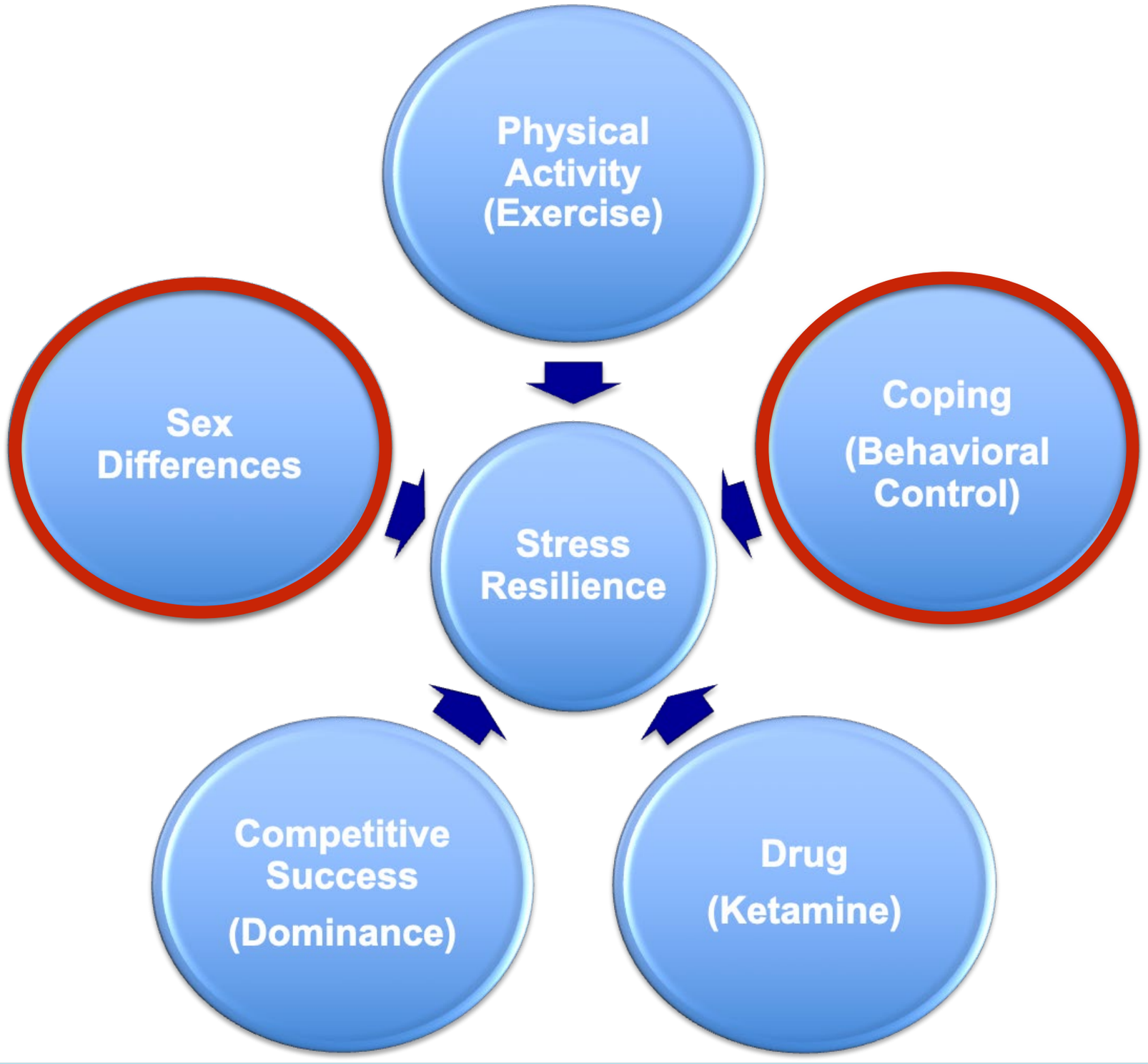
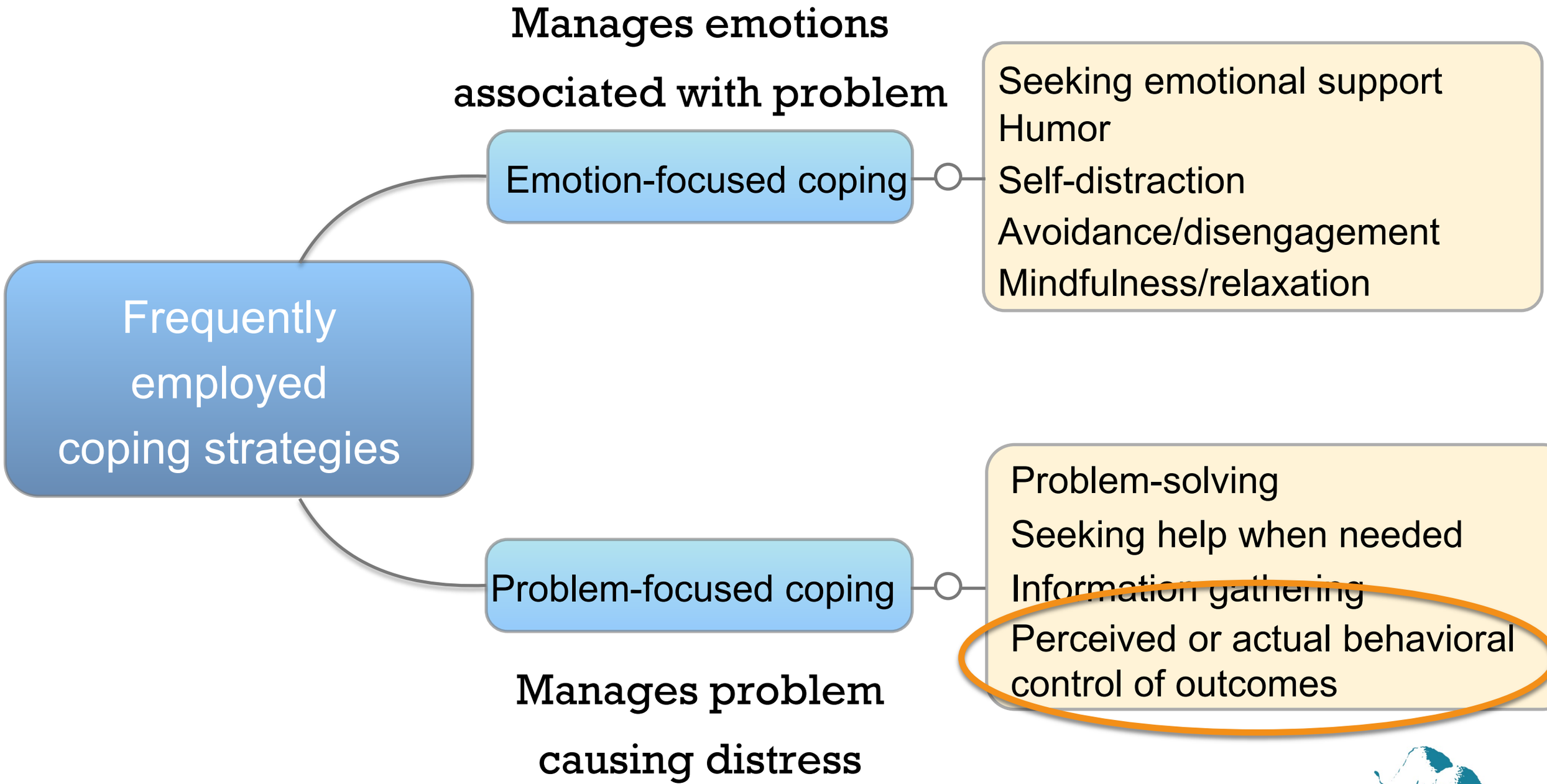
Coping as a neural concept

