

Increased Connectivity in Adolescent Depression

Using Deep Learning for Neuroimaging Insights

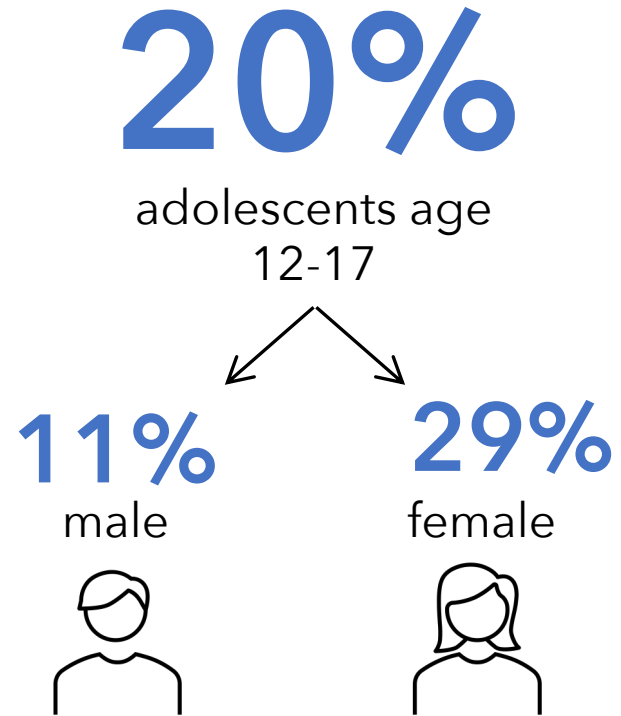
Margot Wagner, PhD

University of California San Diego and The Salk Institute

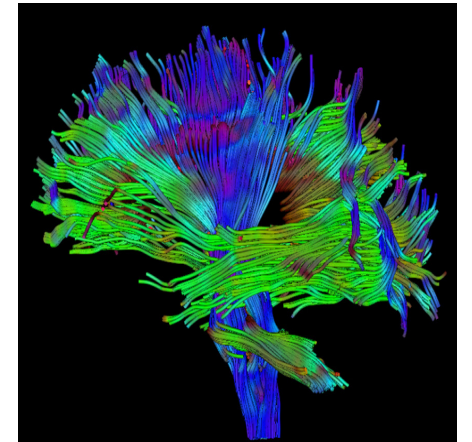
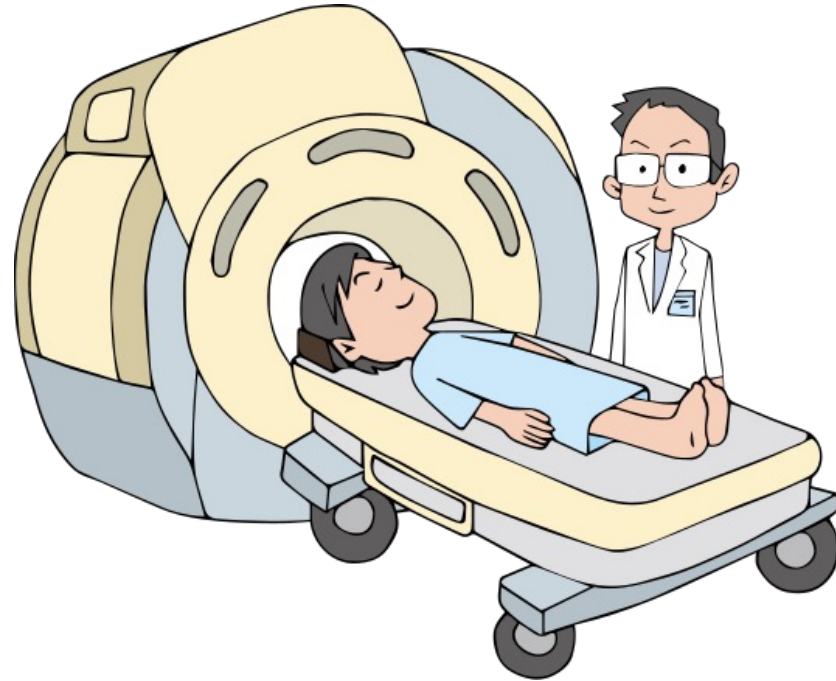
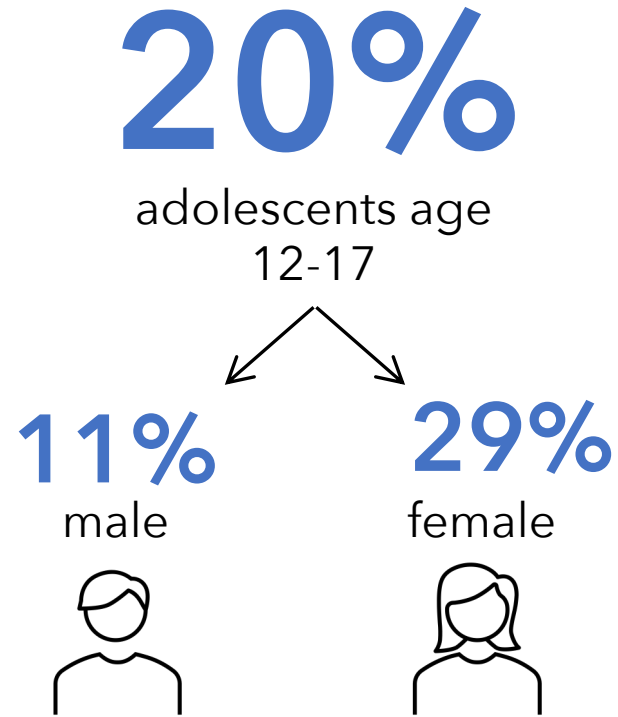
Alessandra Camassa, Yusi Chen, Brandon Liu, Terry Sejnowski

Abstract #15218

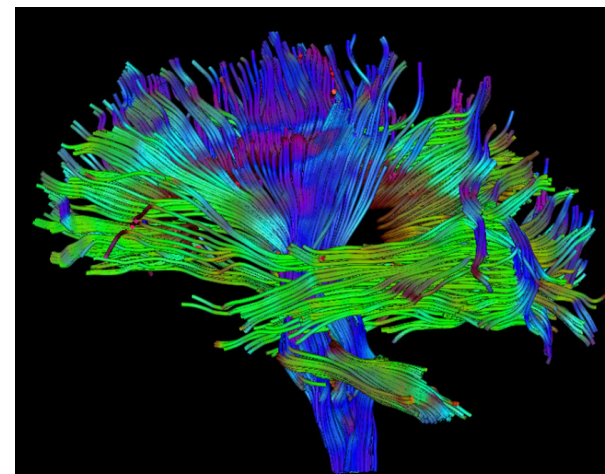
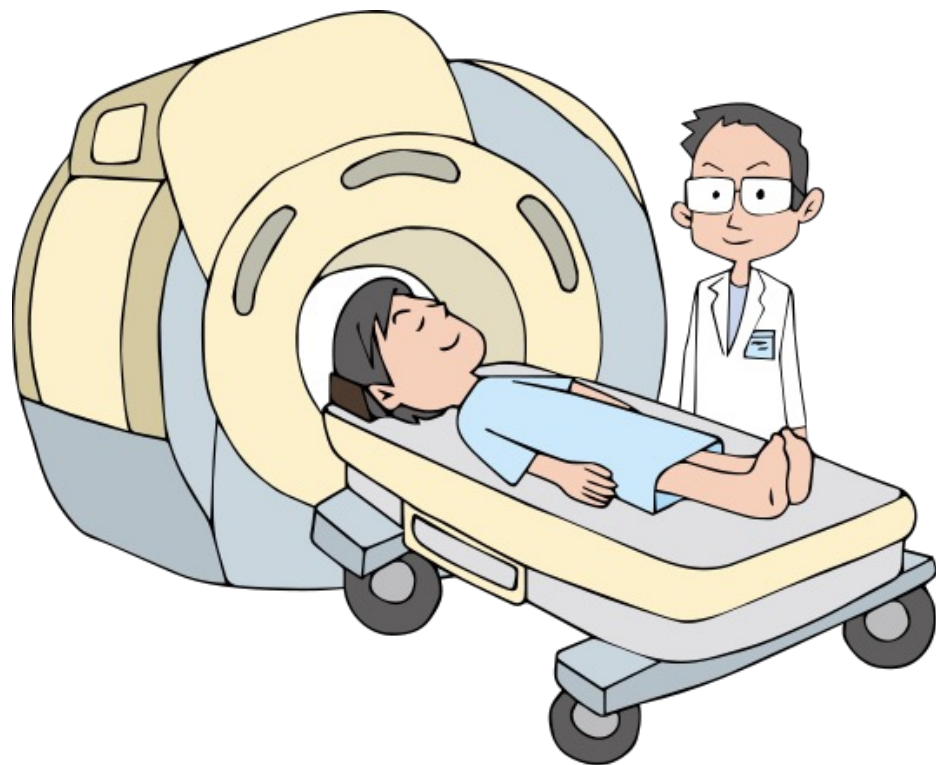
Depression is common, even in adolescents



