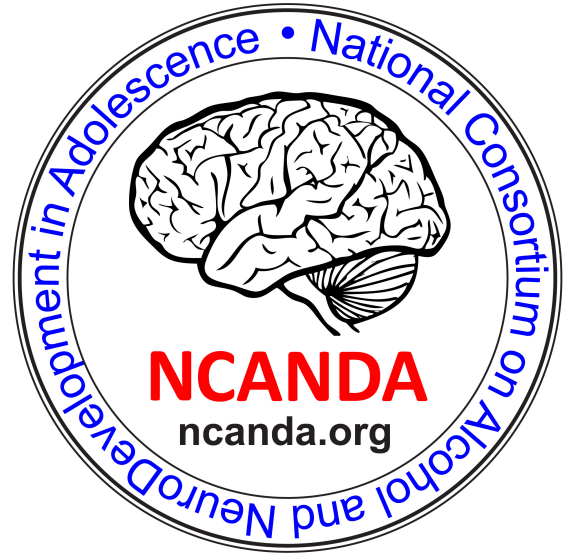
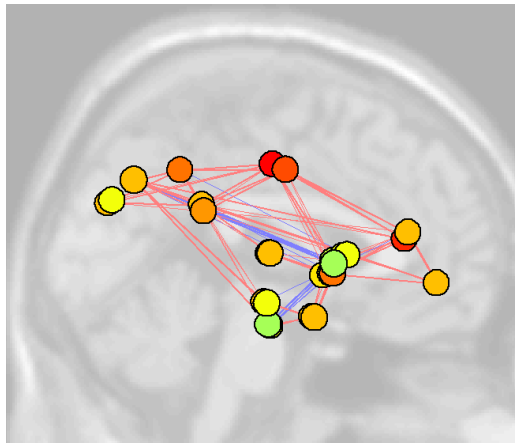


RESTING-STATE FUNCTIONAL CONNECTIVITY IN ADOLESCENCE

rs-fMRI NCANDA data analyzed by Eva M. Müller-Oehring and Daniel Cuneo

Dept. of Psychiatry & Beh. Sciences, Stanford University, Stanford, CA
Neuroscience Program, SRI International, Menlo Park, CA

Adolescents' Functional Brain Networks



The brain's communication pathways change / mature over time during adolescence.

Alcohol interferes with the brain's communication pathways.

Factors that may play a role in how functional brain networks are connected:

- Age
- Sex
- Family History of Alcoholism

Sample characteristics of the first 487

NCANDA rs-fMRI DEMOGRAPHIC DATA

Sites	Age (years)	Girls / Boys	12-13 years	14-15 years	16-17 years	18-19 years	20-21 years	FamHx Alc (n/y)	FamHx Drug	BMI
A	16.1 (2.5) 12.2 – 21.1	39 / 61	22	16	15	15	5	68 / 5	61 / 12	22.7 (5.4) 14.3 – 47.2
B	15.4 (2) 11.6 – 21.3	41 / 49	20	31	23	8	2	83 / 5	82 / 6	21.3 (4) 14.2 – 37.9
C	15.4 (2) 12.1 – 20.5	50 / 49	26	31	14	10	2	95 / 4	87 / 12	22.6 (4.6) 14 – 37.9
D	16 (2.2) 12.1 – 21.4	57 / 58	28	34	23	11	11	106 / 9	110 / 5	22.3 (4.3) 13.7 – 35.1
E	16.7 (2.3) 12 – 21.9	54 / 56	33	38	26	11	4	92 / 18	98 / 12	21.5 (4.4) 13.2 – 39.2
Total	**15.6 (2.3)** **11.6 - 21.9**	**487**	**135**	**156**	**117**	**55**	**24**	**444 / 41**	**438 / 47**	**22 (4.4)** **13.2 – 47.2**
Girls	**15.8 (2.3)** **11.6 – 21.9**	**241**	**66**	**72**	**60**	**31**	**12**	**215 / 21**	**220 / 21**	**22.2 (4.3)** **14 – 39.2**
Boys	**15.5 (2.2)** **12 – 21.5**	**246**	**69**	**84**	**57**	**24**	**12**	**229 / 15**	**218 / 26**	**21.9 (4.6)** **13.2 – 47.2**
P	***n.s.***	***n.s.*[1]**						***.069*[1]**	***n.s.*[1]**	***n.s.***

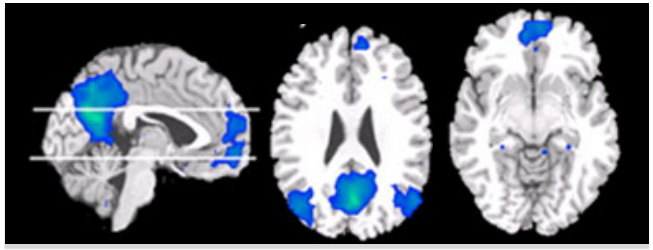
It takes 2 to 3 days for running this number of subjects after everything is set-up and no error messages occur!

