Task-general and task-specifying functional brain dynamics
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Introduction

We recently found that the human brain's functional networks are similar but not identical between rest and a variety of task states (Cole et al., 2014). Here we sought to characterize these changes from rest, identifying the network dynamics that likely make adaptive, task-specific behavior possible.

Methods

Data from the Human Connectome Project (WU-Minn consortium, N=100) was used for analysis. This involved 60 min of rest functional MRI (fMRI) data, as well as 45 min of task fMRI data split among seven highly distinct tasks (as previously described; Barch et al., 2013). We conducted a series of analyses comparing functional connectivity across previously defined brain regions and networks (Power et al., 2011).

Calculate functional connectivity (FC) between each of the 264 regions for each subject
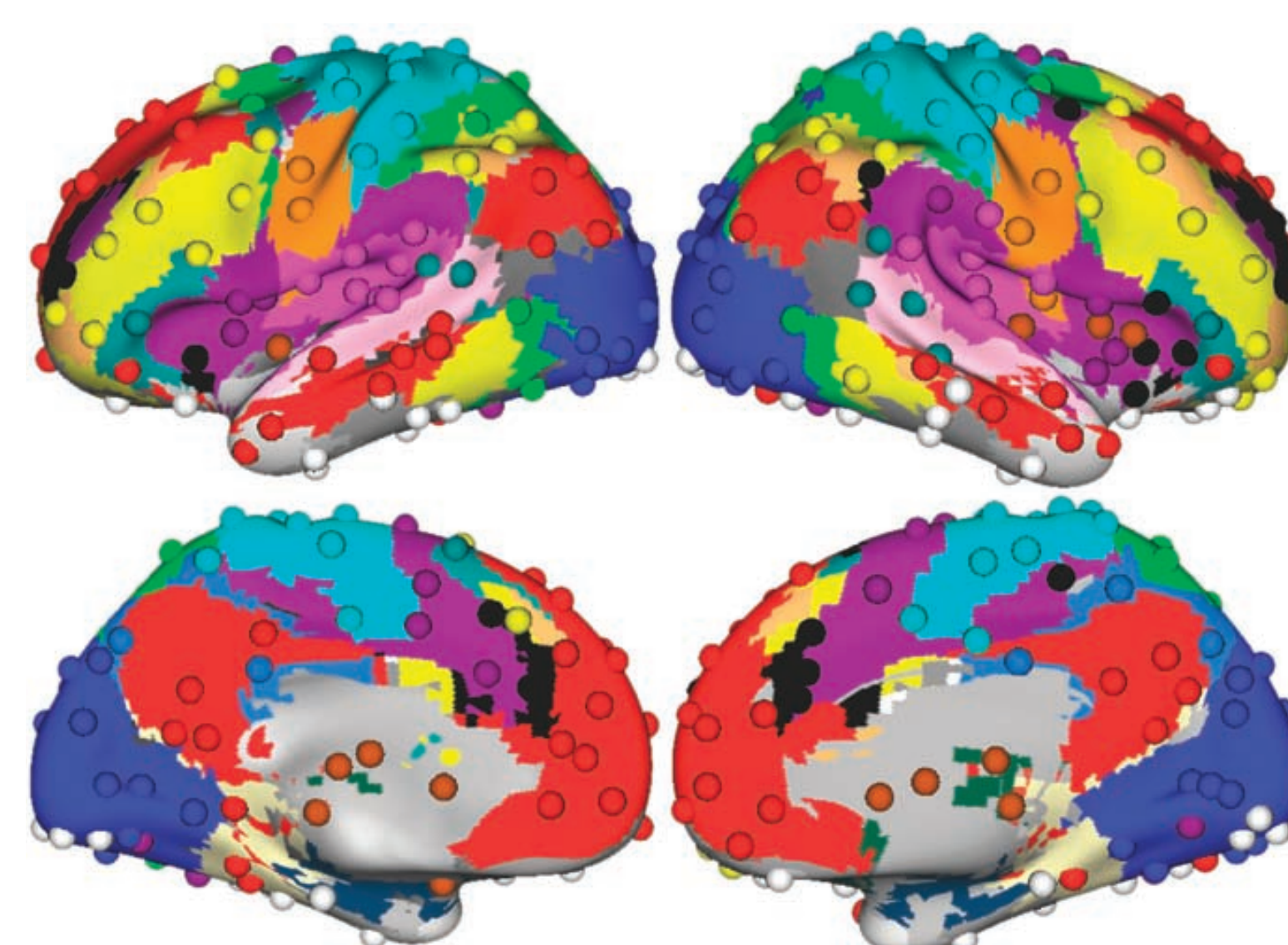
Task