A future where quantitative, biological tests exist for mental health too



A future where quantitative, biological tests exist for mental health too



Functional Connectivity shows promise as a quantitative biomarker

- What is FC?
- Whole brain FC
- Explain subnetworks and their purposes
- Potential images/video here

Can we identify adolescent depression using network connectivity?

9-10

subject ages

1,782

total subjects

353

depressed

1,429

control

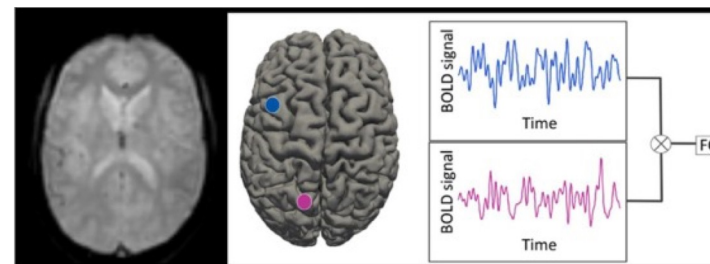
A	Achenbach
S	System of
E	Empirically
B	Based
A	Assessment

inclusion criteria and labels

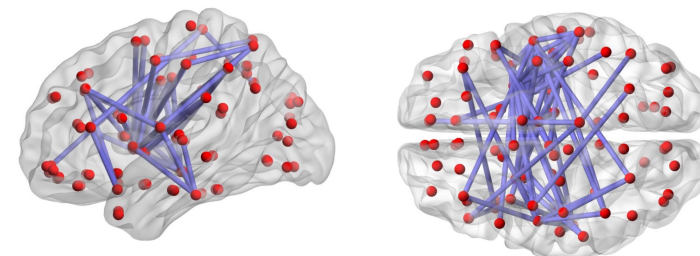


Adolescent Brain Cognitive Development

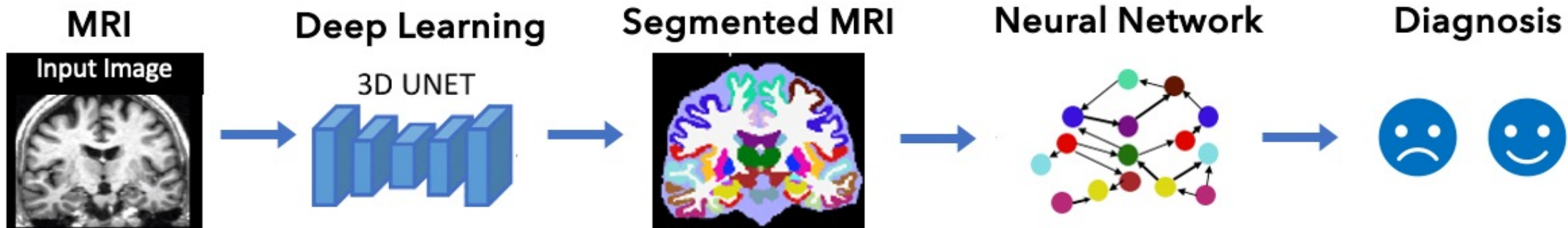
rest fMRI



network connectivity

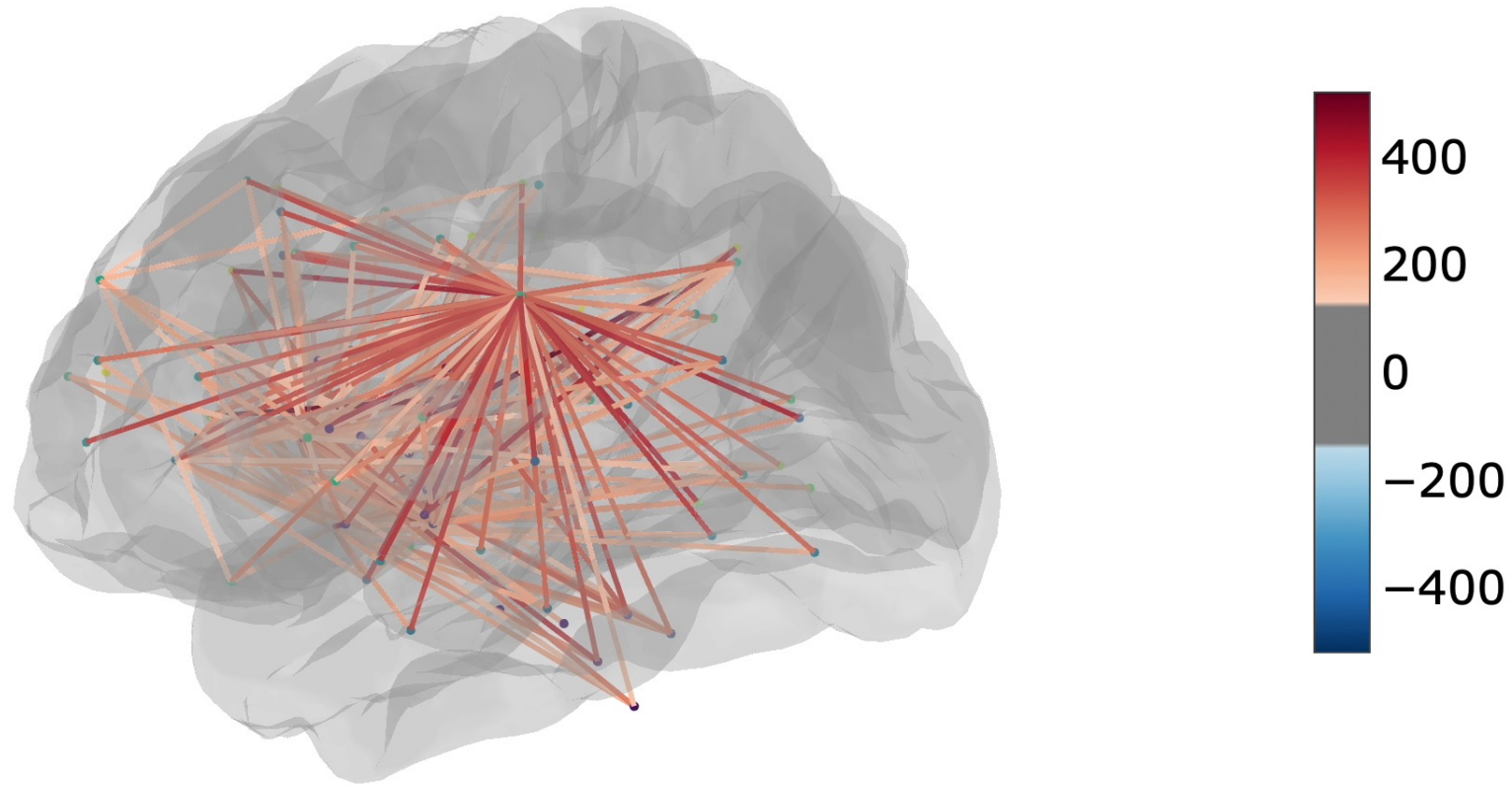


Deep learning to streamline processing of large neuroimaging studies



- Neuroimaging holds promise but analysis is often **manual** leading to small studies
- Big datasets are needed for complex problems
- **Deep learning** is an effective tool to process neuroimaging data!

