Brain state expression and cognitive flexibility in adolescence and young-adulthood

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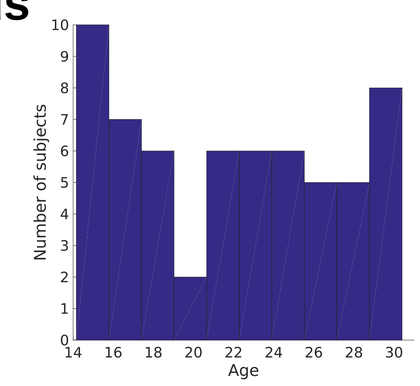
Introduction

- Adolescence is characterized by refinements in cognitive control, the ability to have consistently successful goal-directed behavior.
- Cognitive control requires both the ability to engage higher order cognitive functions, like working memory and inhibitory control, and to flexibly switch between them in service of changing task demands.
- Many studies have examined the neural correlates of specific cognitive functions; fewer have focused on cognitive flexibility.
- Here, we assess this by characterizing whole-brain fluctuations, or brain “states”, that underlie flexible switching between task conditions that tax working memory and inhibitory control during adolescence and young-adulthood.

Methods

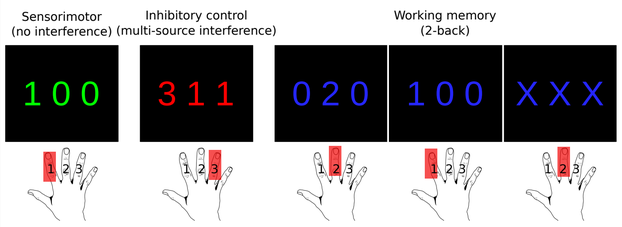
Sample

- N = 61
- Ages 14-30
  - M=21.96
  - SD = 5.14
- 33 male



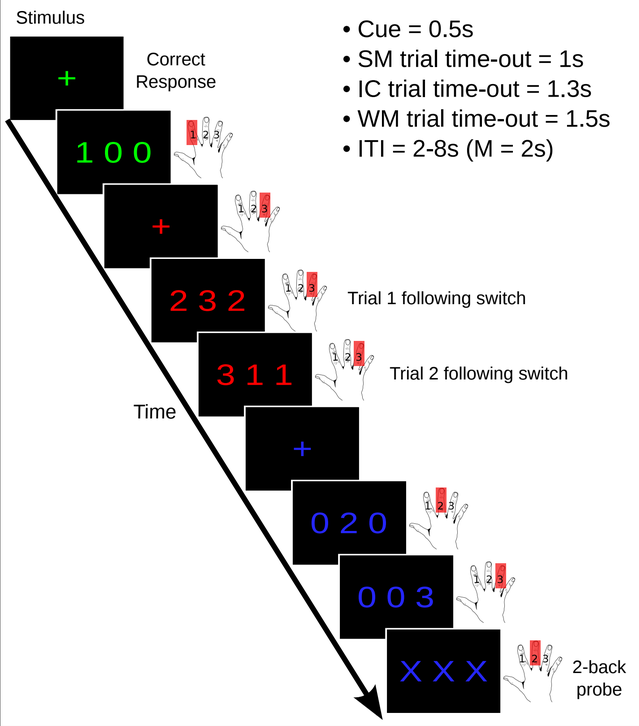
Task design

- 3 trial types:



- All trials consist of a digit sequence and terminate with a motor response
- 3 "pure" blocks
  - 35 trials of one trial type
- 6 "switch" blocks
  - 60 trials with task switches
  - Task switches occur after 2-8 trials of one type