Between group *t*-tests; [1]Chi square; significance level was set at $p < 0.05$, 2-tailed

Background – Resting-state Functional Networks

The human brain is intrinsically organized into dynamic, functional networks that are interconnected by neural "hubs."

Intrinsic connectivity of the DMN



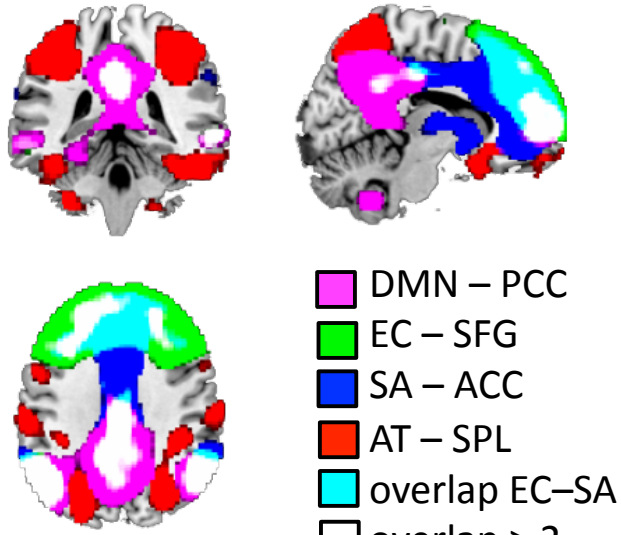
(Menon & Uddin, 2010)

Default mode network (DMN) structures

- are maximally active and functionally coupled during REST

- are typically deactivated and functionally decoupled during TASKS

Self-referential and integrative function networks



(Müller-Oehring et al., 2014)

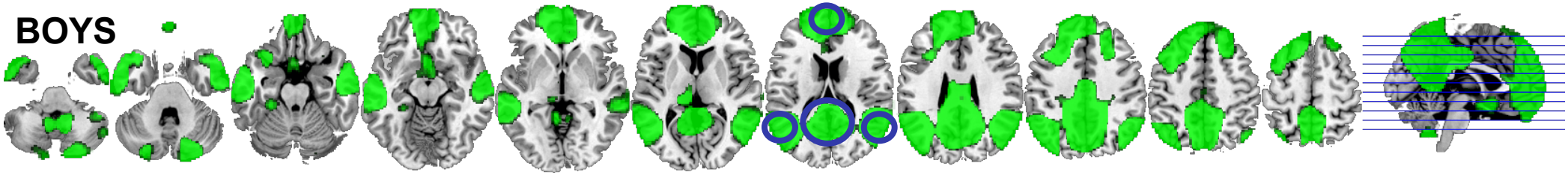
DMN	default mode network
EC	executive control network
SA	salience network
AT	dorsal attention network