There is an overall increase in network connectivity in depressed subjects



Multiple subnetworks have been implicated in depression

1. Default Mode Network (DMN)

Resting state

2. Central Executive Network (CEN)

Cognitive tasks

3. Salience Network (SN)

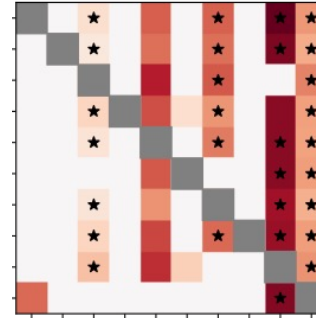
Attention, stimulus response, **DMN <-> CEN**

Largest increases within and between DMN and SN in depressed adolescents

differences

1. Default Mode Network (DMN)

Resting state

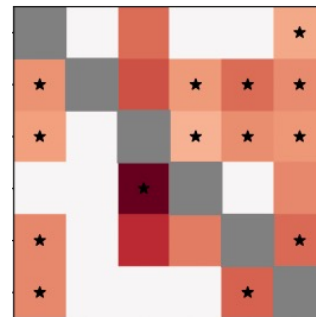


2. Central Executive Network (CEN)

Cognitive tasks

3. Salience Network (SN)

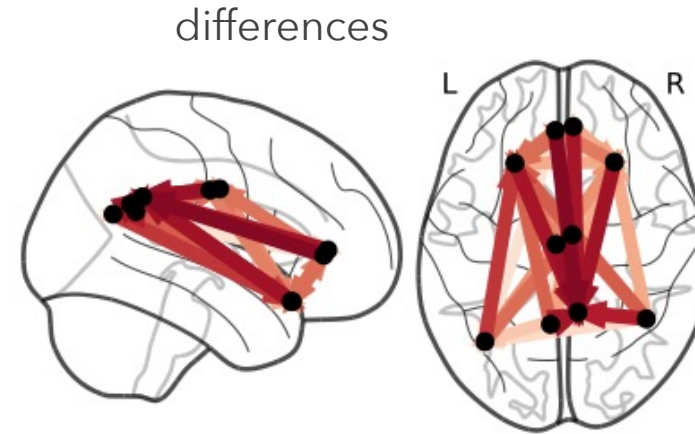
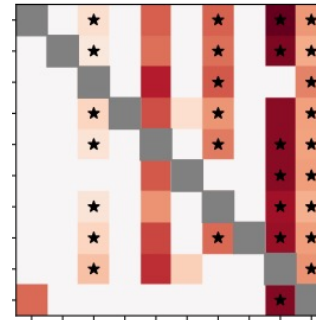
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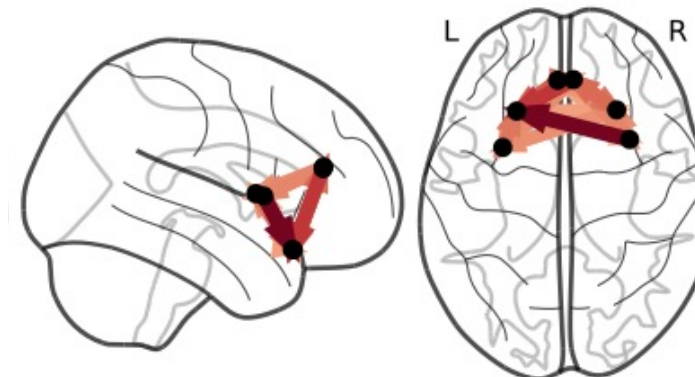
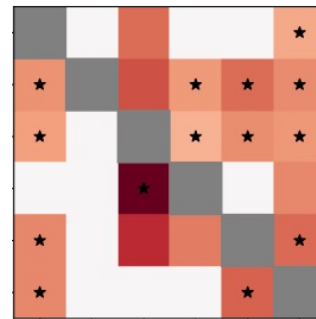
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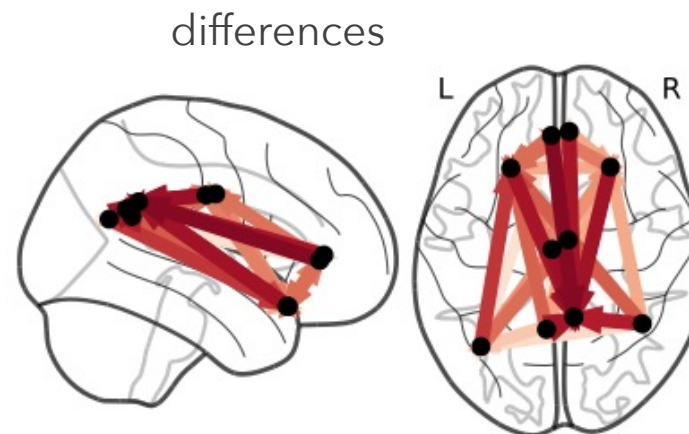
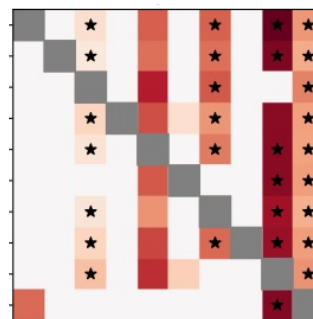
Attention, stimulus response, DMN <-> CEN



CEN saw the smallest change

1. Default Mode Network (DMN)

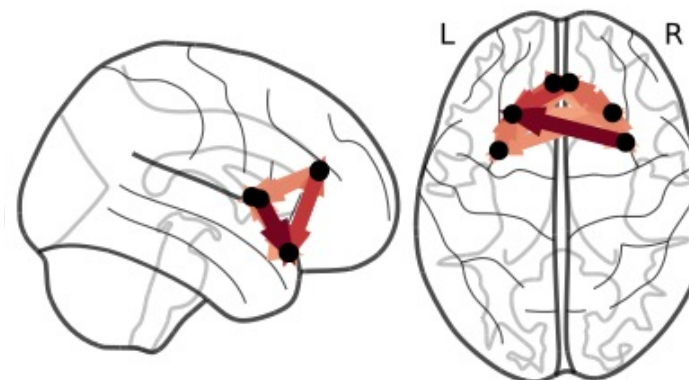
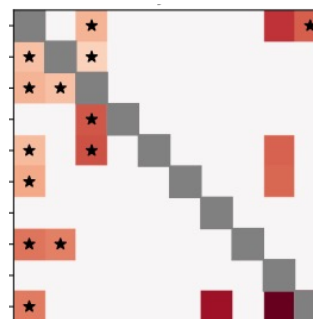
Resting state