Michael Baratta
Department of Psychology & Neuroscience
University of Colorado Boulder

Factors that promote stress resilience



Coping refers to the cognitive and behavioral efforts that *manage* an adverse situation



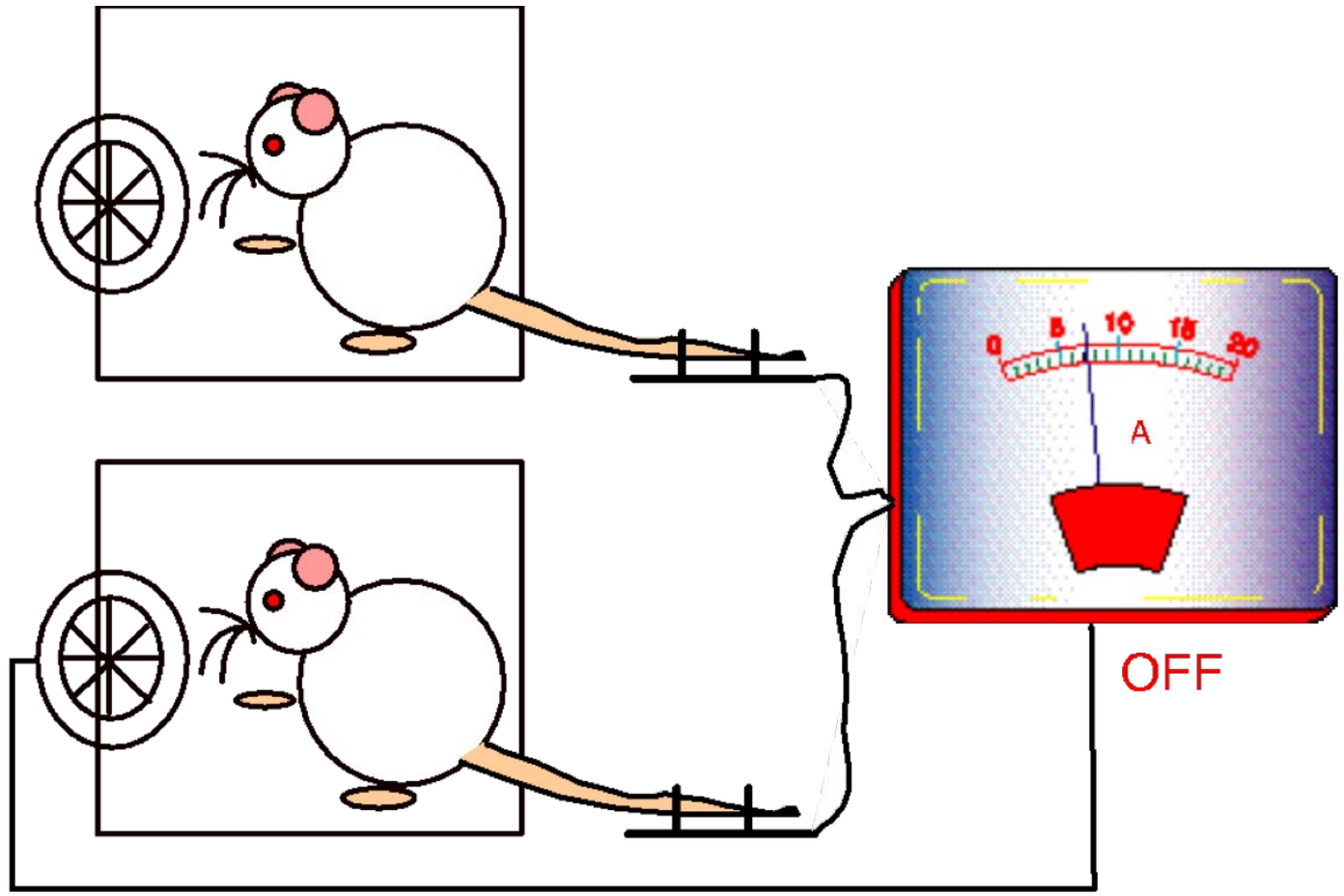
Stressor Controllability Paradigm

Uncontrollable Stress

(Inescapable Stress, **IS**)

