



## Background

- Stress and mental health disorders are associated with decreased flexibility in learning, reflected in a diminished reliance on model-based behaviour<sup>1</sup>.
  - The impulse to approach reward-predictive cues and avoid punishment-predictive cues (Pavlovian bias) positively links to stress and psychopathology<sup>2</sup>.
  - Research has highlighted the importance of situation-specific shifting between habitual and more cognitively demanding modes of learning<sup>3</sup>.
- Under controllable situations in which actions can bring about desired outcomes a more flexible learning strategy may be called for, but in uncontrollable environments, less flexibility might become the more cost-effective tactic as one's actions are inconsequential in obtaining a goal<sup>4</sup>.

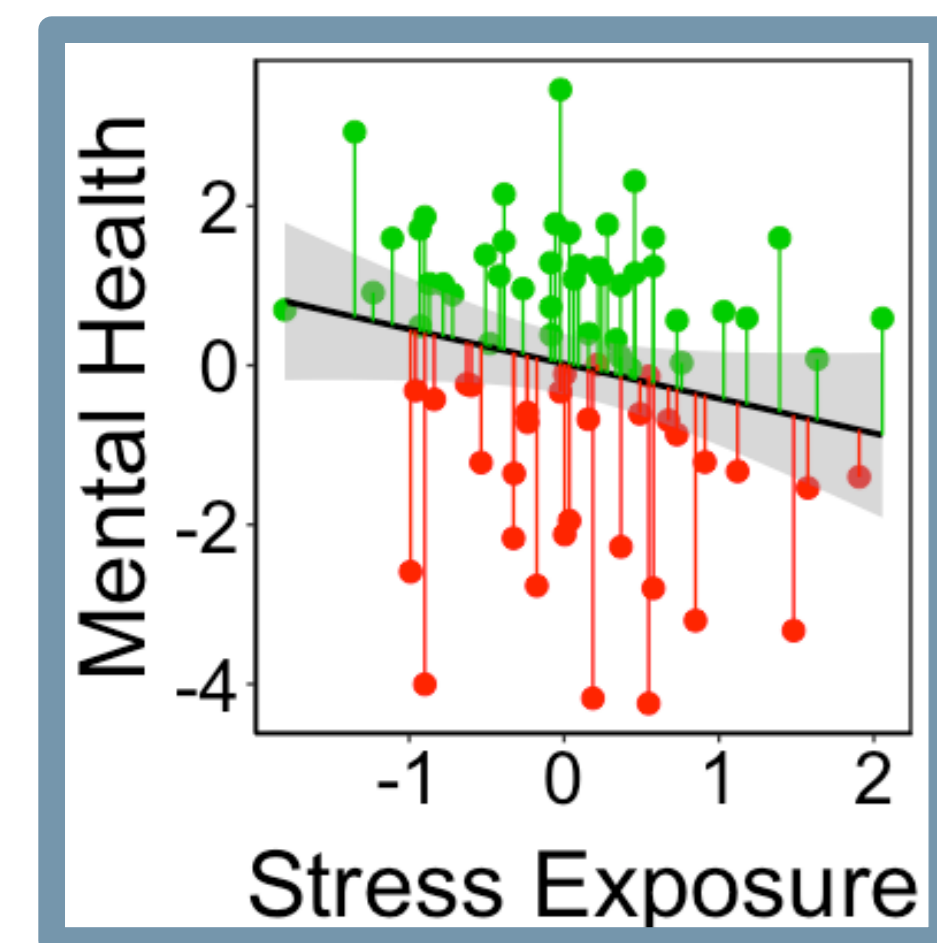
## Question

Are both the tendency to use a more flexible strategy and the ability to flexibly shift between strategies, depending on the controllability of the environment, positively related to resilience?