mOFC
TP
PCC
Prec
IPL

2. Central Executive Network (CEN)

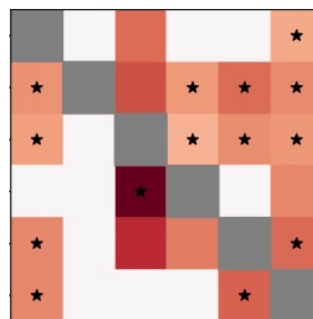
Cognitive tasks



raACC
TP
Ins

3. Salience Network (SN)

Attention, stimulus response, DMN \leftrightarrow CEN



Largest increases within and between DMN and SN in depressed adolescents

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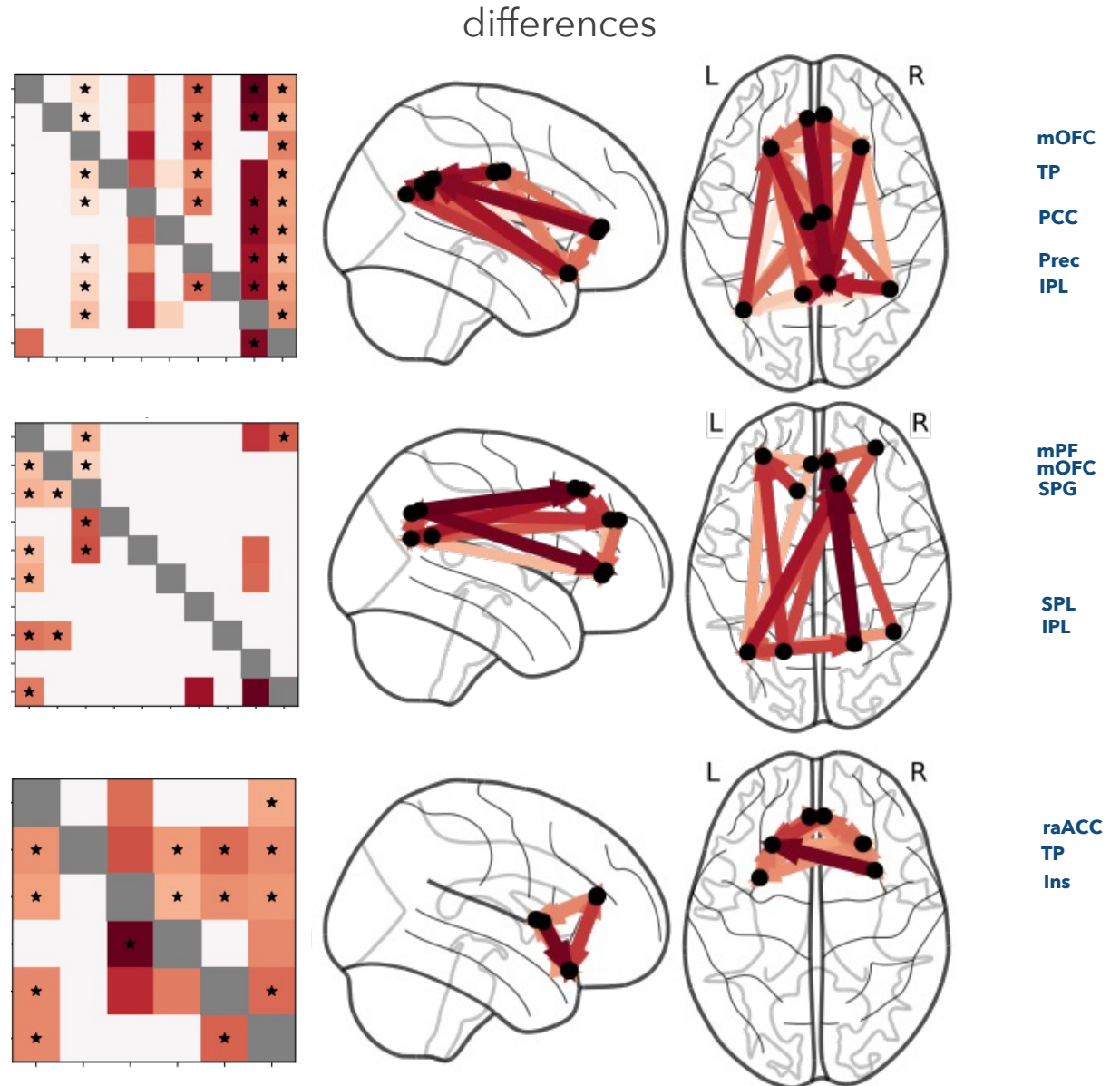
Resting state

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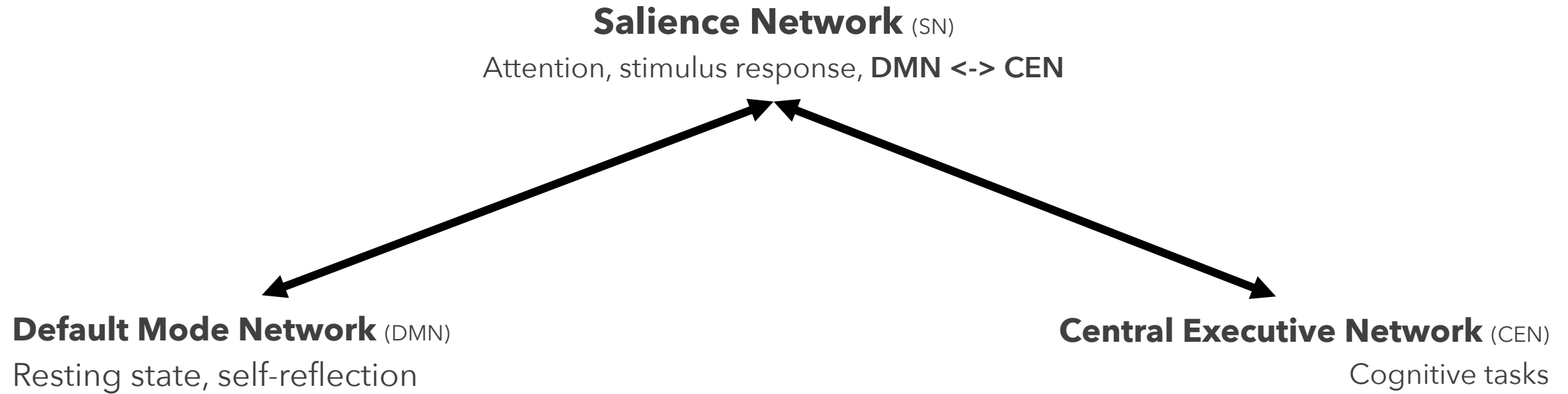
Cognitive tasks

3. Salience Network (SN)

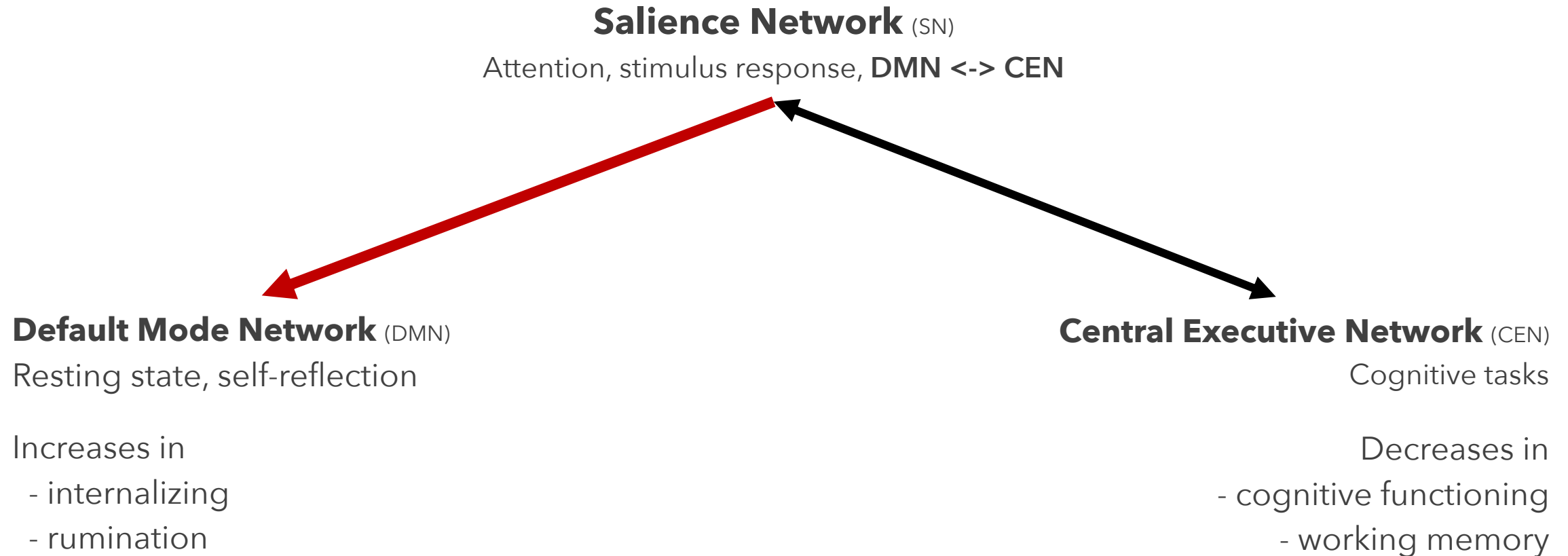
Attention, stimulus response, DMN \leftrightarrow CEN



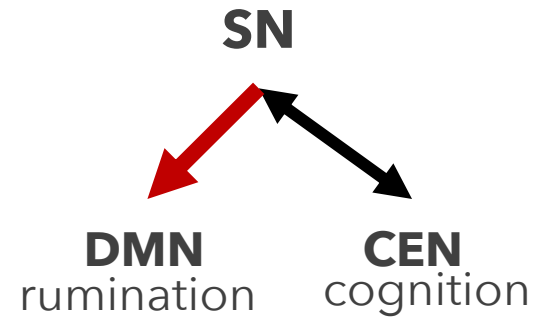
SN shows increased preference towards DMN vs CEN state in depressed adolescents