Controllable Stress

(Escapable Stress, **ES**)

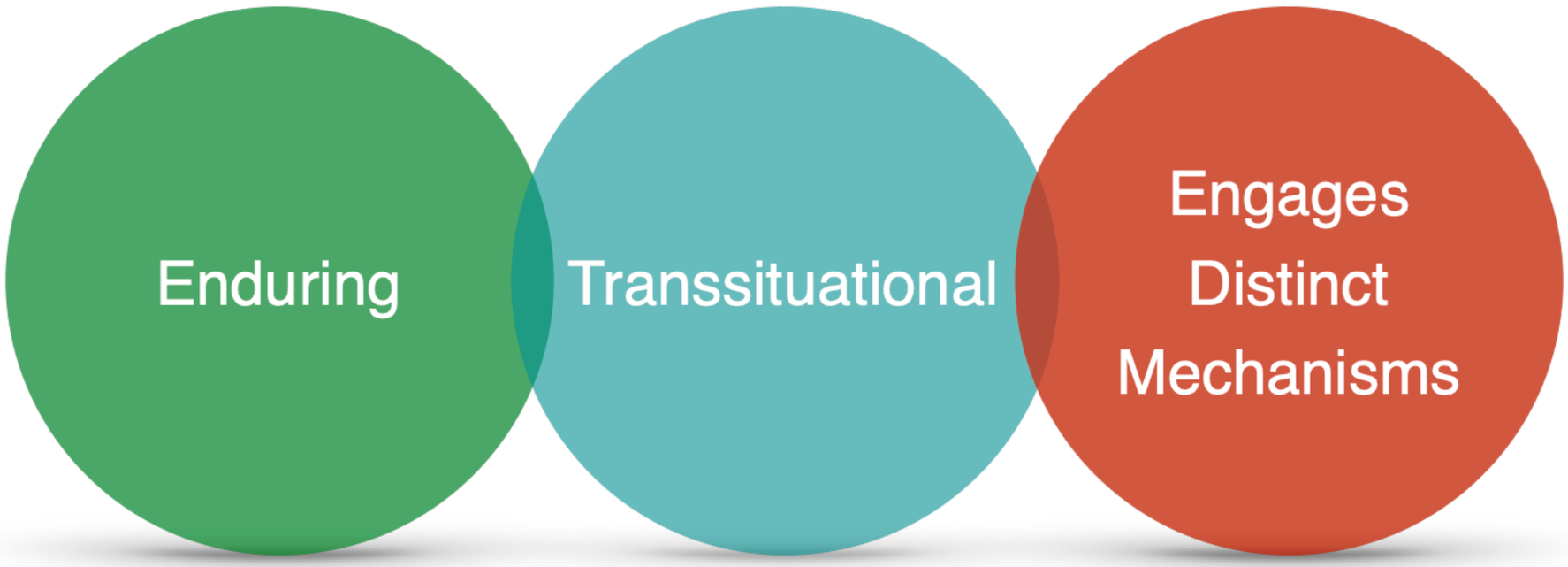


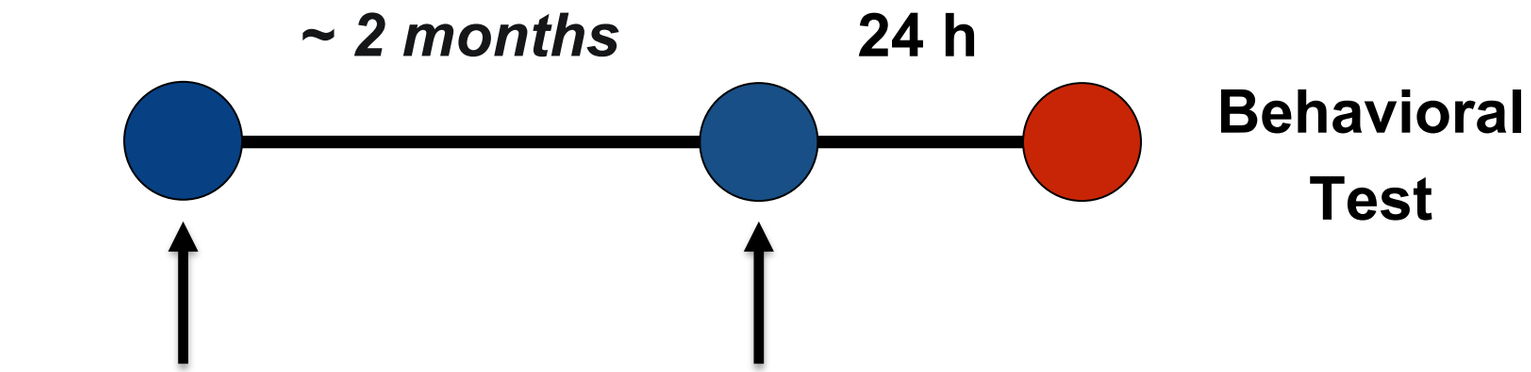
Intensity, duration, onset/offset, temporal pattern of shock are identical

Behavioral outcomes following uncontrollable, but not, controllable, stressors

- Exaggerated fear conditioning
- Resistance to fear extinction
- Exaggerated shock-elicited freezing
- Deficit in attention set-shifting
- Exaggerated fear to ambiguous cues
- Neophobia
- Decreased juvenile social exploration
- Sensitivity to blockade by anxiolytics
- Impaired escape behavior
- Reduced food and water intake
- Reduced aggressive behavior
- Reduced sexual behavior
- Reduced brain stimulation reward
- Immobility in swim tests
- Increased morphine conditioned place preference
- Impaired extinction of drug-seeking

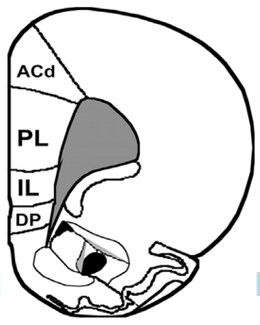
Behavioral control elicits key features of resilience





