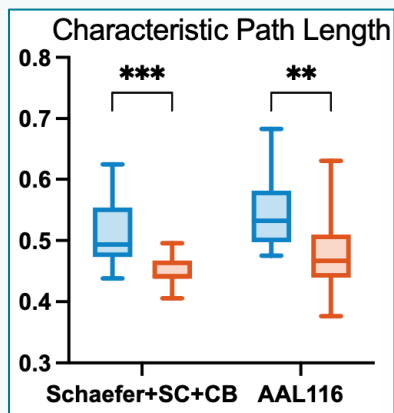
Results – Graph Metrics

Results – Graph Metrics

In Migraine Patients:

- Decreased Characteristic Path Length

- Increased Global Efficiency

Results – Graph Metrics

Node degree of Posterior Lobe of the Cerebellum increased in patients bilaterally

Results – Graph Metrics

Characteristic Path Length
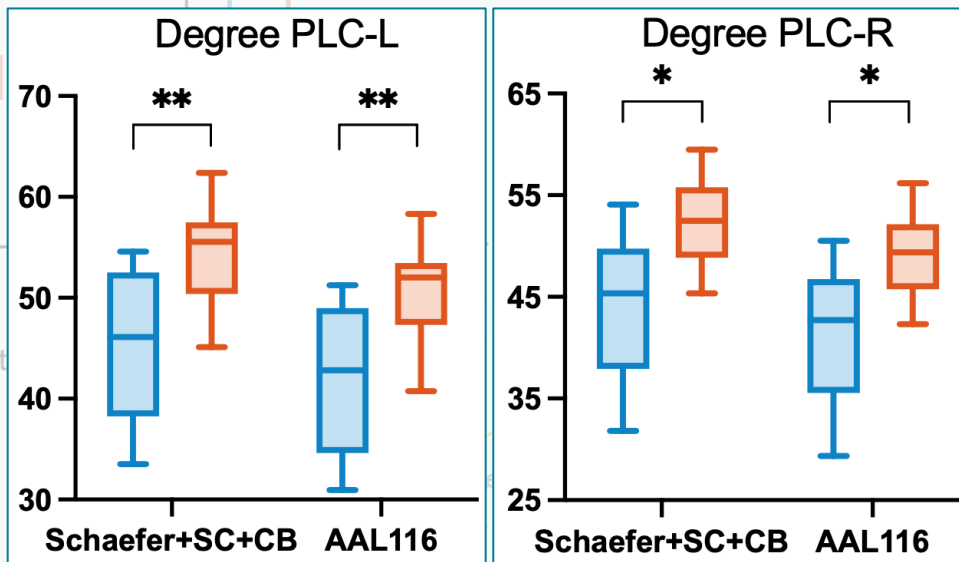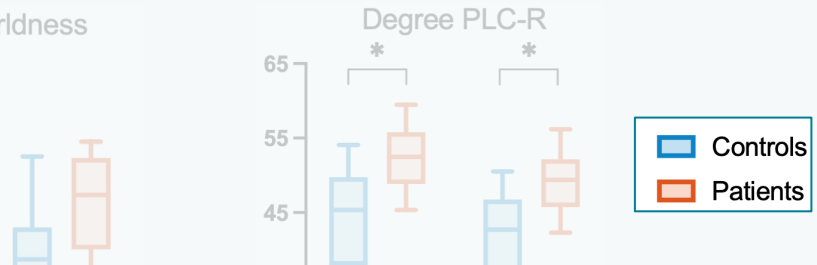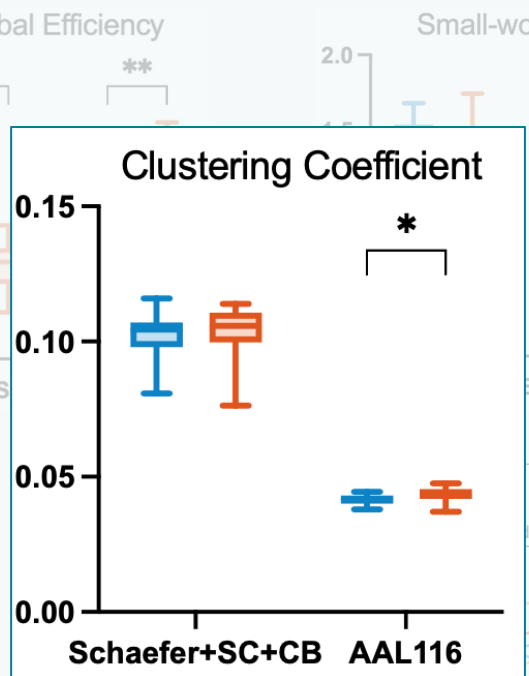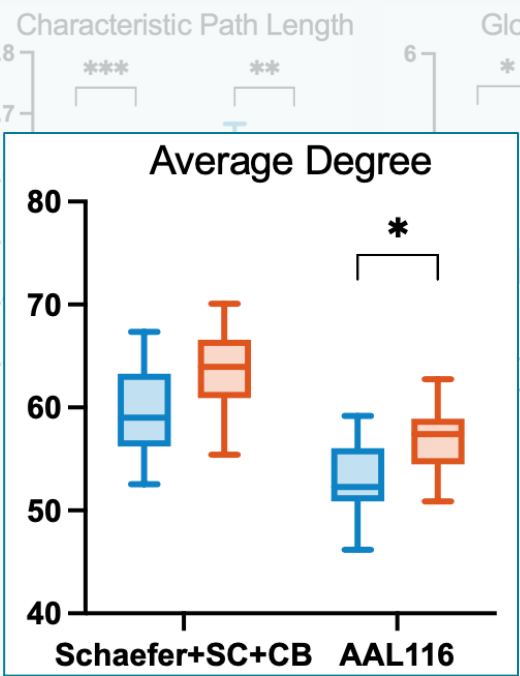
Global Efficiency