SN shows increased preference towards DMN vs CEN state in depressed adolescents



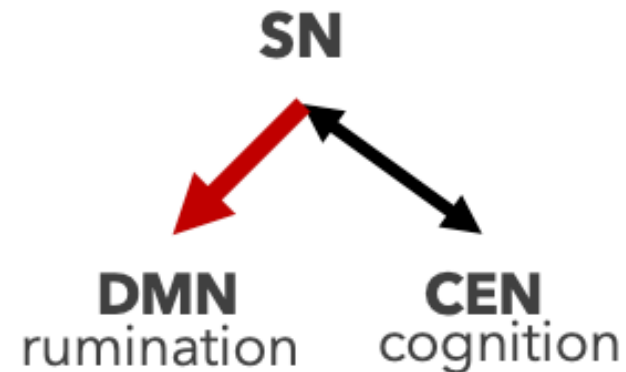
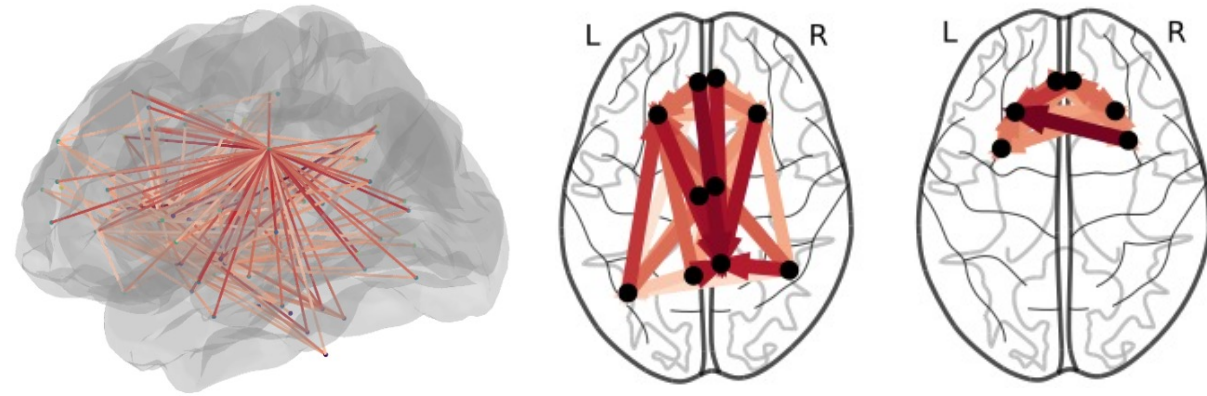
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Conclusion

- Increased connectivity
 - at the whole brain level
 - within DMN and SN
 - between DMN and SN
- Abnormal SN causes abnormal balance between DMN and CEN
- **DMN** changes related to the patient's **rumination** symptoms
- **CEN** changes related to decreased **cognitive performance** symptoms
- Biomarkers for disorder detection
- Biological basis for treatment