- Emotion Task 352 TRs
- Gambling Task 506 TRs
- Language Task 632 TRs
- Motor Task 568 TRs
- Relational Task 464 TRs
- Social Task 548 TRs
- Working Memory Task 810 TRs

From Cole et al., 2013

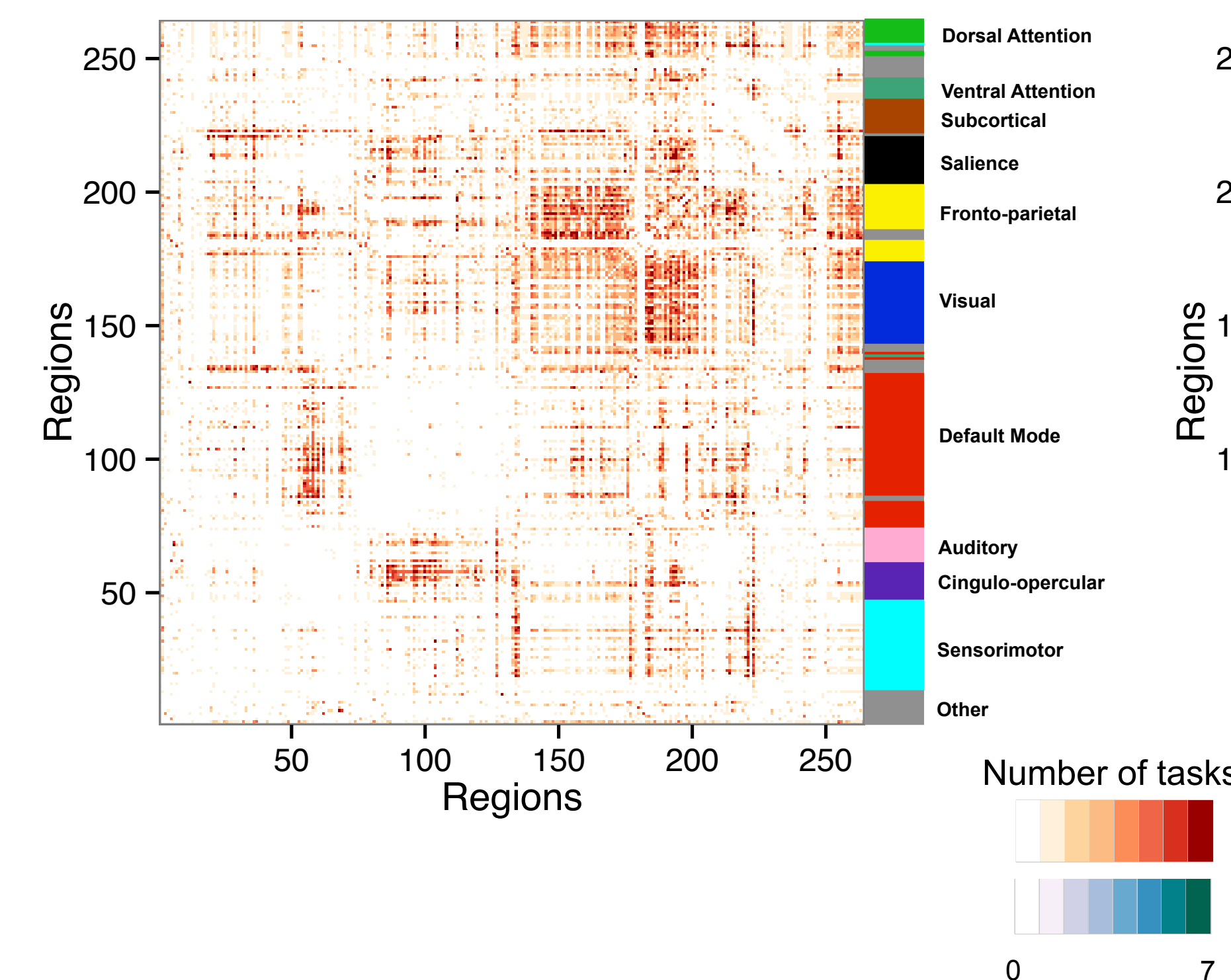Rest