Small-worldness

Degree PLC-R

Average Degree

Clustering Coefficient
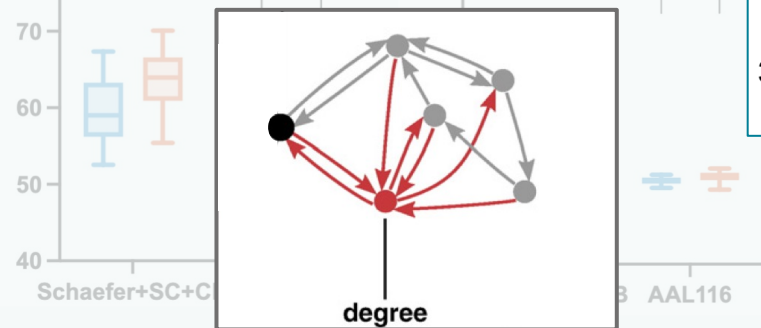
Controls
Patients

When using AAL116:

- Average Degree and Clustering Coefficient are increased in patients

shortest path
characteristic path length
global efficiency

triangle
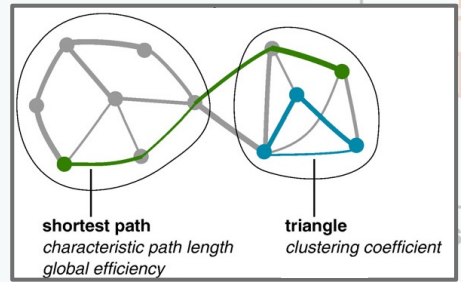*clustering coefficient*

degree
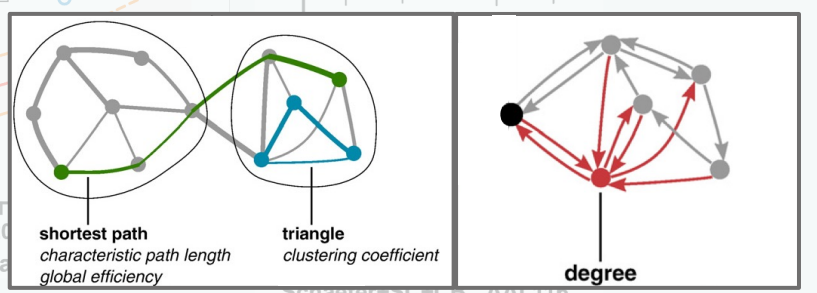
Results – Graph Metrics
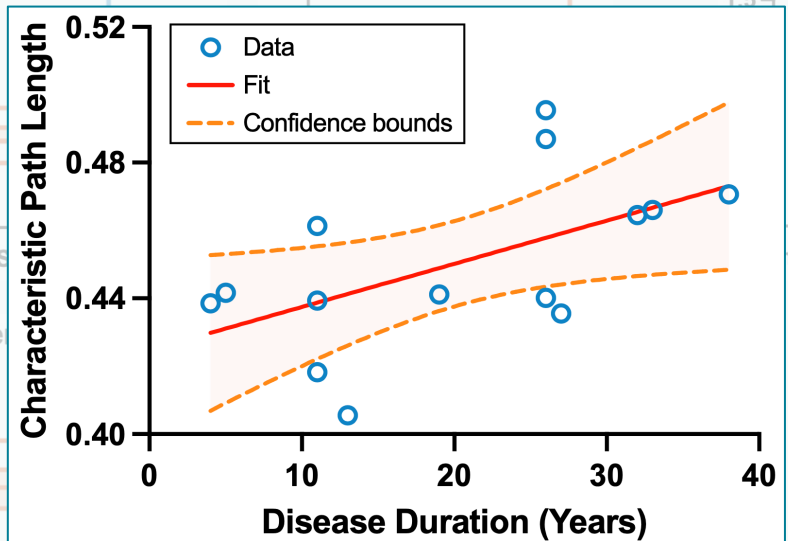
Positive correlation:

- Characteristic Path Length and Disease Duration
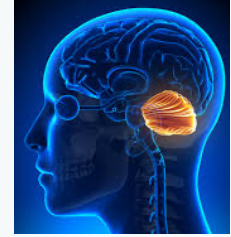- R=0.56
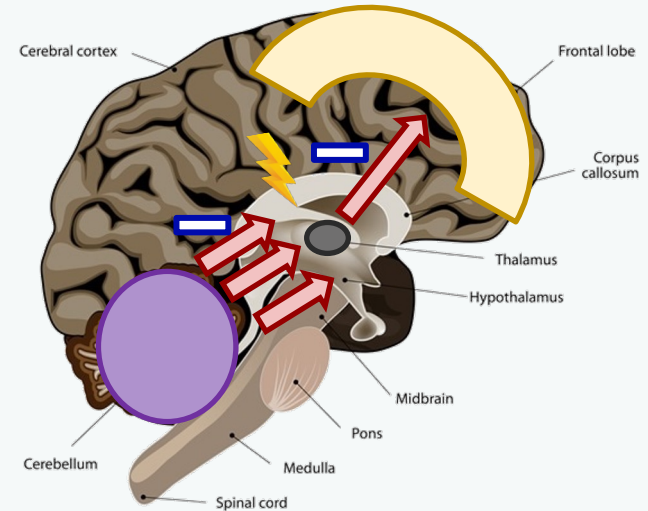- p=0.038

Discussion

- Structural connectivity disruptions in the cerebellum

  ➥ Consistent between parcellations

- Inhibitory role in pain processing through thalamus

  ➥ Dysfunctional negative feedback loop

- The crus is involved in cognitive functions

  ➥ Cognitive deficits common in migraine

Cerebral cortex — Frontal lobe — Corpus callosum — Thalamus — Hypothalamus — Midbrain — Pons — Cerebellum — Medulla — Spinal cord
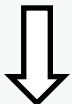
Discussion

Global Efficiency

Characteristic Path Length

Increased pain information dissemination

Characteristic Path Length

Disease Duration

Plastic Adaptation

Conclusion

⇨ **Take-home message 1**: The structural connectome of migraine patients is shown to be altered, having an increased integration that may be associated with heightened pain information dissemination.

⇨ **Take-home message 2**: The cerebellum is shown to play an importante role in migraine pathophysiology and should therefore be included in connectome studies.
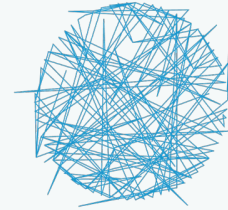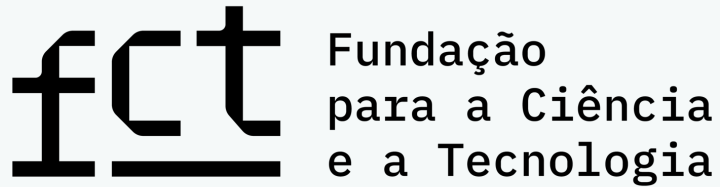
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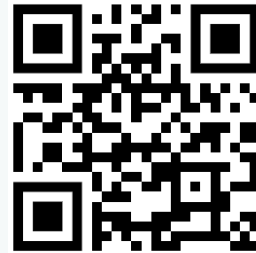
Acknowledgements

This work was supported by:

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