Default Mode Network: Girls and Boys

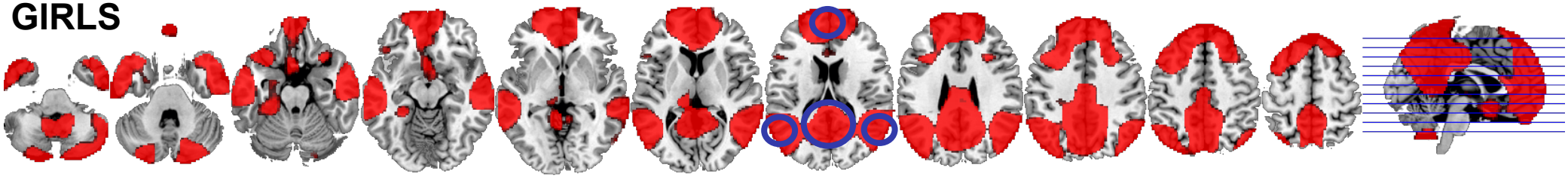
Posterior Cingulate Cortex (PCC) seed

all p<0.001 peak; cluster level at p<0.05 FWE-corrected

BOYS



GIRLS

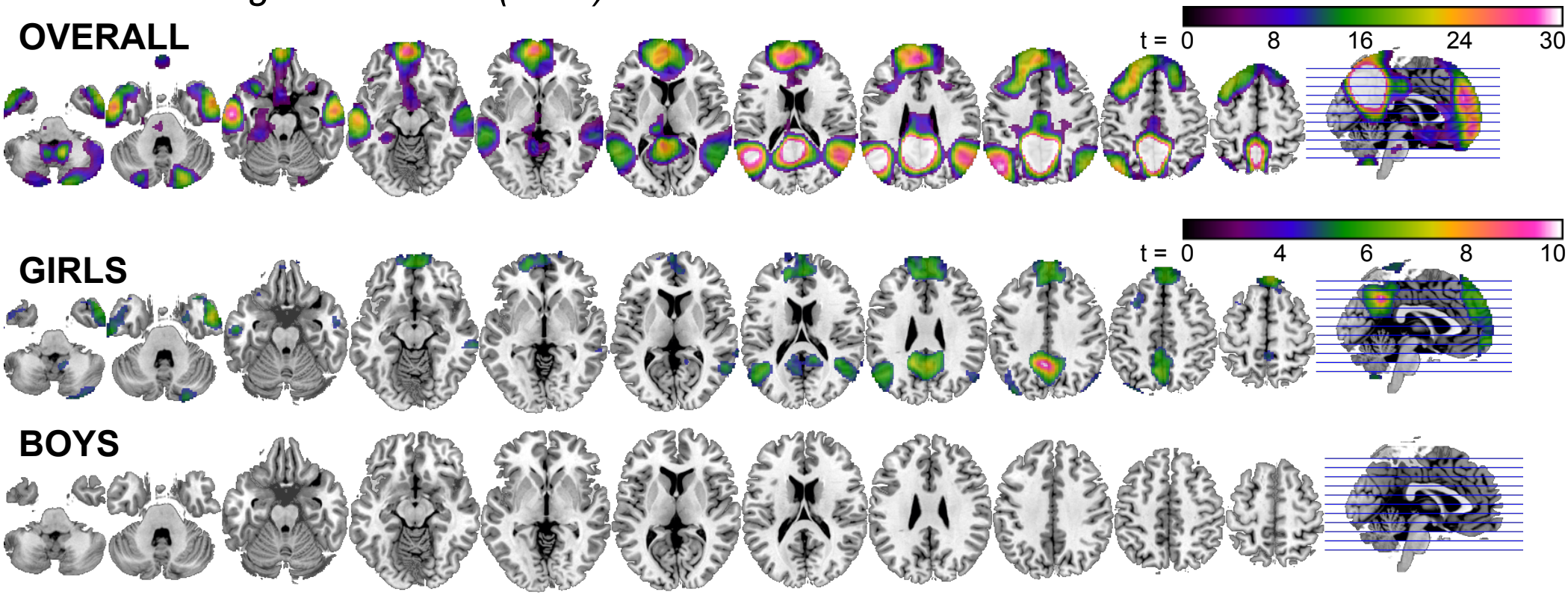


Adolescent boys and girls show the typical DMN pattern,
i.e., activation synchrony between the PCC, lateral left and right parietal and medial prefrontal cortices

Default Mode Network: Age effects

Posterior Cingulate Cortex (PCC) seed

all p<0.001 peak; cluster level at p<0.05 FWE-corrected



Overall, older adolescent age is a significant contributor to DMN connectivity.

Girls, but not boys, showed significantly greater connectivity with older age.

