TRANSITORY NETWORKS SUPPORTING COGNITIVE CONTROL

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BRAIN FUNCTION: A MATTER OF INTEGRATION

(also Hoel, Albantakis, Tononi, PNAS, 2013)

Figure generated by Dr David Lloyd
COGNITIVE CONTROL

NEURAL PROCESSES INVOLVED IN FLEXIBLY INTEGRATING INFORMATION TO ACHIEVE INTERNAL GOALS IN A NOISY AND CHANGING ENVIRONMENT
Initiate and adapt control on a trial-by-trial basis

Control through the stable maintenance of task sets

BRESSLER AND MENON TICS, 2010

- fMRI time-resolved analyses
- Granger causality analyses
INTERIM SUMMARY

CONTROL RELIES ON SEGREGATED OR ANTAGONISTIC NETWORK DYNAMICS
CONTROL COMPLEXITY AND CROSS NETWORK DYNAMICS

Initiate and adapt control on a trial-by-trial basis

Control through the stable maintenance of task sets
TASK-DEPENDENT DMN-CCN INTERACTIONS

Leech et al., J. Neuro., 2011
GOAL-DIRECTED RECOLLECTION

Fornito et al., PNAS, 2013
**Meta(stable)-system**: Transitory, task-induced changes in integration between *brain regions* encompassing specialized functional systems.

This cross-systems interaction allows the resulting meta-systems to support functions that transcend those of specialized networks.

(Cocchi et al, TICS, 2013; see also Tognoli and Kelso, Neuron, 2014)
EXAMPLES OF META-SYSTEMS

Low cognitive control (e.g. diffuse attention)

High cognitive control (e.g. task-based selective attention)

Cocchi et al., TICS, 2013
Mr X

Mean A-B (0.7)

Mean C-D (0.48)

Mean D-E (0.02)

Mean E-F (-0.48)
FUTURE DIRECTIONS

Link between non-stationary endogenous fluctuations and emergence of meta systems?

Zalesky et al., PNAS, 2014
Consider the spatio-temporal multidimensionality of the processes supporting control.
FUTURE DIRECTIONS

Structure-function relationship: What impact for the emergence of meta-systems?

Functional connectivity: Controls > Schizophrenia (frontal-temporal-thalamic-striatal network)

Reduced white matter and loss of function-structure association (less anatomical constraints on dynamics)

Cocchi et al., NeuroImage: Clinical, 2014
Control emerge from the *transitory* ability to flexible integrate segregated neural functions.

Overall network-structure is preserved, the task-induced reconfiguration of endogenous patterns of integration support complex cognitive functions.

Transient dynamics supporting control are likely to involve multiple temporal and spatial scales.
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EXAMPLES OF META-SYSTEMS

Low working memory load, diffuse attention

Body (autonomic information)

High working memory load, selective attention

Body (autonomic information)

Cocchi et al., TICS, 2013