- Equivalent # of TRs

Comparisons

- Task-specific FC to task-general FC (mean of other 6 tasks)
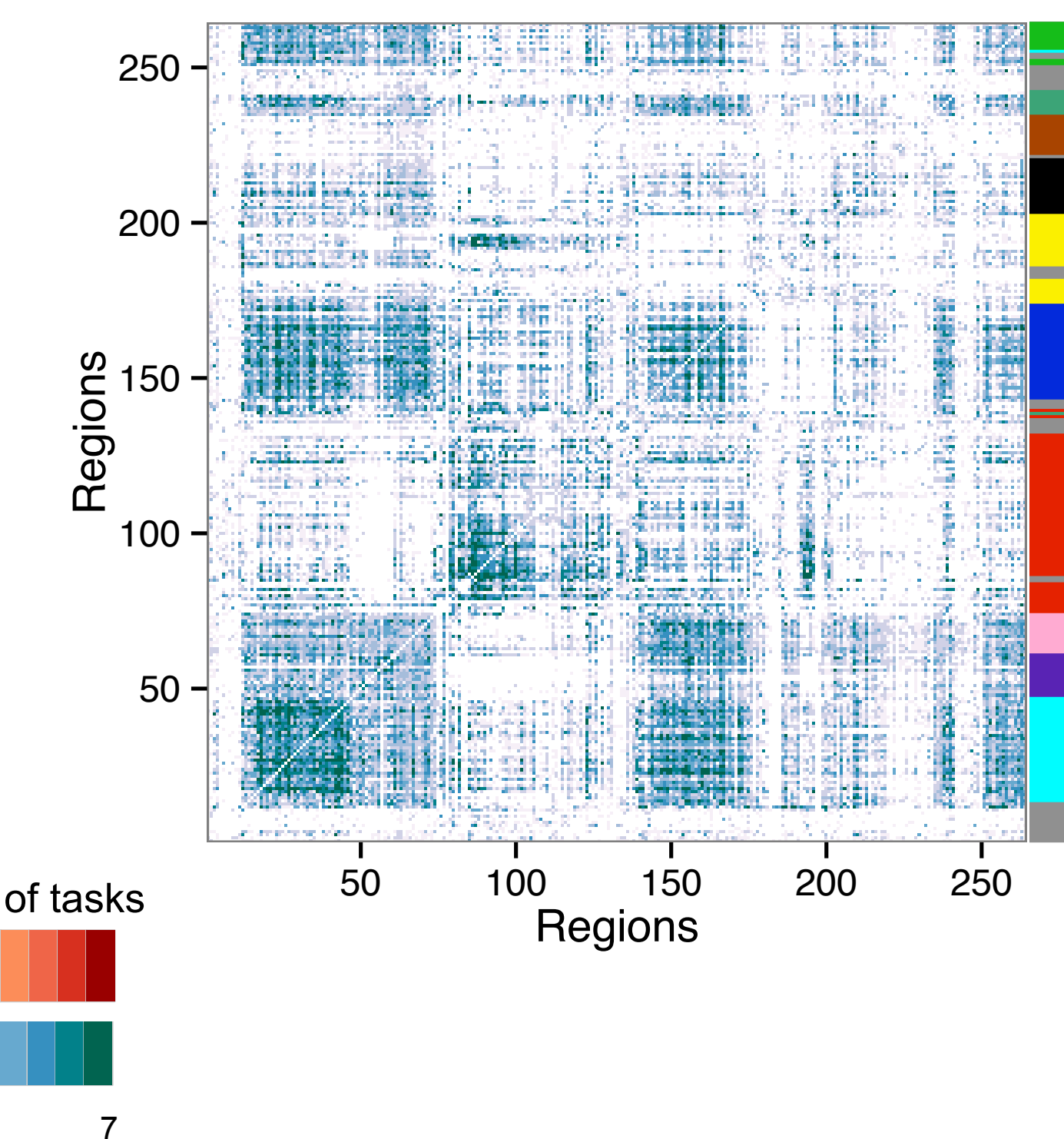- Task-specific FC to rest FC
- Task-specific FC to mean task-specific FC (top 5 fluid intelligence)