✔ Prelimbic Cortex (PL)

✔ Prelimbic Cortex (PL)



Coping as a process

Detection of behavioral control

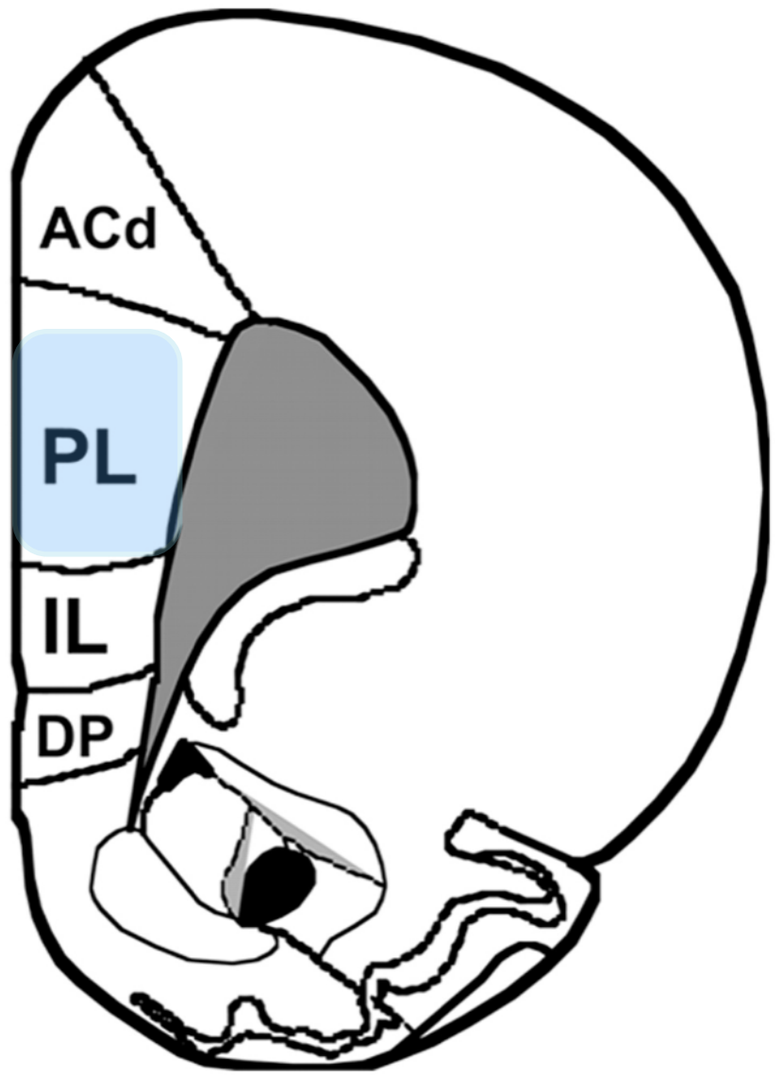
Instrumental learning;
Projection to dorsal striatum

Regulation of stress-responsive structures

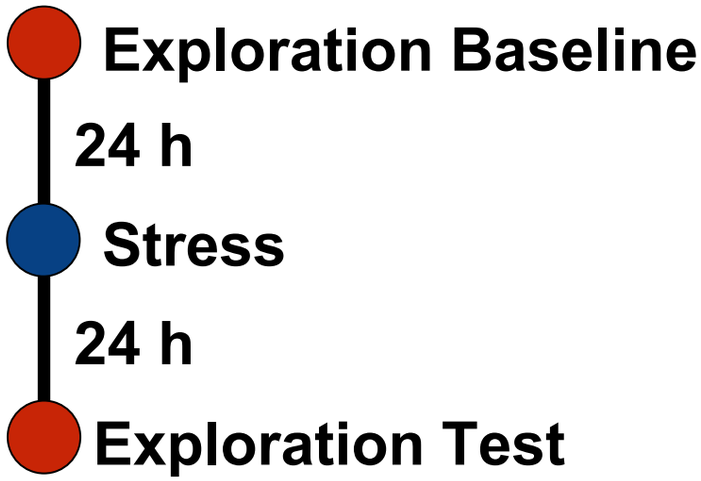
Top-down inhibition;
Projection to dorsal raphe

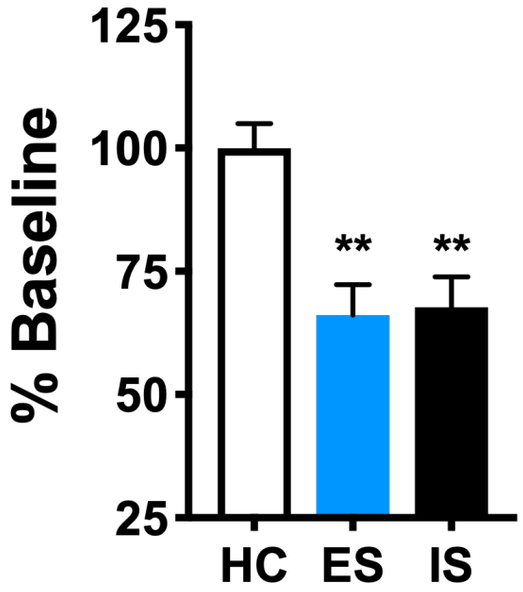
Blunted neurochemical & behavioral outcomes

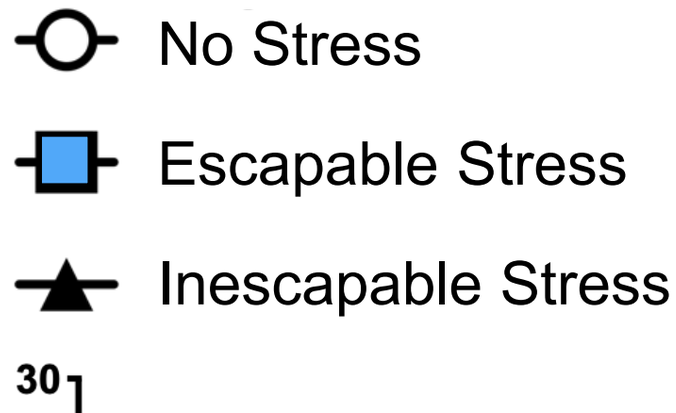
Prelimbic Cortex (PL)