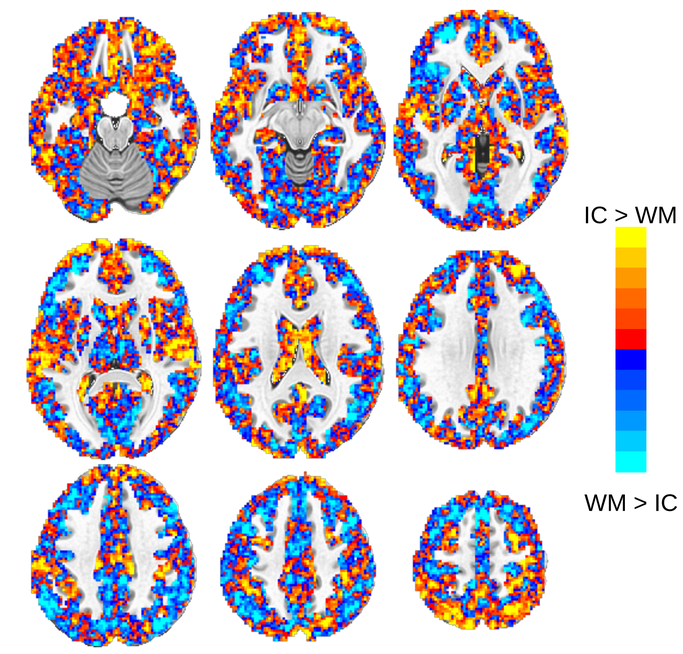
Switch block:



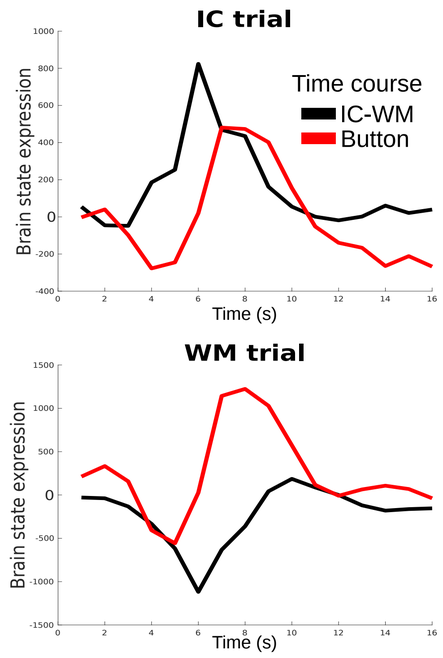
- Cue = 0.5s
- SM trial time-out = 1s
- IC trial time-out = 1.3s
- WM trial time-out = 1.5s
- ITI = 2-8s (M = 2s)

Brain states

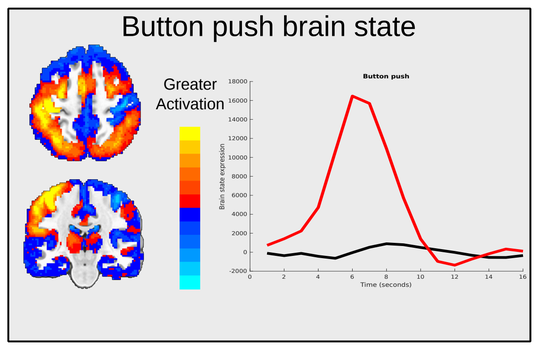
Inhibitory control - Working memory brain state



Average trial brain state expression



Button push brain state

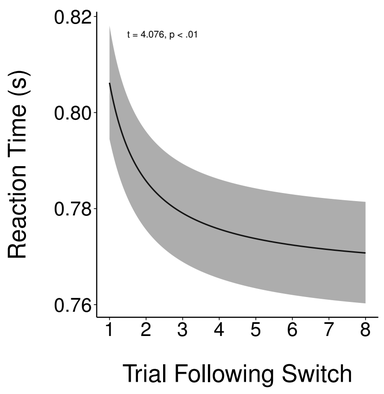


- Brain states were calculated from the "pure" blocks of the task and averaged across subjects.
- The estimated brain states were then projected onto the residual time-series of the "switch" blocks.