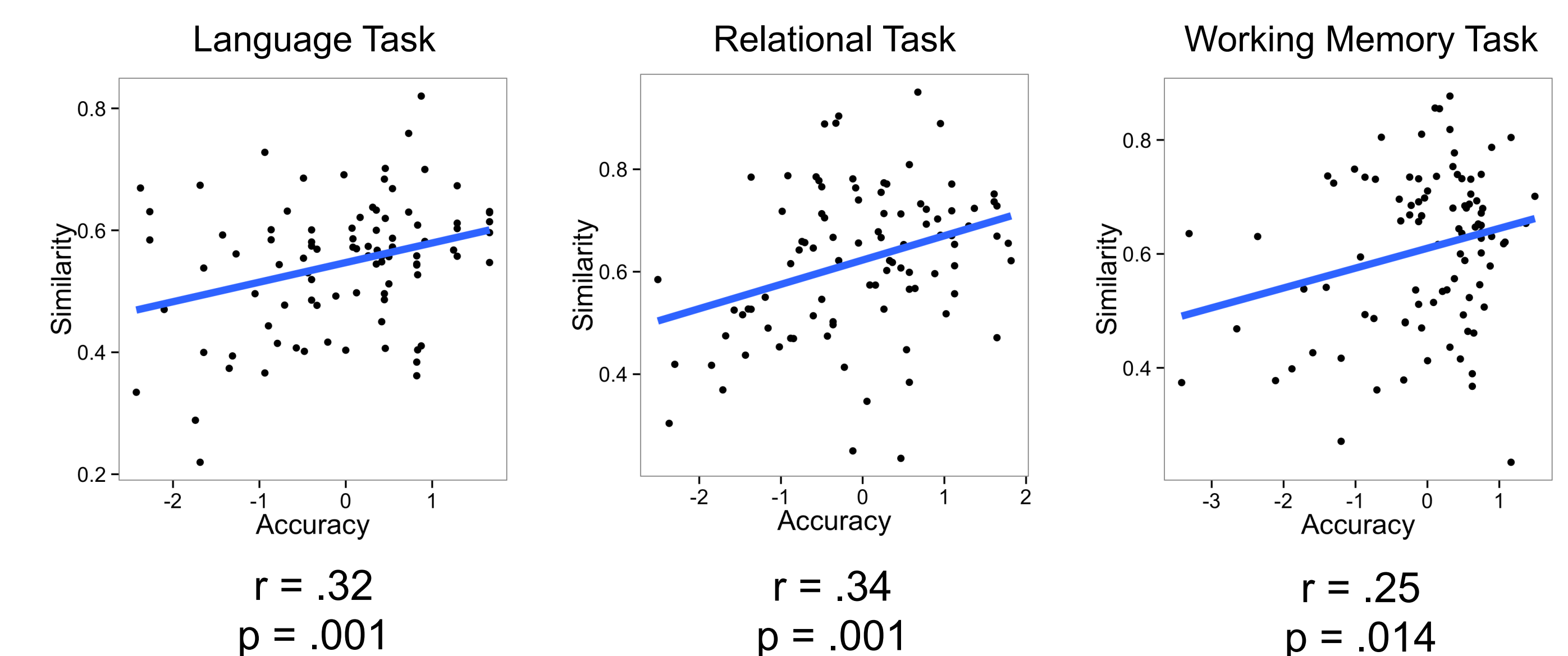## Configuration of FC is consistent across many different tasks