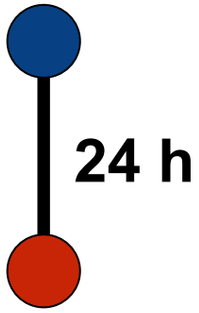
Behavioral control is not protective in female rats







Stress



Freezing

Shuttlebox Escape

Baratta et al., *European Journal of Neuroscience*, 2018

Instrumental learning come in two varieties

Detection of behavioral control

Instrumental learning; PL projection to dorsal striatum

Regulation of stress-responsive structures

Top-down inhibition; Projection to dorsal raphe

Blunted neurochemical & behavioral outcomes

Action-Outcome system

Encodes the contingent relationship between actions and their consequences

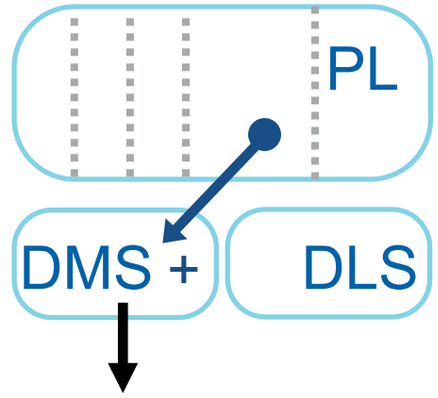
Association between the response and the outcome (R—>O)

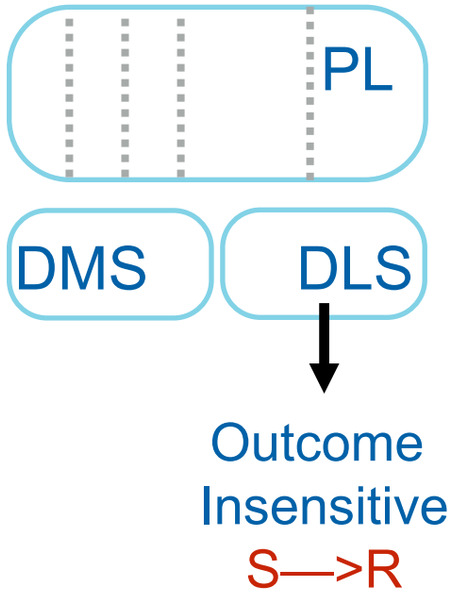
Habit system

Reflexive, automatic responses (R) are simply elicited in the presence of cue or stimulus (S—>R)

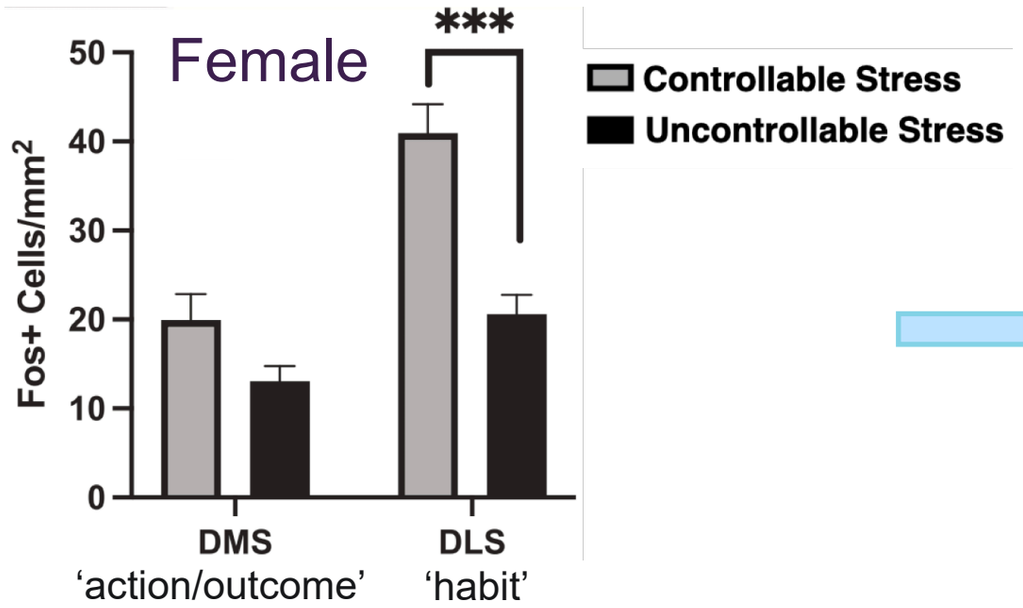
Evident after extensive practice; accelerated by drugs of abuse or stress exposure