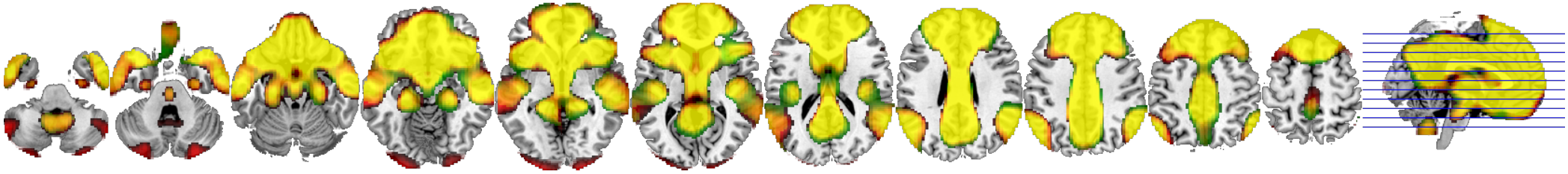
Salience: Girls and Boys

Anterior Cingulate Cortex (ACC) seed

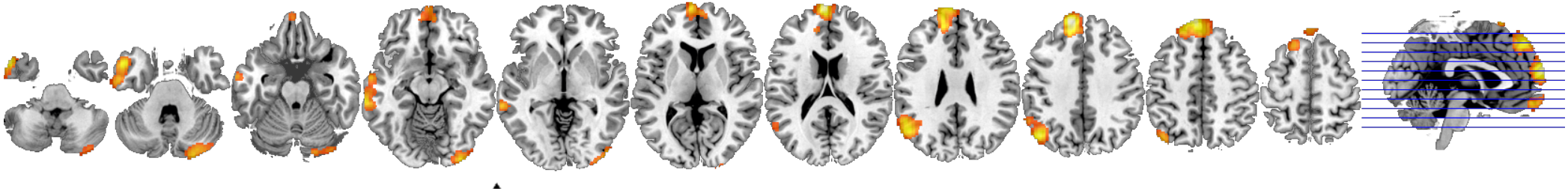
all p<0.001 peak; cluster level at p<0.05 FWE-corrected

GIRLS = BOYS

girls boys overlay



GIRLS > BOYS

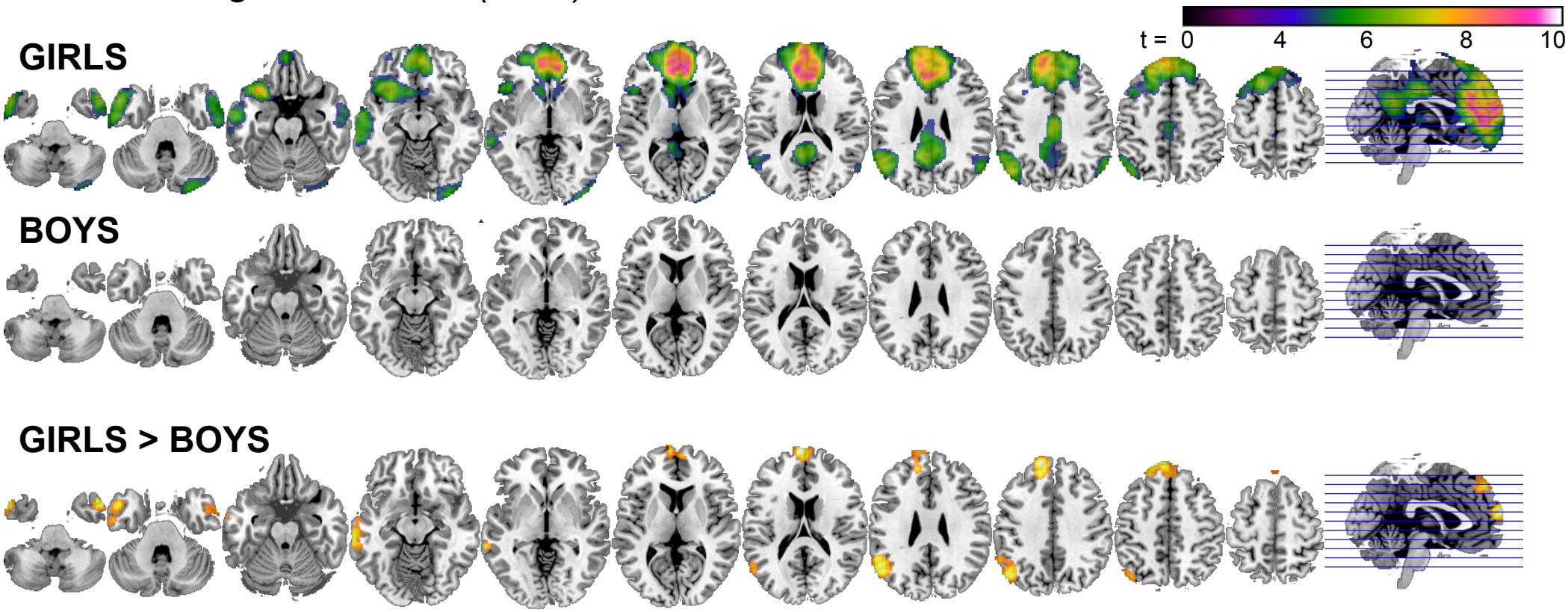


Compared with boys,
girls showed *greater ACC connectivity* to
mPFC, left temporoparietal and right cerebellar regions