Number of tasks showing a significant increase in FC from rest

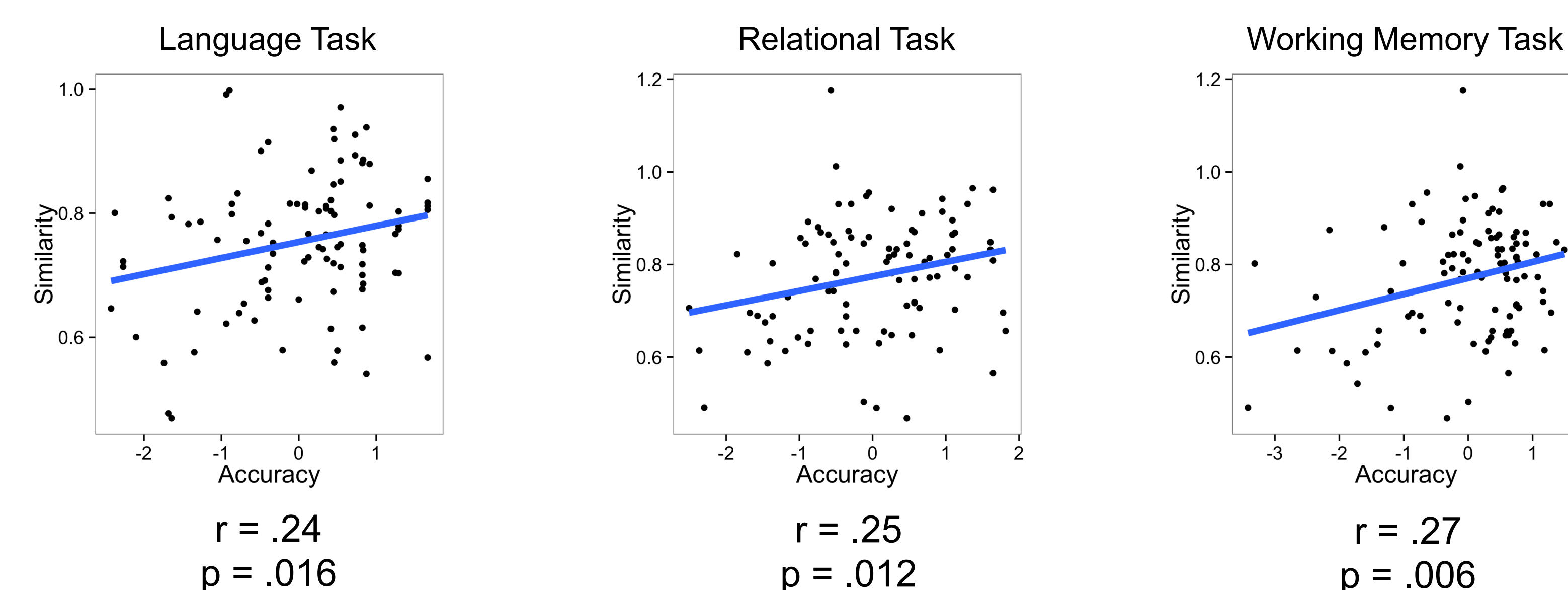Number of tasks showing a significant decrease in FC from rest

Dorsal Attention
Ventral Attention
Subcortical
Salience
Fronto-parietal
Visual
Default Mode
Auditory
Cingulo-opercular
Sensorimotor
Other

Number of tasks
0   7

How does task-general FC relate to behavior?

Language Task
r = .24
p = .016

Relational Task
r = .25
p = .012

Working Memory Task
r = .27
p = .006

Similarity between task-specific FC and task-general FC is positively correlated with behavior

Is the similarity between task and rest FC related to behavior?

Language Task
r = .31
p =.007

Relational Task
r = .25
p = .012

Working Memory Task
r = .23
p = .02

Similarity between task-specific FC and rest FC is positively correlated with behavior

Do high fluid intelligence individuals have more effective network architectures?