Neural substrates

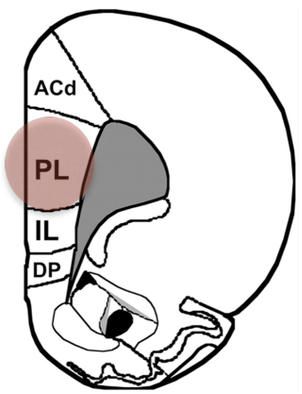


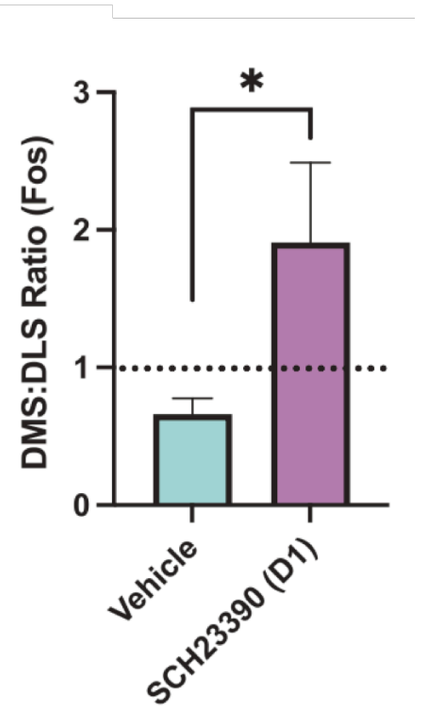


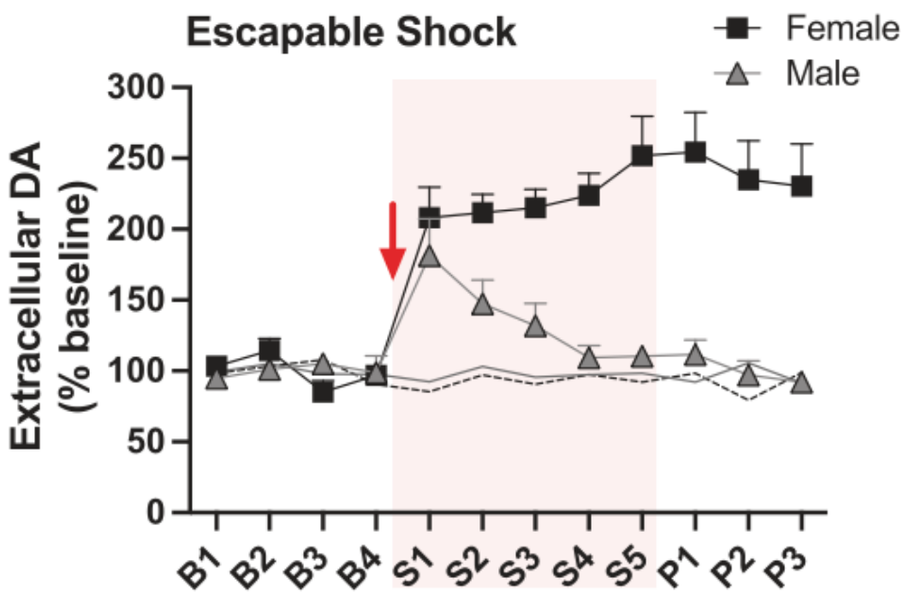
Modulating prefrontal DA signaling establishes the stress-buffering properties of control in females

