

# The cost of cognitive control as a solution to the stability-flexibility dilemma

Sebastian Musslick<sup>1</sup>, Seong Jun Jang<sup>1</sup>, Michael Shvartsman<sup>1</sup>, Amitai Shenhav<sup>2</sup> & Jonathan D. Cohen<sup>1</sup>

<sup>1</sup>Princeton Neuroscience Institute, Princeton University <sup>2</sup>Department of Cognitive, Linguistic, and Psychological Sciences, Brown Institute for Brain Science, Brown University

## Introduction

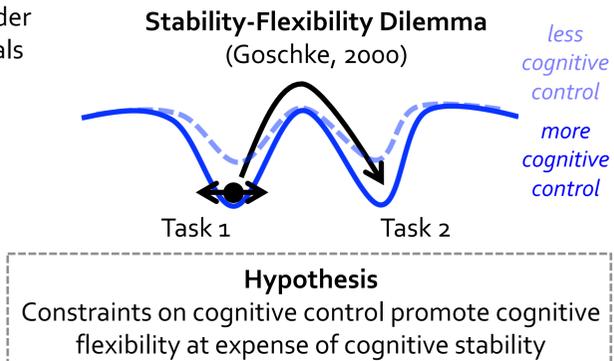
**Cognitive Control:** Ability to override habitual responses in order to successfully guide behavior in the service of current task goals



» Cognitive control is fundamentally **limited** (Shiffrin & Schneider, 1977)

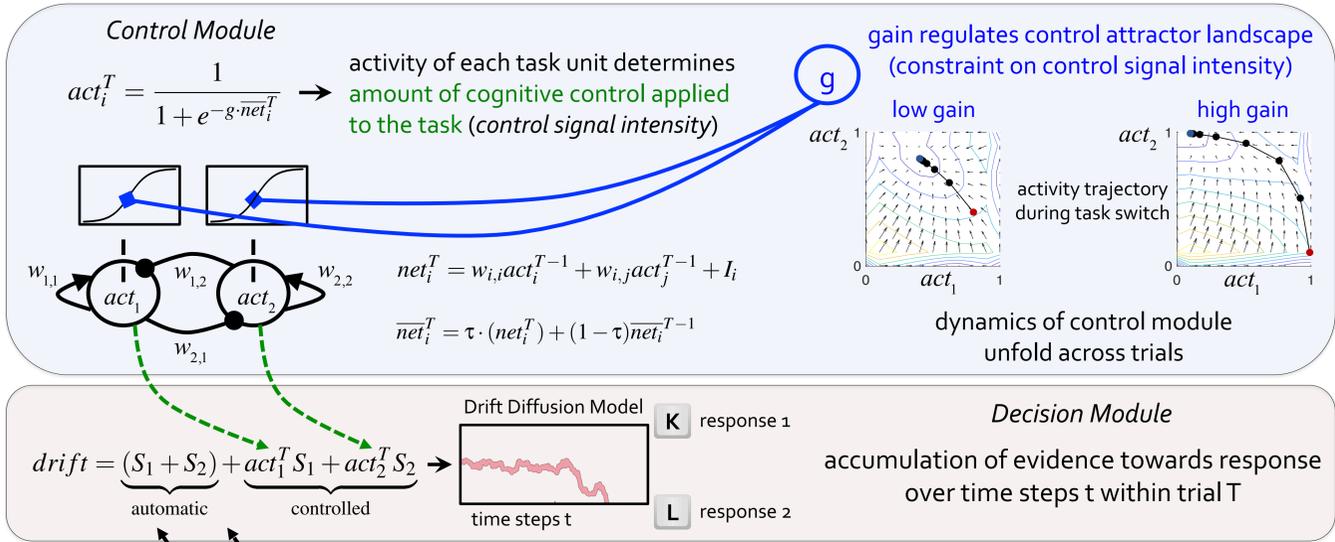
» **Costs** attached to increases in control signal intensity (Shenhav, Botvinick & Cohen, 2013; Shenhav et al., 2017)

» **Why constrain the amount of cognitive control allocated to a task with a cost?**

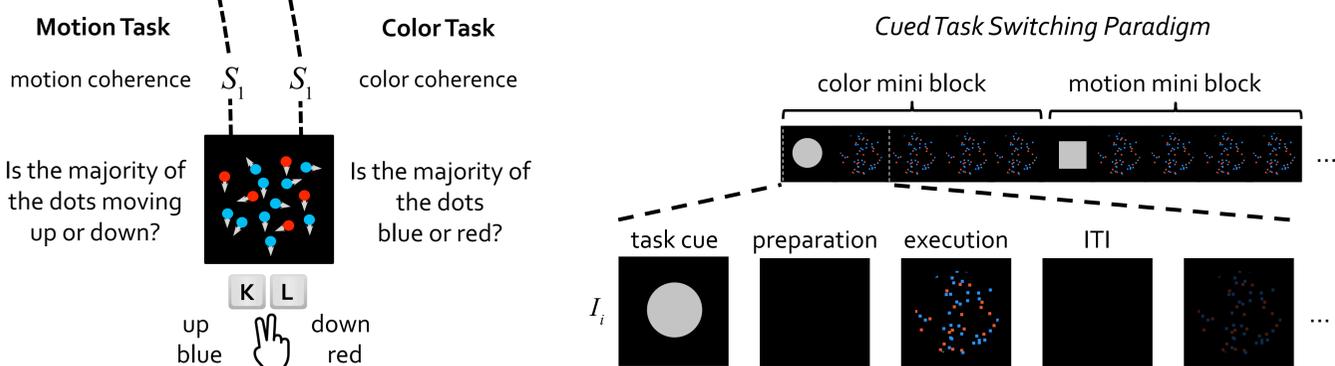


## Model

(Musslick et al., 2018)

