Exploring the Interplay Between Brain Structural and Functional Connectivity in Alzheimer's Disease: A Multivariate Approach

Edoardo Paolini[a], Virginia Filippi[b], Federica Cruciani[b], Lorenza Brusini[b], Gloria Menegaz[b], Ilaria Boscolo Galazzo[b], Silvia F. Storti[b]

[a] Dept. of Computer Science, [b] Dept. of Engineering for Innovation Medicine, University of Verona, Verona, 37134, Italy

INTRODUCTION

Alzheimer's Disease (AD) leads to the **deterioration of brain tissue**, resulting in the impairment of neurological and physical functions[1].

The **correlation** between **structural (SC)** and **functional (FC) connectivity** alterations in **AD continuum** remains unclear, owing to variances in methodology and sample sizes.

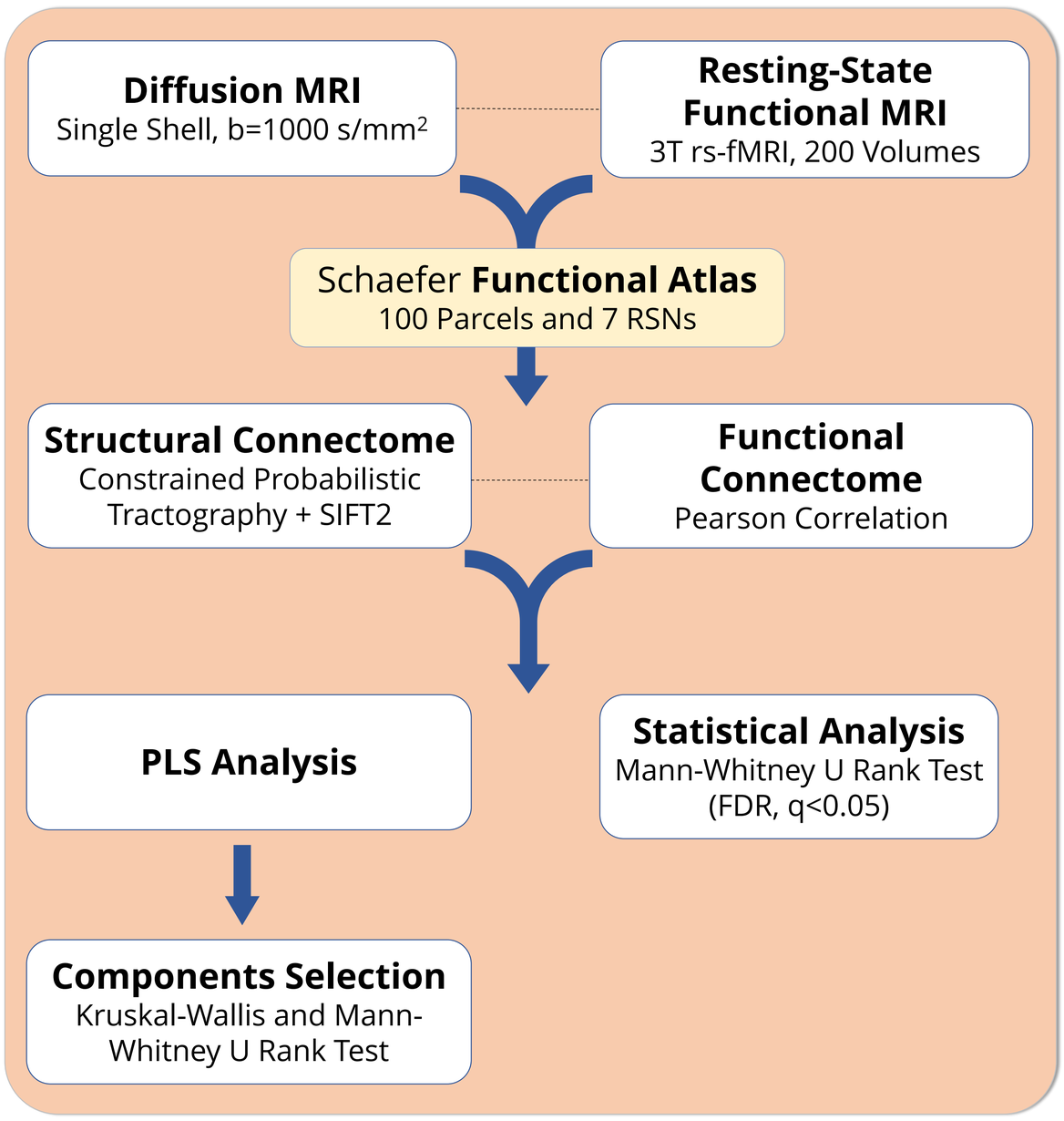
In addition to traditional statistics, **multivariate statistical approaches** are suggested to analyse the relationship between SC and FC[2].