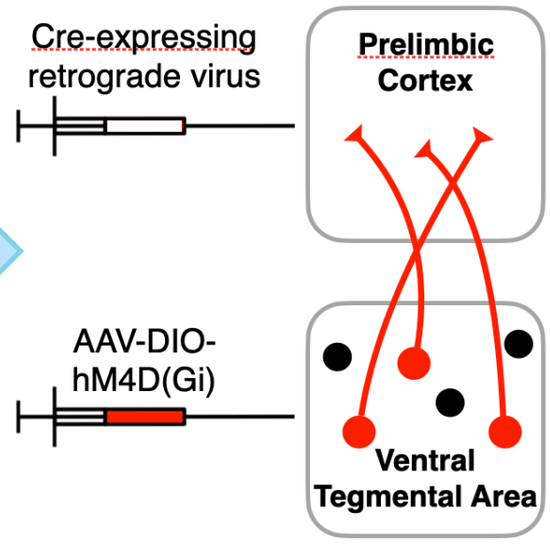


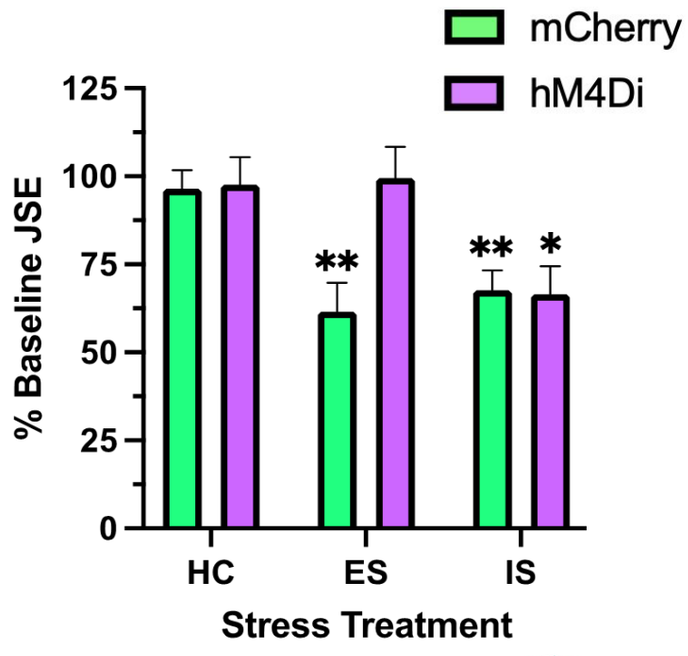
D1 antagonist







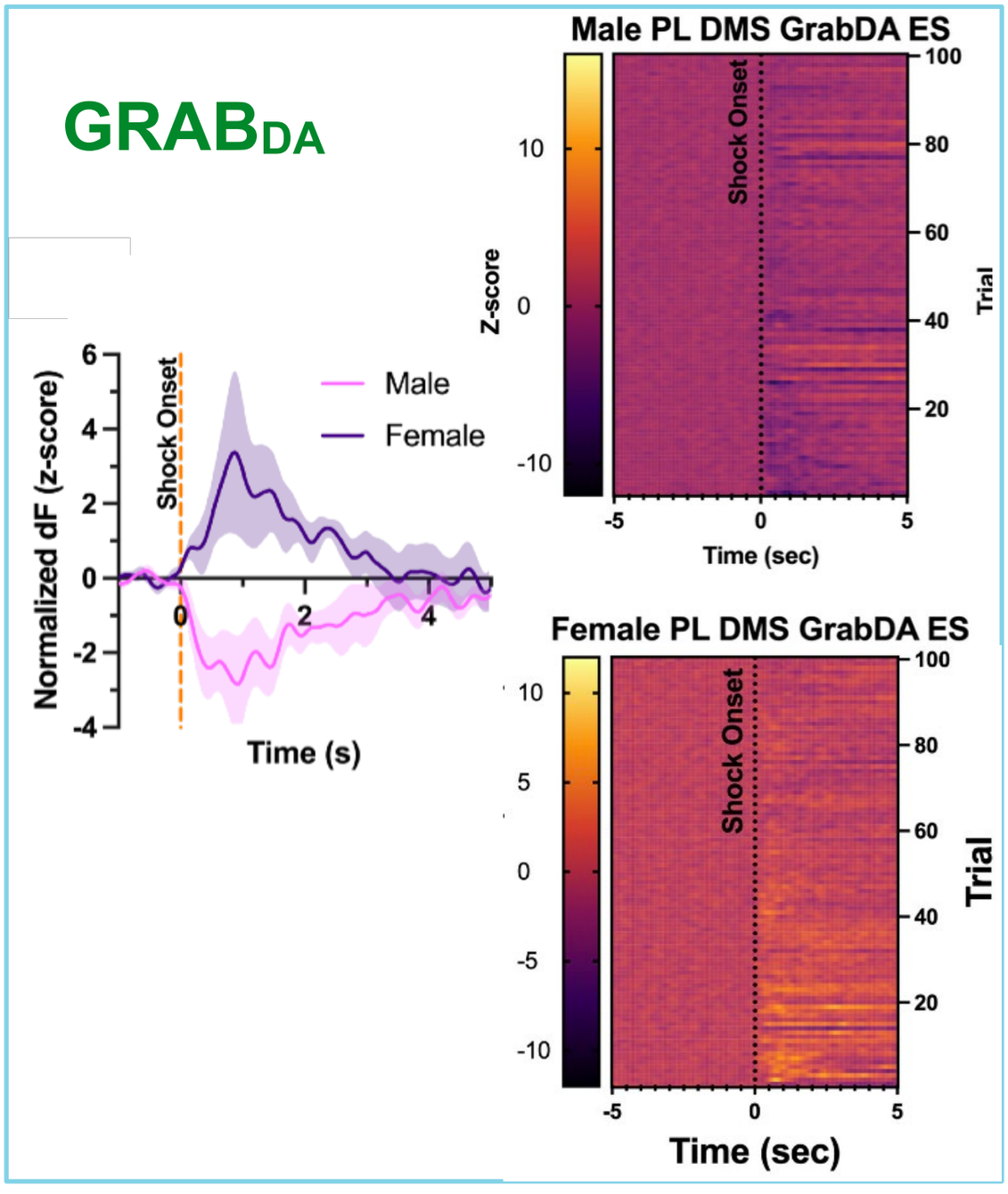




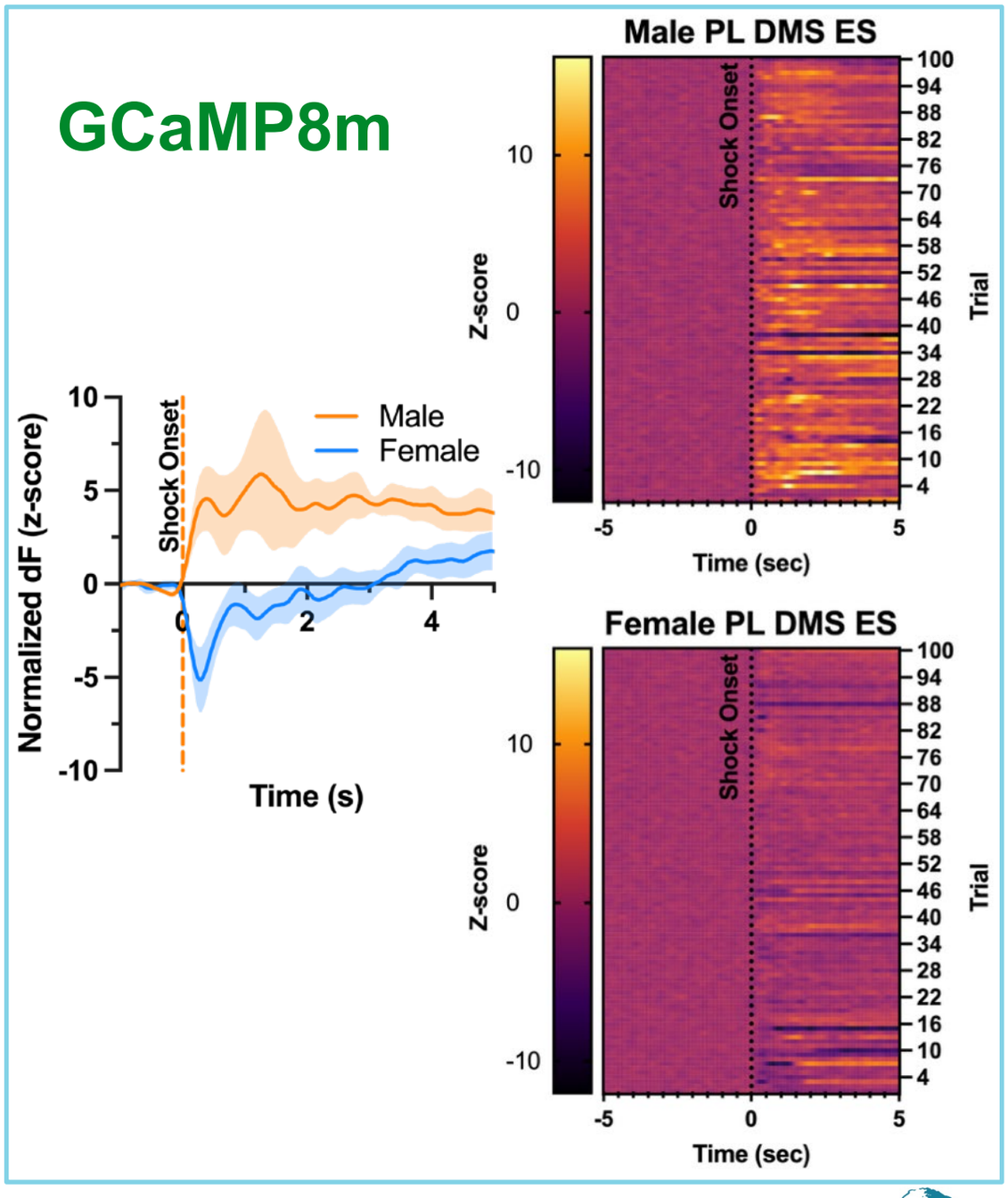
McNulty, Fallon et al., *Neuropsychopharmacology*, 2023; McNulty et al., *in preparation*