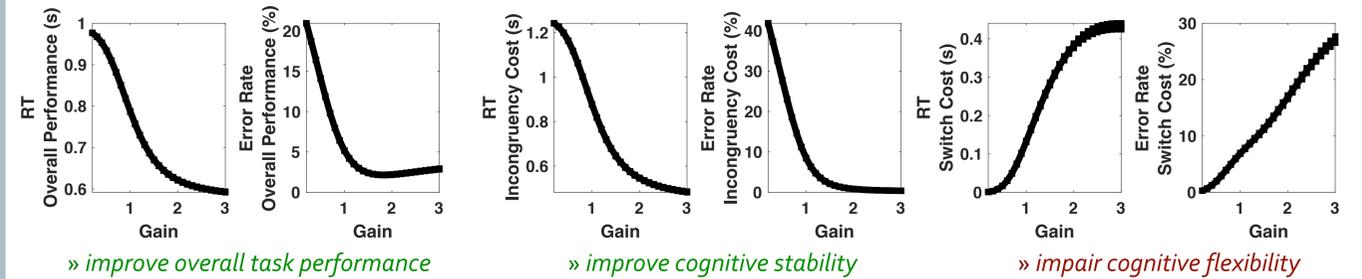


## Task Environment

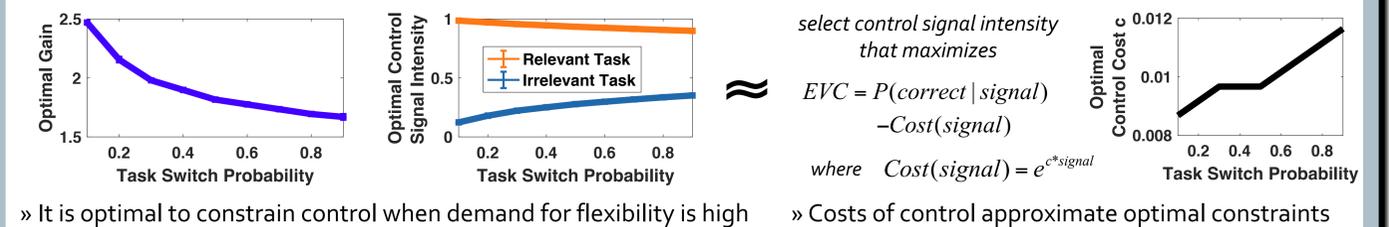


## Computational Analyses

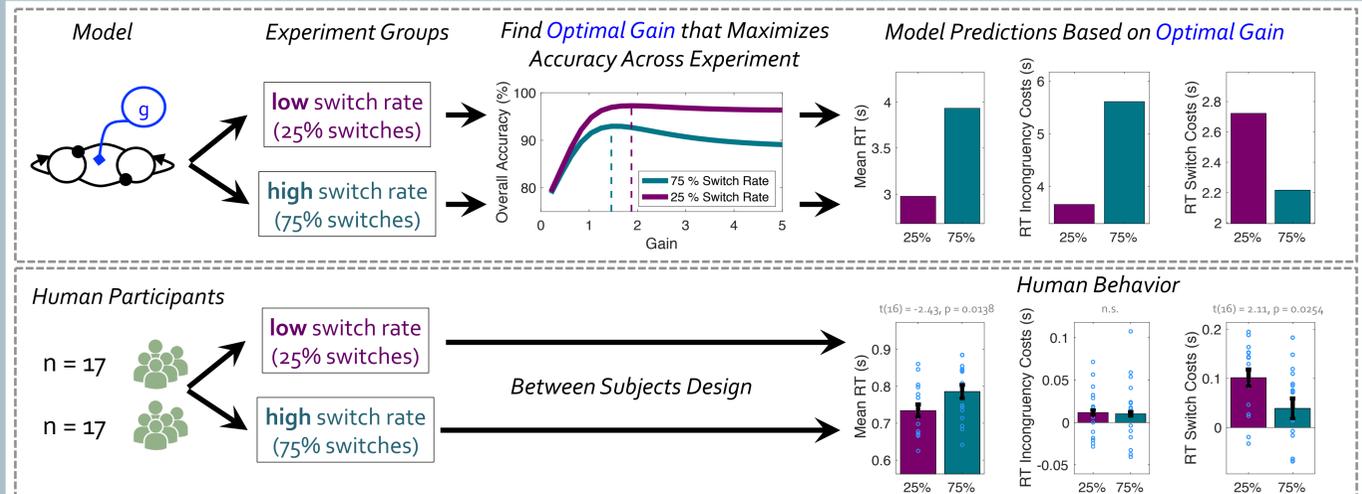
### Lower Constraints on Control (Higher Gain)...



### Optimal Constraints on Control as a Function of Demand for Flexibility



## Model Predictions and Experiment Results



## Conclusions

- Constraints on cognitive control can improve cognitive flexibility at the expense of cognitive stability
- Higher constraints on cognitive control are optimal in environments with higher demand for flexibility
- Costs associated with cognitive control may reflect an approximate solution to the stability-flexibility dilemma in neural systems

## References & Acknowledgements

T. Goschke, Attention and performance XVIII, 18, 331-335 (2000)  
S. Musslick et al., CogSci, 806-811 (2018)  
A. Shenhav, M. M. Botvinick, J. D. Cohen, Neuron 79, 217-40 (2013)  
A. Shenhav et al., Annu Rev Neurosci 40, 99-124 (2017)  
R. M. Shiffrin, W. Schneider, Psychol. Rev. 84, 127-190 (1977)

This publication was made possible through the support of a grant from the John Templeton Foundation. The opinions expressed in this publication are those of the authors and do not necessarily reflect the views of the John Templeton Foundation.