Acknowledgements

Computational Neurobiology Lab



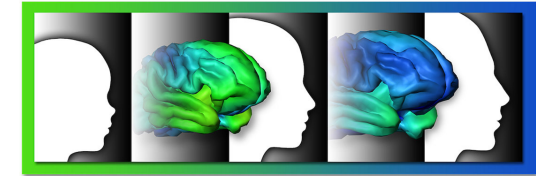
SALK INSTITUTE
FOR BIOLOGICAL STUDIES

Institute for Neural Computation



UC San Diego

Adolescent Brain Cognitive Development (ABCD) Study



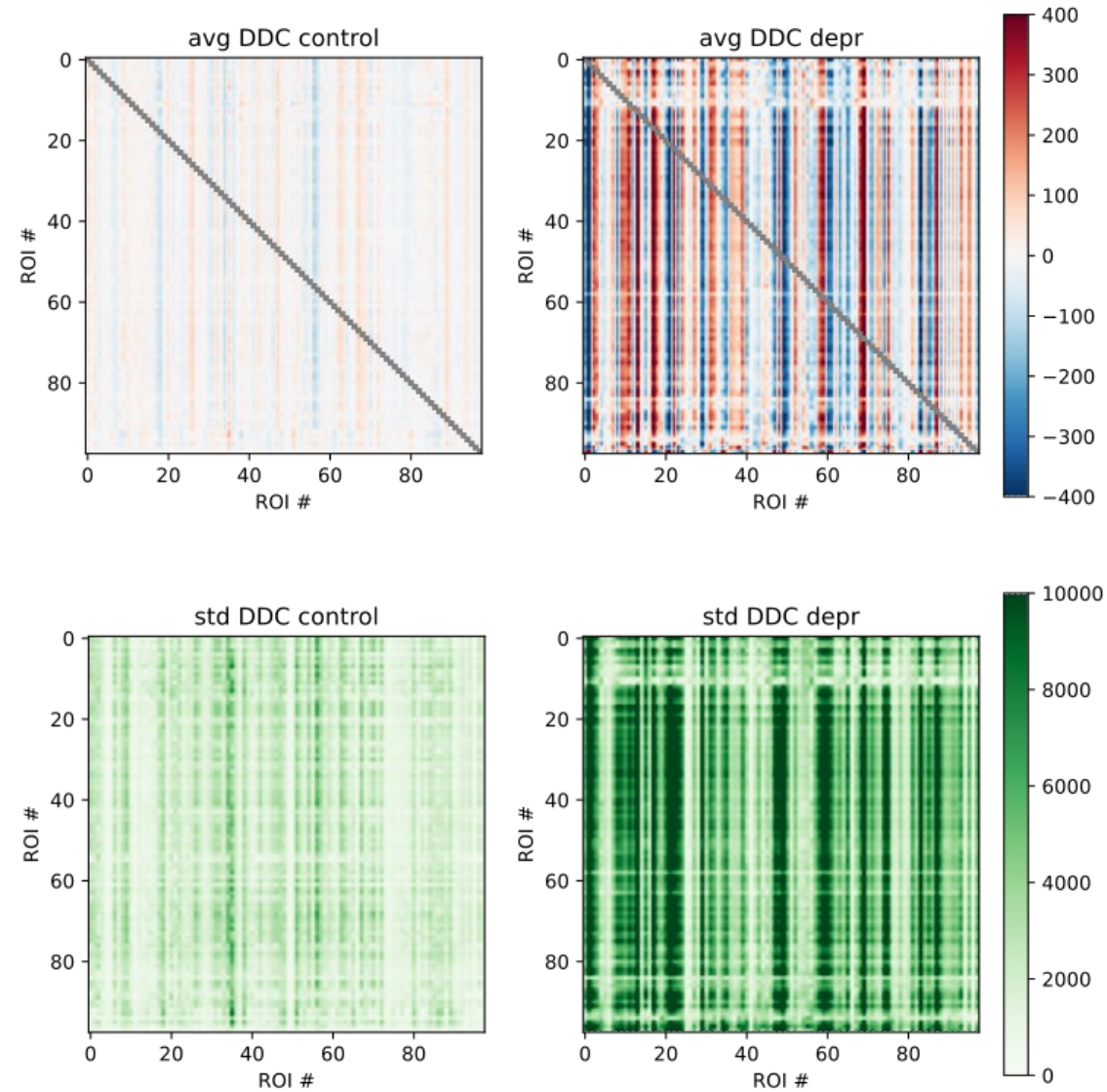
Adolescent Brain Cognitive Development®

Co-authors: Alessandra Camassa, Yusi Chen, Brandon Liu, Terry Sejnowski