Behavioral control elicits opposite patterns of corticostriatal activity in males and females

GRAB$_{DA}$



GCaMP8m

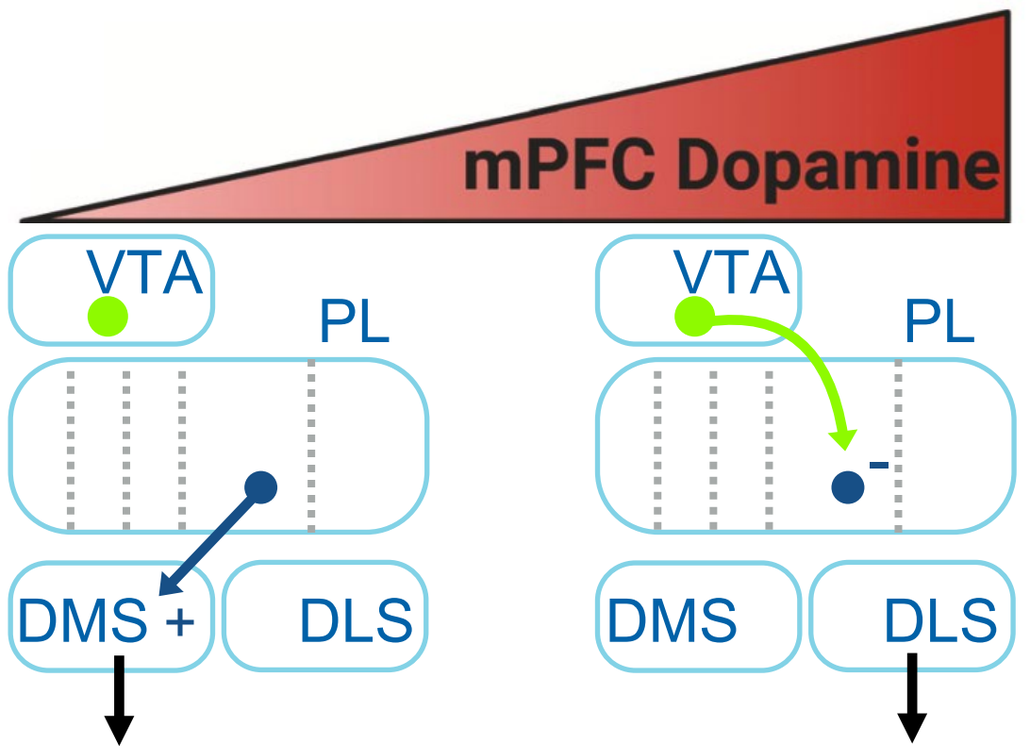


McNulty et al., *in preparation*

Summary

- *Aversively-motivated instrumental learning recruits different neural systems in females and males*

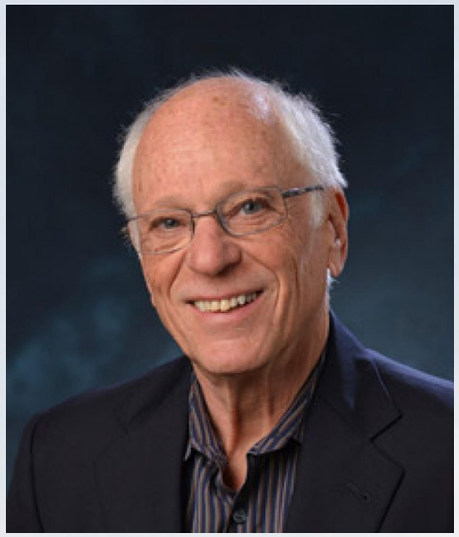
- *The operation of control is protective depending on the circuity that is used for its performance*



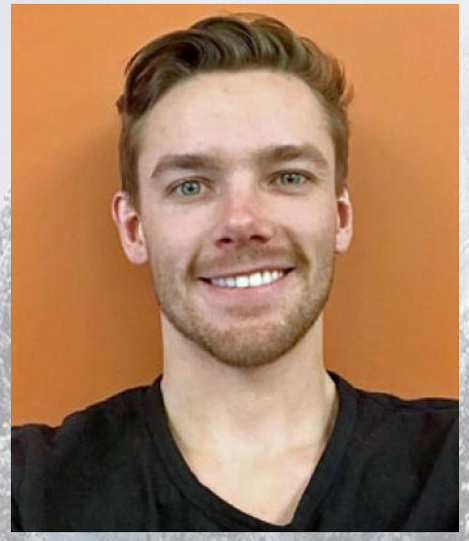
- *Reduced benefit from coping responses may represent a novel approach for understanding differential sex prevalence in stress-related psychiatric disorders*

Collaborators & Funding

Steven Maier



Jose Amat



Connor McNulty

Isabella Fallon

R21 MH106817

American Australian Association Fellowship

R21 MH116353

NARSAD Young Investigator

CU Anschutz-Boulder Nexus Initiative

R01 MH050479 [2024-]

R01 MH130576 [2024-]

Northeastern University

Rebecca Shansky

University of Toronto

Robert Rozeske

University of Colorado Boulder

David Root