## Methods

76 participants ages 18-24 (68% female,  $M_{age} = 19$  years)

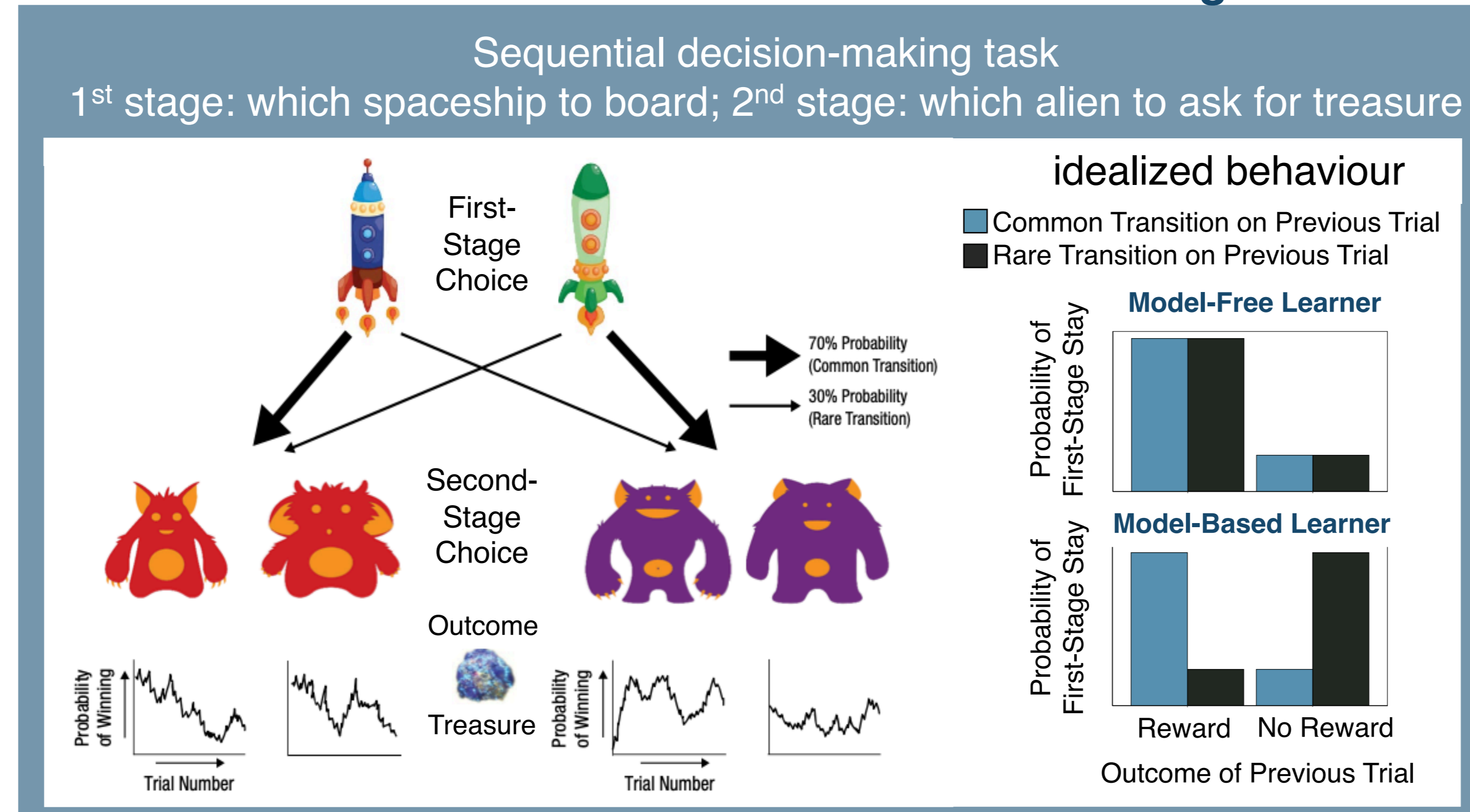
### Resilience<sup>5</sup>



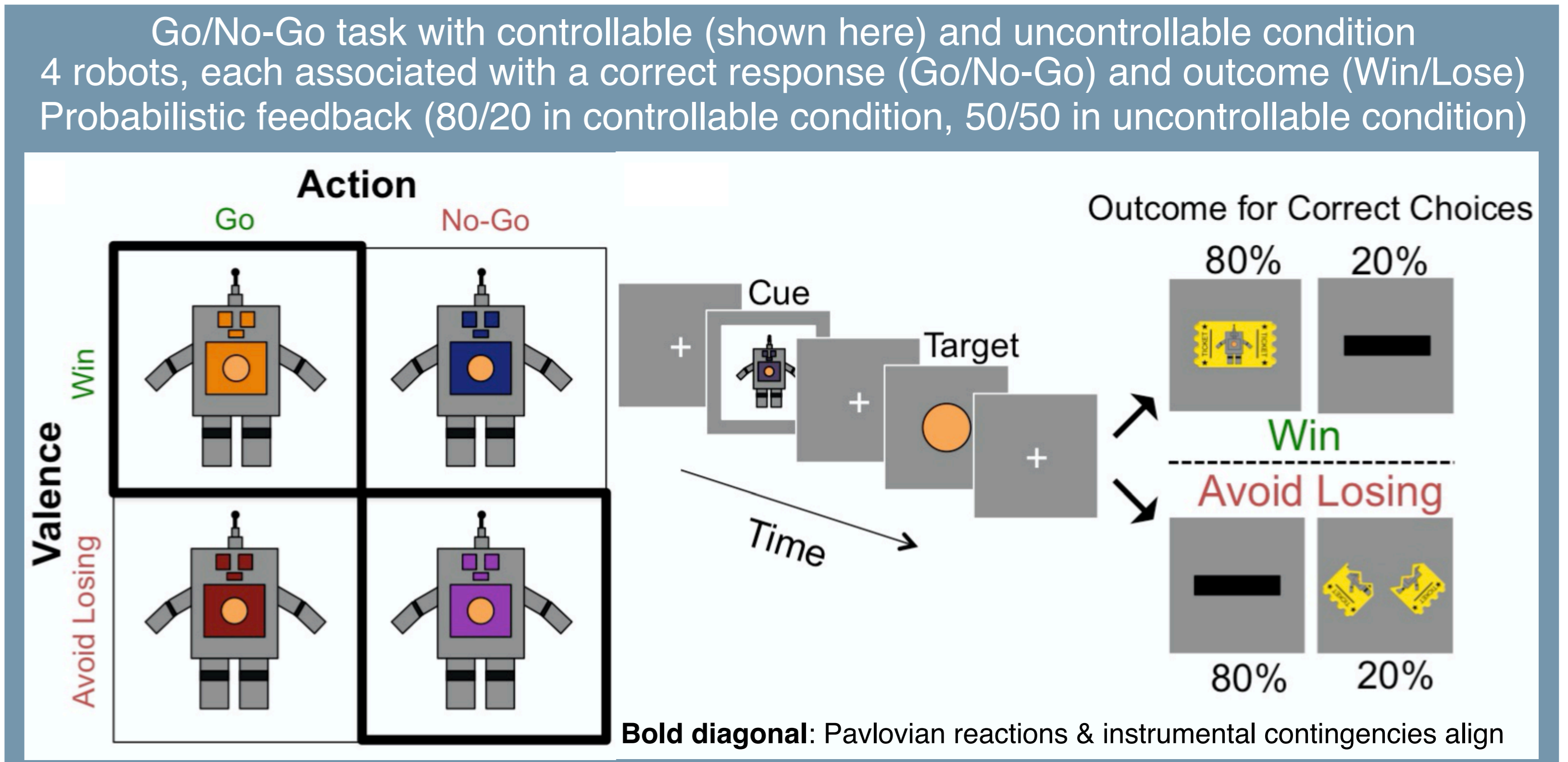
1. PCA to obtain principal stress and mental health components
2. Regressed 1<sup>st</sup> mental health component on 1<sup>st</sup> stress component
3. Residuals denote resilient functioning, i.e. how much better or worse than predicted an individual is functioning

- **Stress Exposure:** Daily Stress Inventory & Life Experiences Survey
- **Mental Health:** WHO-5 Well-Being Index & General Health Questionnaire-28