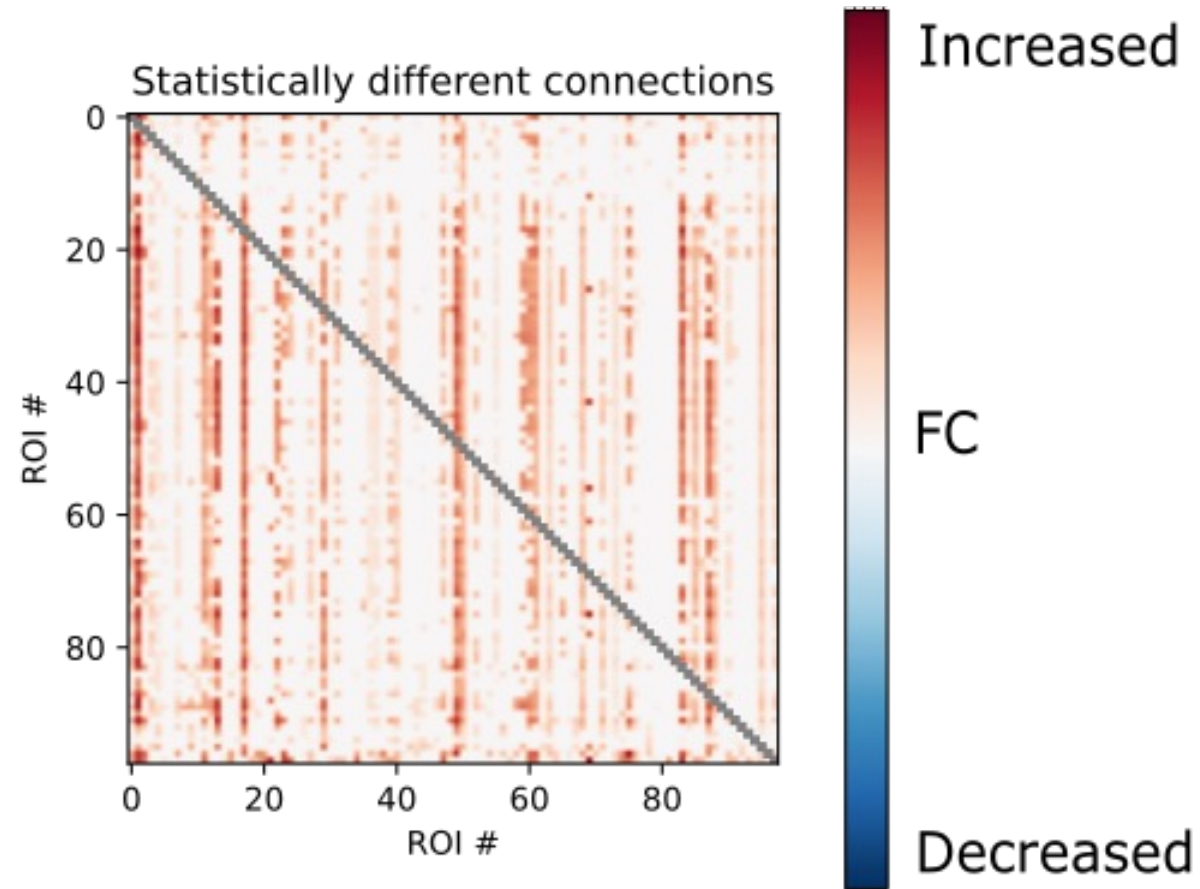


Additional Slides

Whole brain connectivity statistics

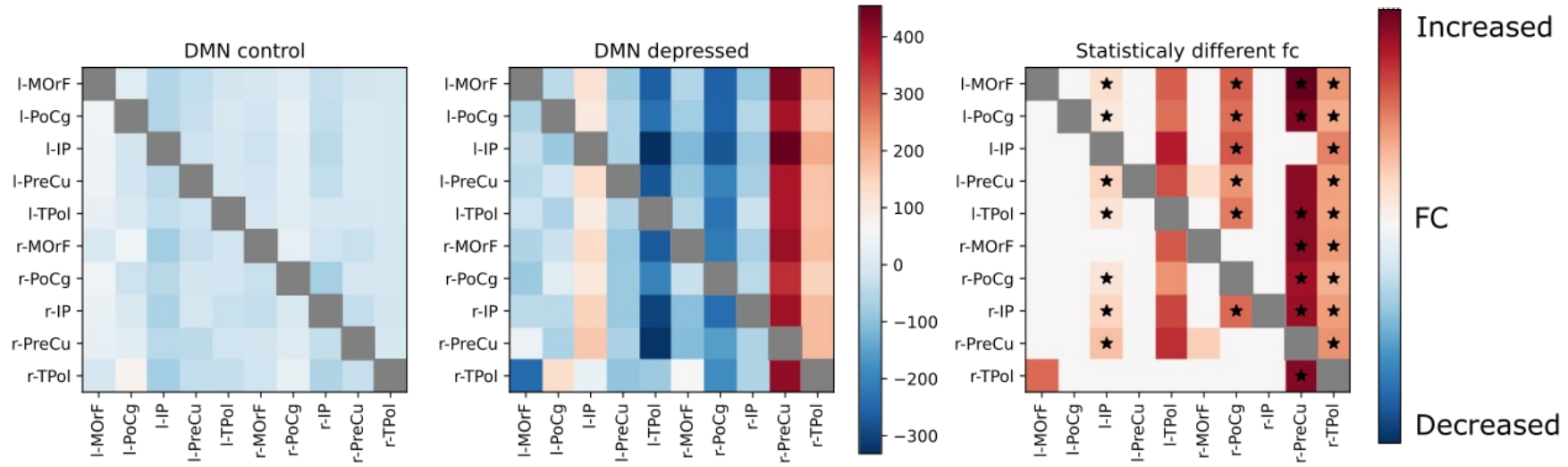


Whole brain – significant differences

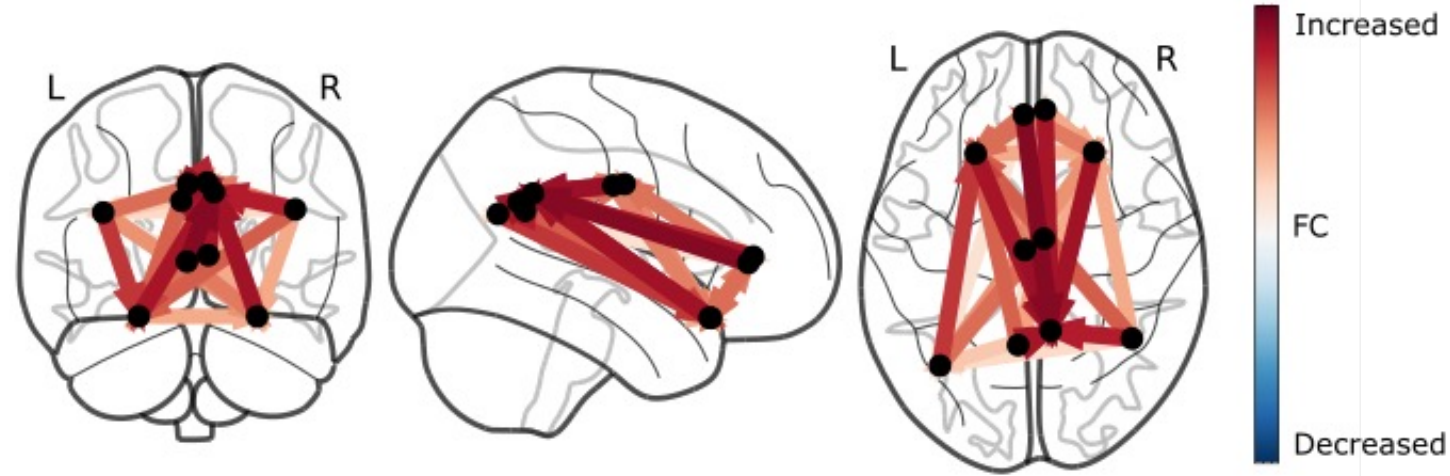




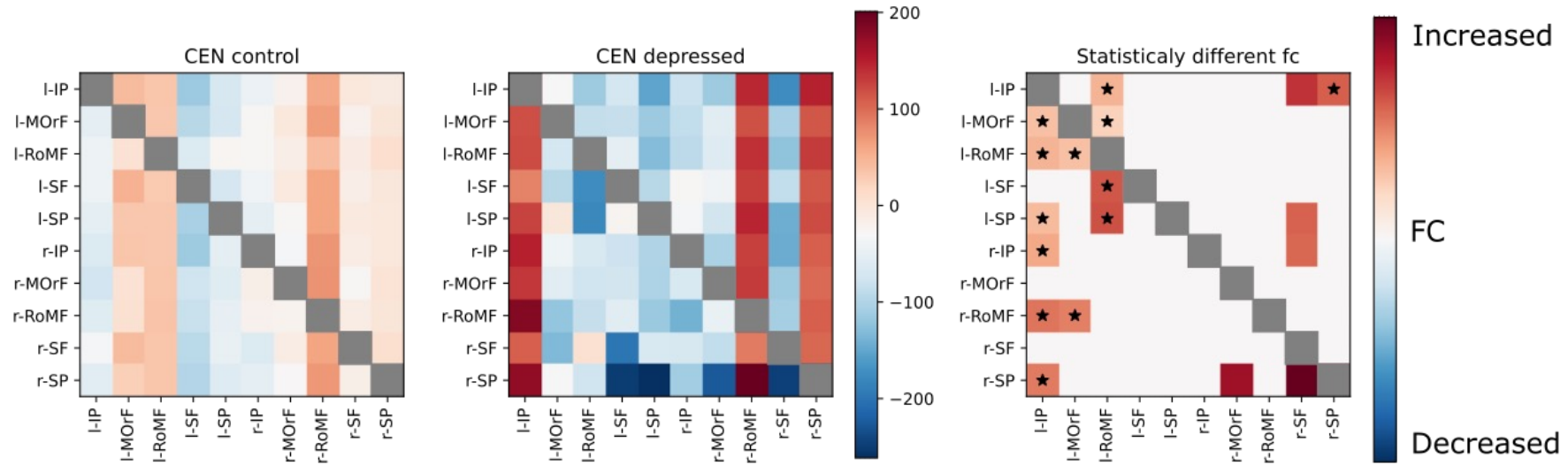
Default Mode Network



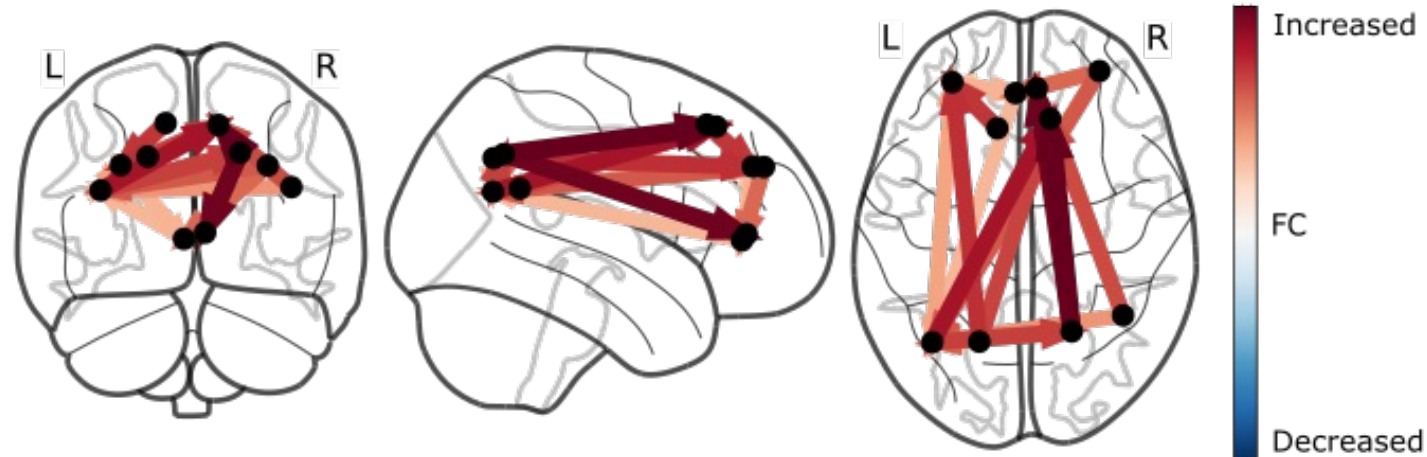
DMN



Central Executive Network

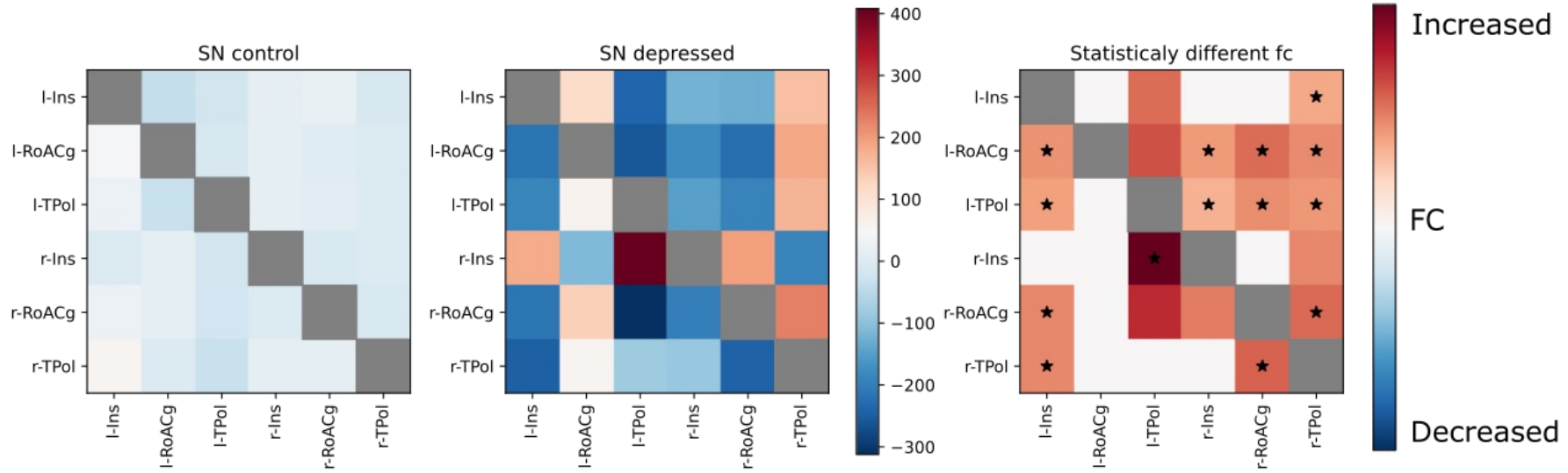