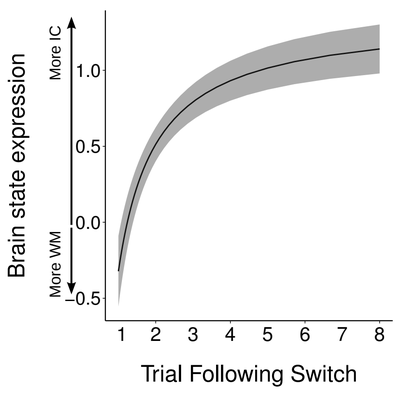
The influence of task-switching on brain-state expression and behavior

Switches from WM to IC:

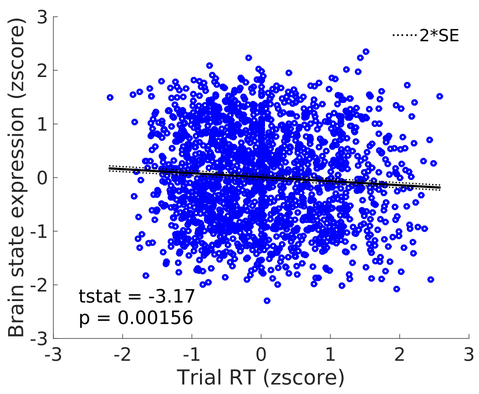
Task-switching influences reaction time

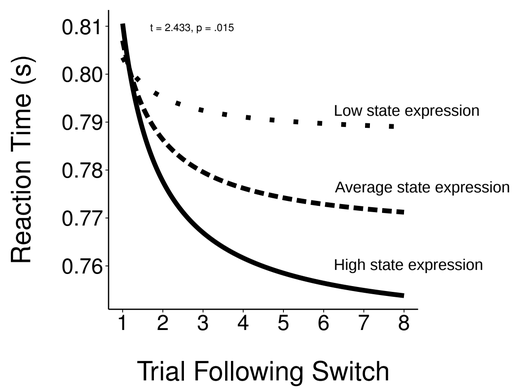


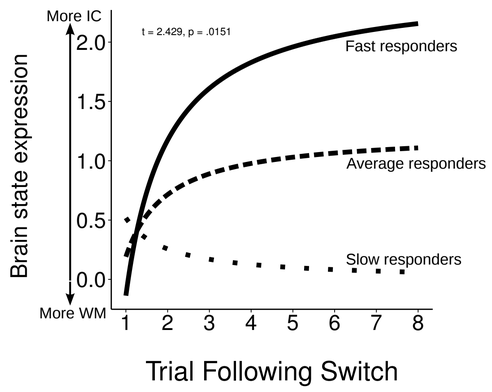
Task-switching influences brain state expression



Brain state expression predicts reaction time irrespective of trial following switch

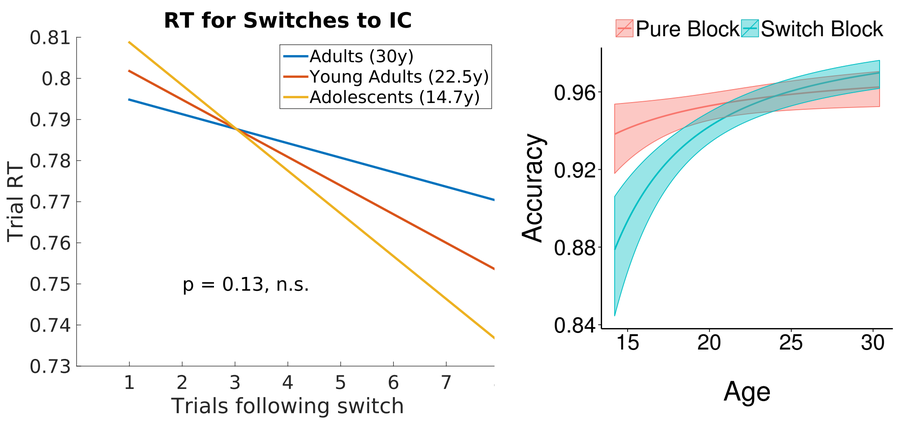






- Subjects with a faster performance improvement during switch transitions to IC show greater average expression of the IC brain state.
- Likewise, greater and more rapid transistions to the IC brain state are associated with faster response times.

Future directions: Development



Conclusions

- The expression of task-related brain states is related to cognitive task performance.
- Cognitive flexibility may be driven by the ability to reliably and readily engage effective brain states in service of changing task demands.
- Future work will examine the development of brain state expression supporting the development of cognitive flexibility.

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