Language Task
r = .32
p = .001

Relational Task
r = .34
p = .001

Working Memory Task
r = .25
p = .014

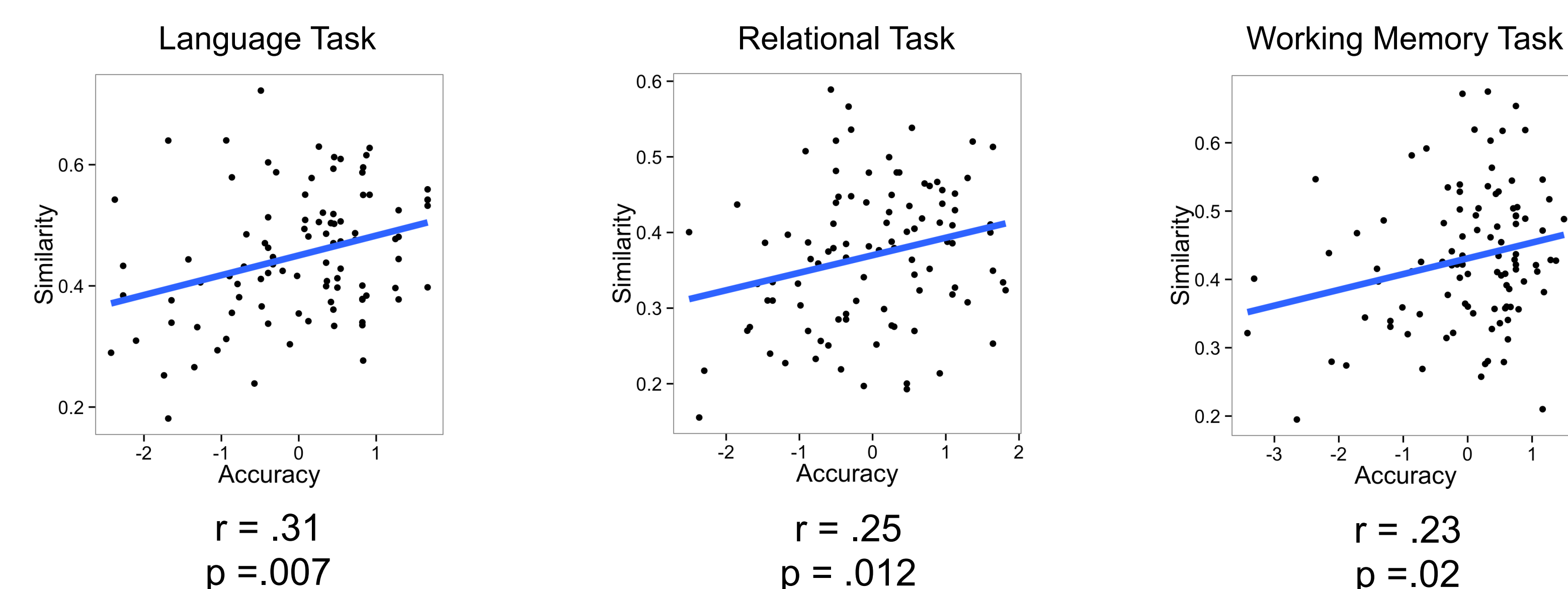Similarity (of task-specific FC) with high fluid intelligence participants is positively correlated with behavior

Conclusions

- ◆ FC patterns are consistent across many different tasks
- ◆ Task-general FC architecture is important for task performance
- ◆ High performers show similar task and rest FC
  - ◆ More efficient brain network updates
- ◆ Effective task network configurations related to high fluid intelligence

References

Barch, D.M., et al.; WU-Minn HCP Consortium (2013). Function in the human connectome: task-fMRI and individual differences in behavior. Neuroimage 80, 169–189.

Cole, M.W., et al., (2014). Intrinsic and task-evoked network architectures of the human brain. Neuron, 83, 238-251.

Cole, M.W., et al., (2013). Multi-task connectivity reveals flexible hubs for adaptive task control. Nature Neuroscience, 16, 1348-55.

Power, J.D., et al., (2011). Functional network organization of the human brain. Neuron 72, 665–678.

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