CEN

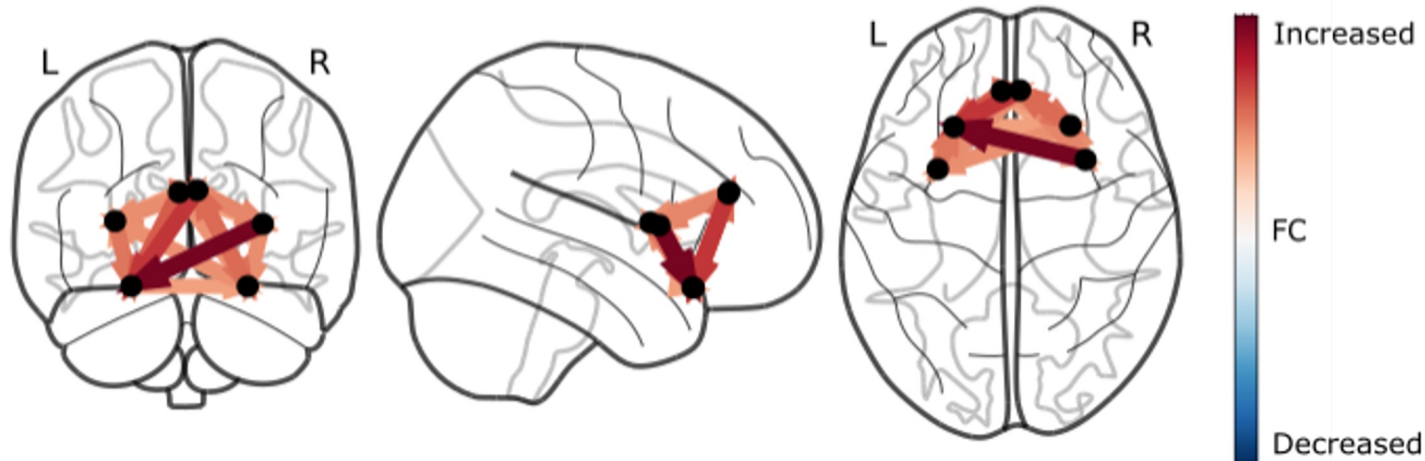




Saliency Network



SN



Altered functional neural networks in depressed adolescents

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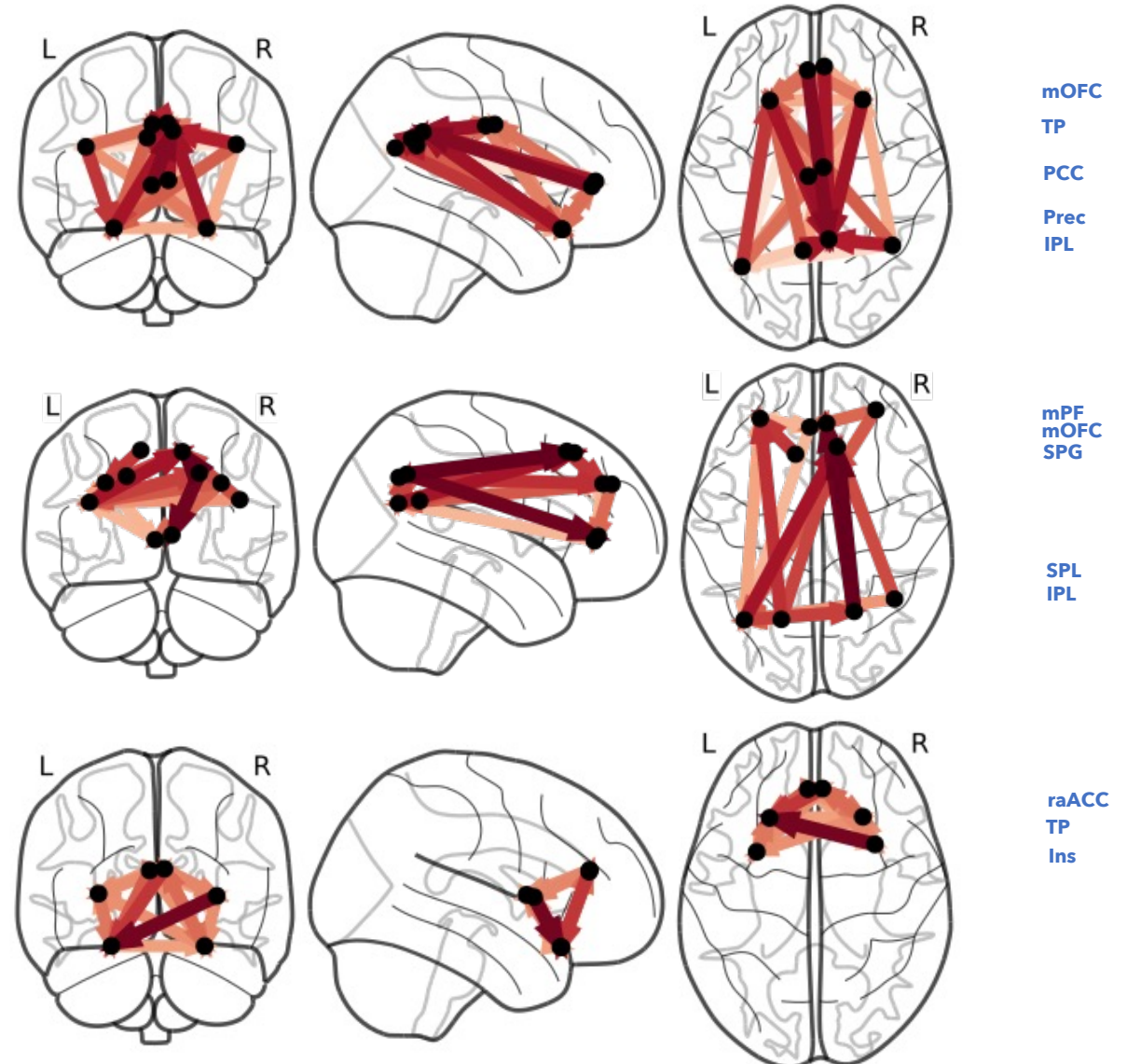
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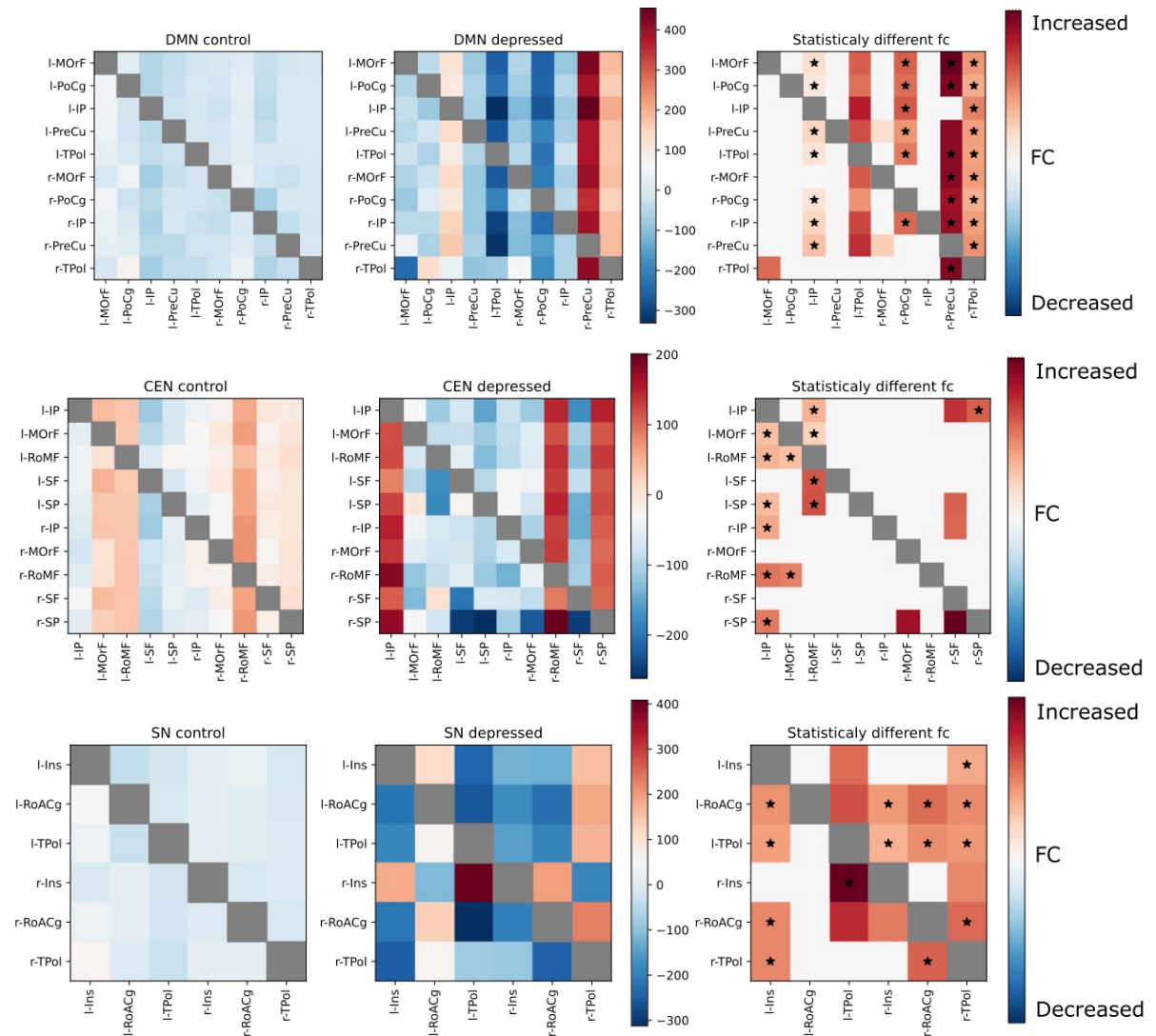
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Decrease Increase