Salience Network: Age effects

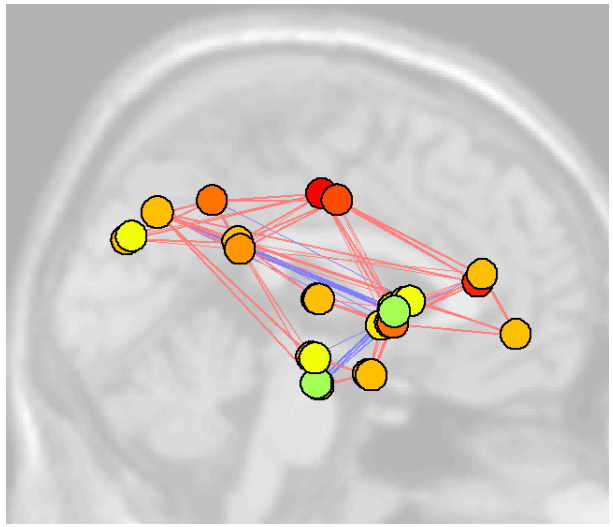
Anterior Cingulate Cortex (ACC) seed

all p<0.001 peak; cluster level at p<0.05 FWE-corrected



In girls, but not boys, older adolescent age is associated with greater SA network connectivity.

Graph Based Network Analysis



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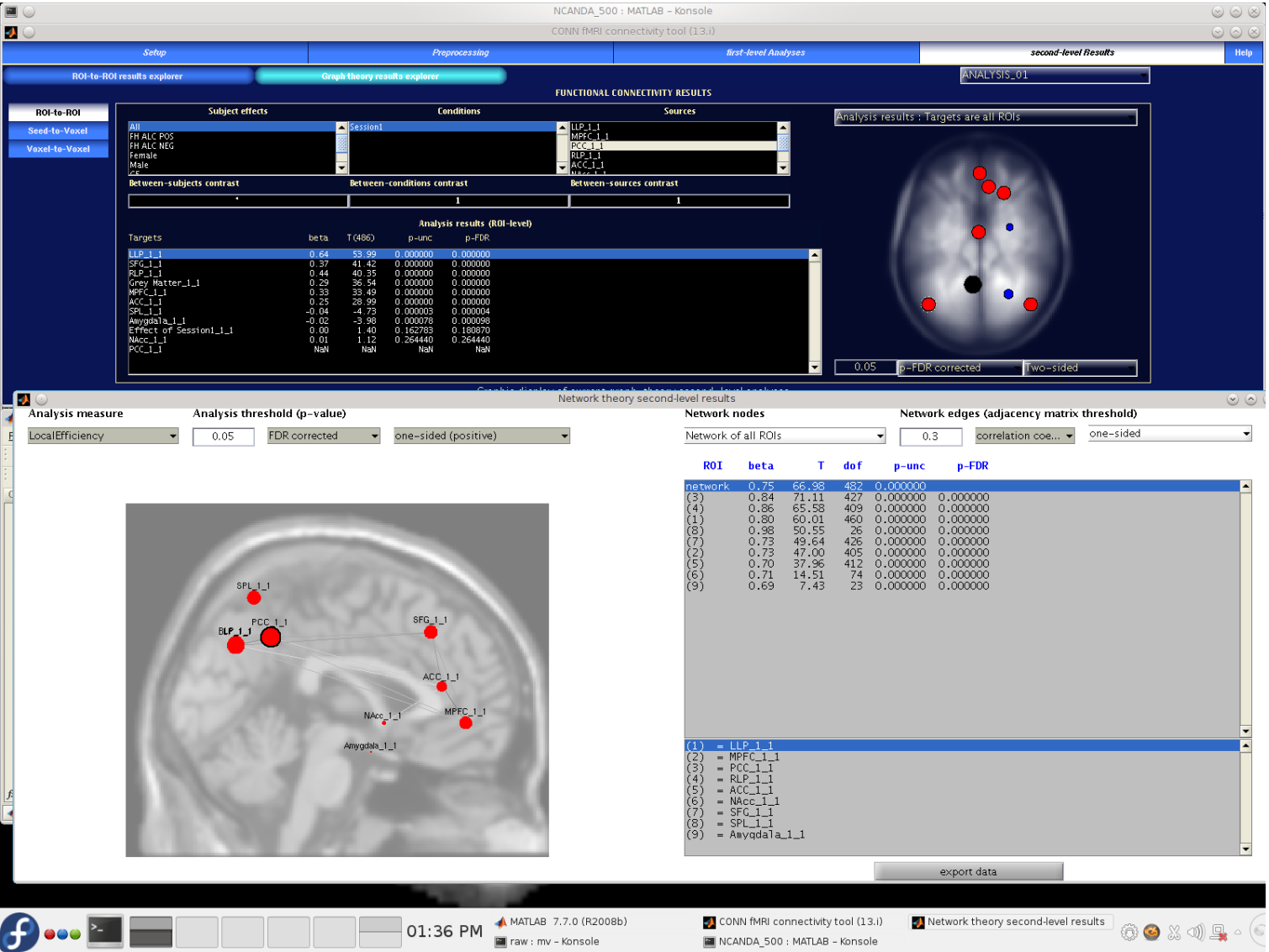
Exploring Functional Connectivity Networks with Multichannel Brain Array Coils