AIM

Understand the **differences** in **SC** and **FC** of resting state networks (**RSNs**)[3] between subjects in the **AD continuum**, exploiting both **traditional statistical techniques and** a multivariate approach called Partial Least Squares (**PLS**).

MATERIALS AND METHODS

Study cohort: **570 subjects** obtained from the AD Neuroimaging Initiative (ADNI) Phase 3, divided into 245 healthy controls (**CN**), 135 early mild cognitive impairment (**EMCI**), 125 late mild cognitive impairment (**LMCI**), 65 **AD**.

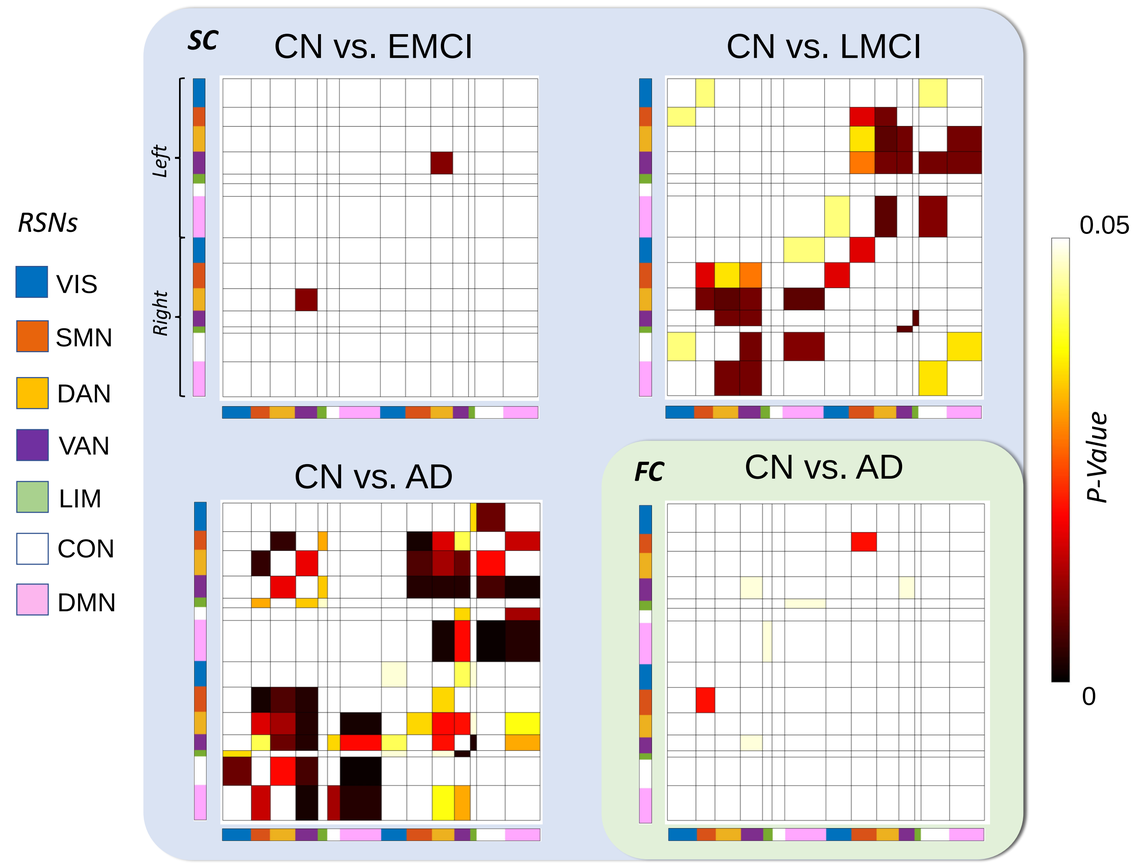


REFERENCES:

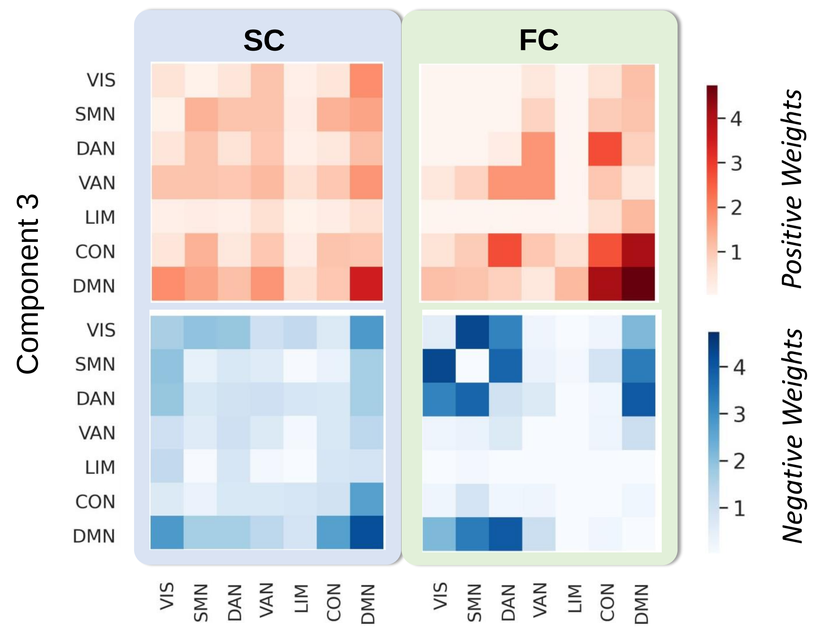
[1]C. Qiu et al., *Dialogues in clinical neuroscience*, vol. 11, no. 2, pp. 111–28, 2009.
[2]B. Mišic´ et al., *Cerebral Cortex*, vol. 26, no. 7, pp. 3285–96, 2016.
[3]A. Schaefer et al., *Cerebral Cortex*, vol. 28, no. 9, pp. 3095–14, 2018.
[4]K. Mevel et al., *Int. Journal of Alzheimer's Disease*, vol. 2011, 2011

RESULTS

Mann-Whitney U Rank Test on original data showed:
- In FC few alterations between CN and AC.
- **In SC** a gradual increase in **differences** between CN and the various stages of impairment.



In **PLS** analysis components 3, 9, 10, and 26 exhibited statistical differences. For example, **Component 3** seems to show a slight correlation between positive weights, but a more pronounced **anticorrelation** between positive FC and negative SC weights in DMN.



The figure displays Component 3, specifically the percentage of connections with **weights above the 85th percentile** that positively (red squares) or negatively (blue squares) impact each pair of RSNs.

CONCLUSION

- While traditional statistical analysis effectively **captures** the progression of **SC deterioration**, it **fails** in establishing a clear **one-to-one** correspondence between **FC** and **SC** communities.
- PLS analysis revealed an **interconnection** between **SC** and **FC**, therefore it can **offer valuable insights** into this interplay among AD stages. **DMN**, which has gathered attention in AD research[4], is involved in an interesting anticorrelation between SC and FC.
- Functional-structural network coupling shows **potential as a biomarker** for monitoring AD progression.

Contact: edoardo.paolini@univr.it