Sheeba Arnold Anteraper,[1] Susan Whitfield-Gabrieli,[2] Boris Keil,[3] Steven Shannon,[1] John D. Gabrieli,[2] and Christina Triantafyllou[3]

A network is a collection of nodes and edges,

- nodes indicate basic elements within the system of interest
- edges indicate the associations among those elements

Graph Based Network Analysis



Local efficiency

Node level:

Local efficiency of a node represents the "locality" of the node's connectivity, i.e., the extent of connectivity of the node with its neighbors.

Network level:

It means the extent of locality, (short-range connections) i.e., nodes with high local efficiency are connected to neighbors that form a strong or well connected local network, while nodes with low local efficiency are connected to neighbors that are sparsely connected or distant from each other.

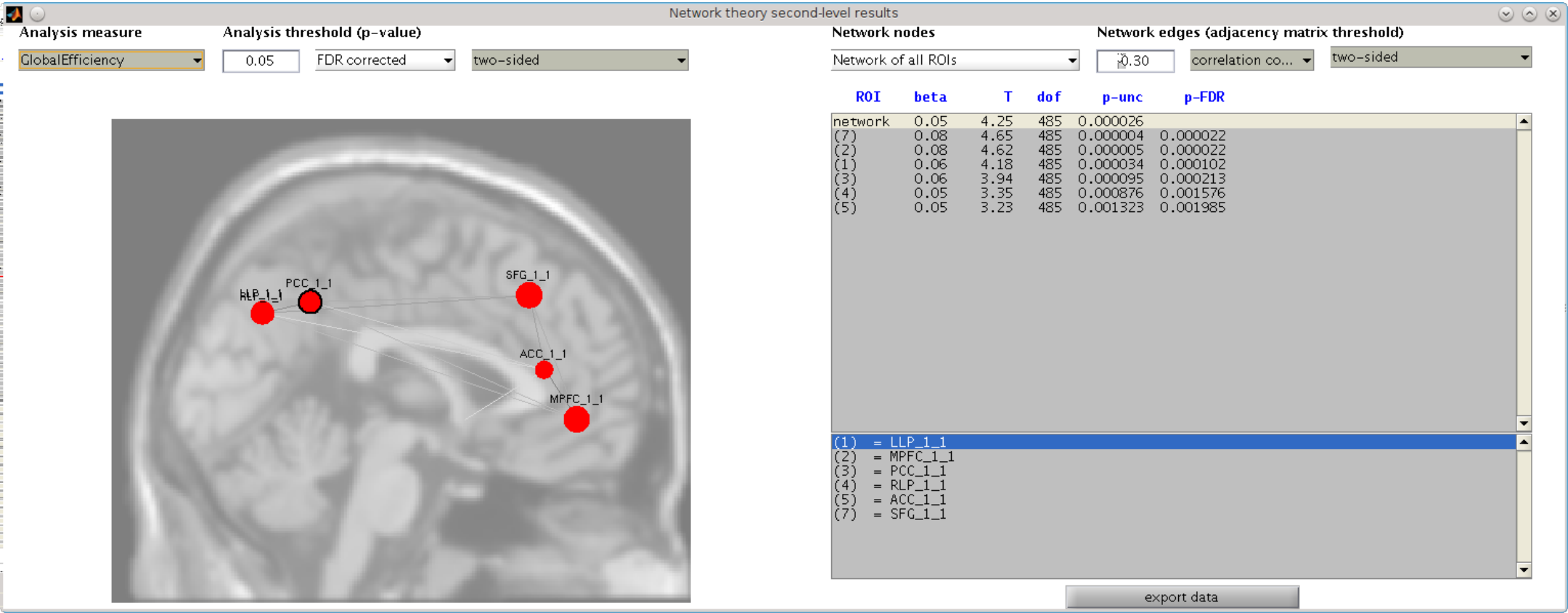
Graph Based Network Analysis

Contrast:

GIRLS > BOYS for **Global Efficiency:** higher global efficiency means better long-range connectivity

Node level: Global efficiency of a node is the ‘‘centrality’’ of the node’s connectivity

Network level: measure of the extent of centrality as well as the ‘‘efficiency’’ of this connectivity (nodes with higher global efficiency are ‘‘better connected

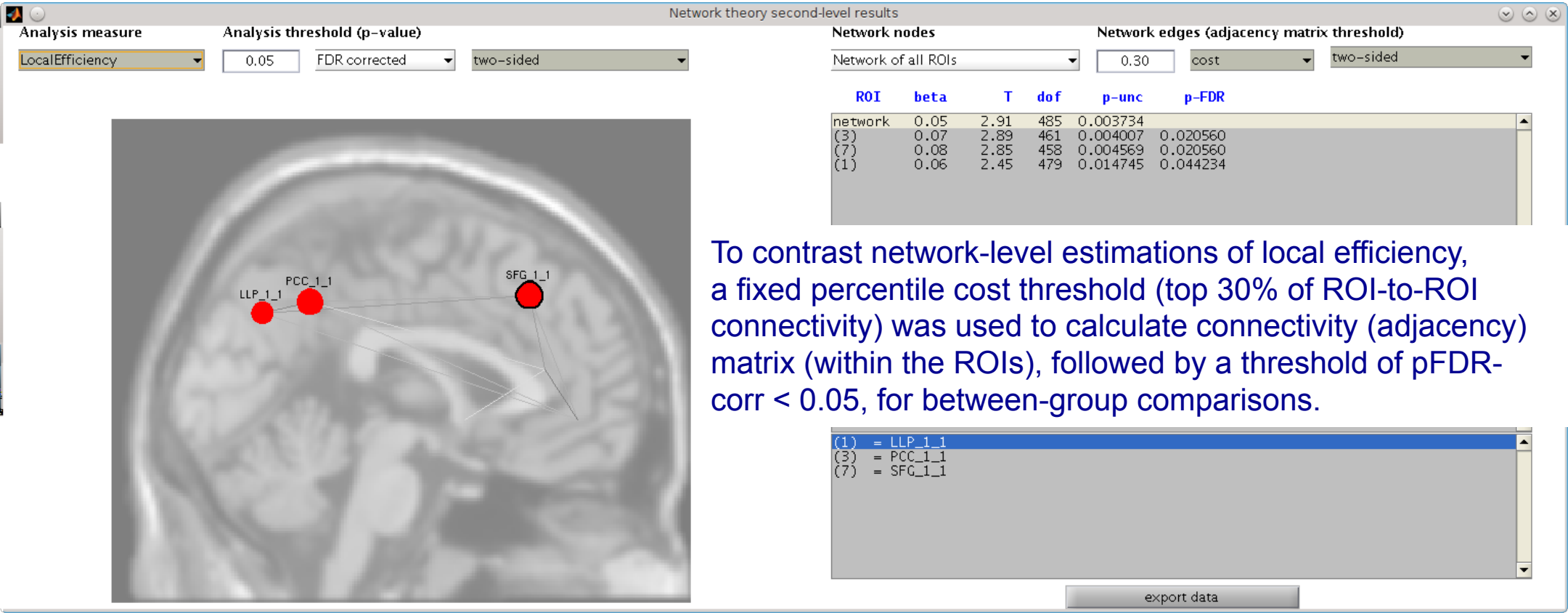


Graph Based Network Analysis

Contrast: GIRLS > BOYS for Costs:

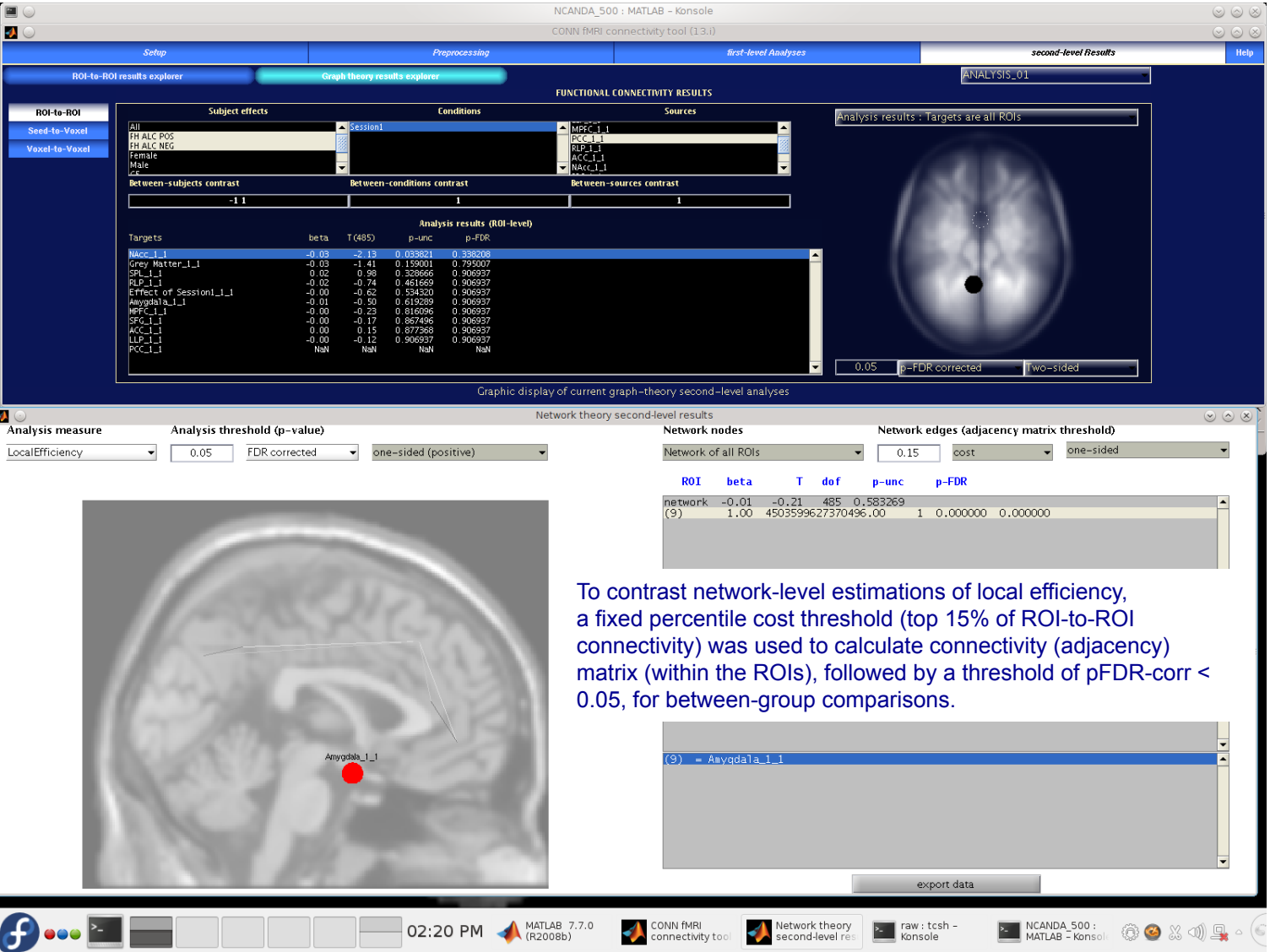
Node level: cost of a node can be interpreted as the strength of connectivity of a node

Network level: cost indicates hypo/hyperconnectivity in the overall network (e.g., higher cost = overall hyperconnectivity.



To contrast network-level estimations of local efficiency, a fixed percentile cost threshold (top 30% of ROI-to-ROI connectivity) was used to calculate connectivity (adjacency) matrix (within the ROIs), followed by a threshold of pFDR-corr < 0.05, for between-group comparisons.

Graph Based Network Analysis



To contrast network-level estimations of local efficiency, a fixed percentile cost threshold (top 15% of ROI-to-ROI connectivity) was used to calculate connectivity (adjacency) matrix (within the ROIs), followed by a threshold of pFDR-corr < 0.05, for between-group comparisons.

Contrast:

FhxAlc Positive > FhxAlc Negative for Costs:

Node level:
cost of a node can be interpreted as the strength of connectivity of a node

Network level:
cost indicates hypo/ hyperconnectivity in the overall network (e.g., higher cost = overall hyperconnectivity.