### Model-based and Model-free Learning<sup>6</sup>

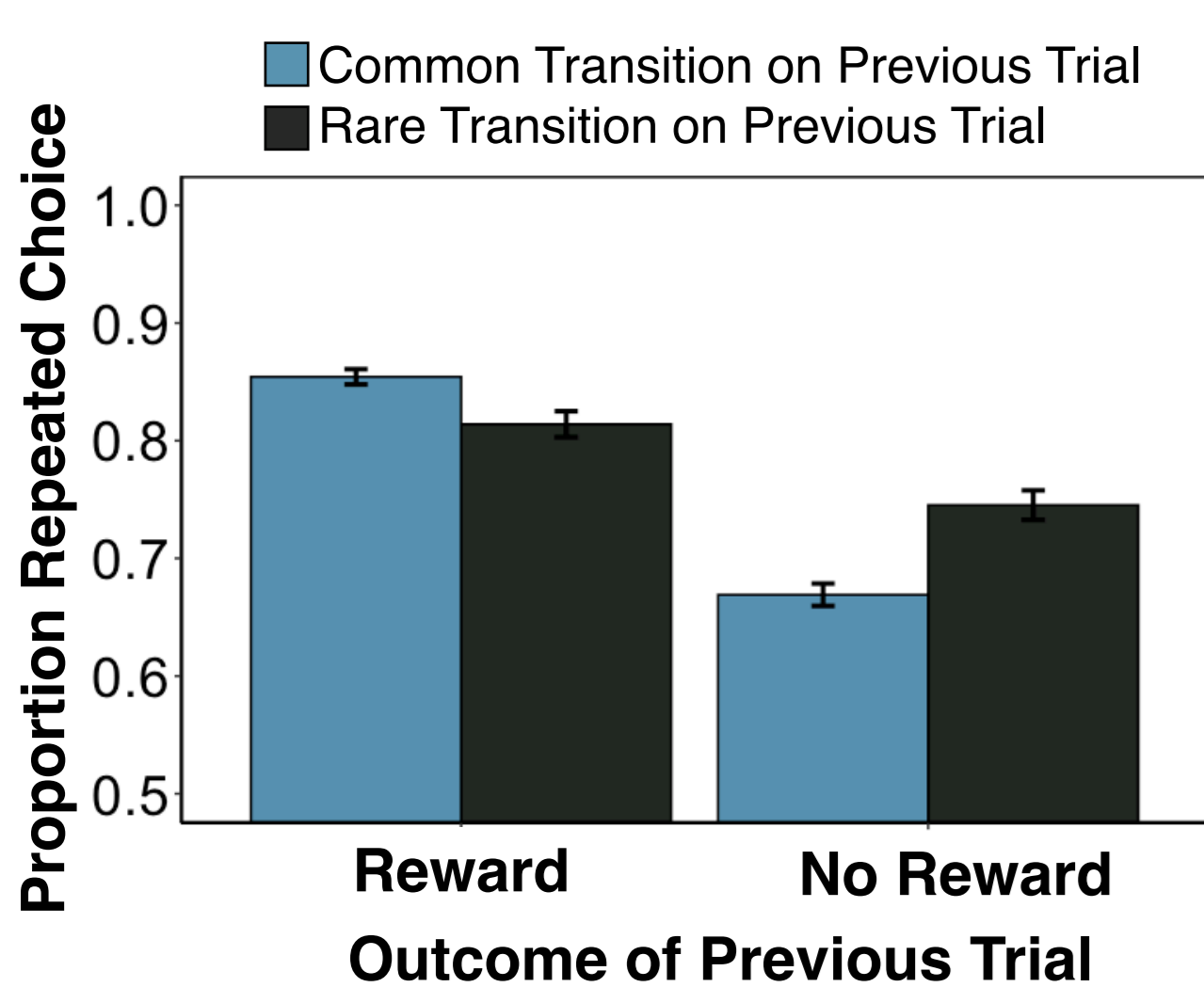


### Pavlovian Bias<sup>7</sup>



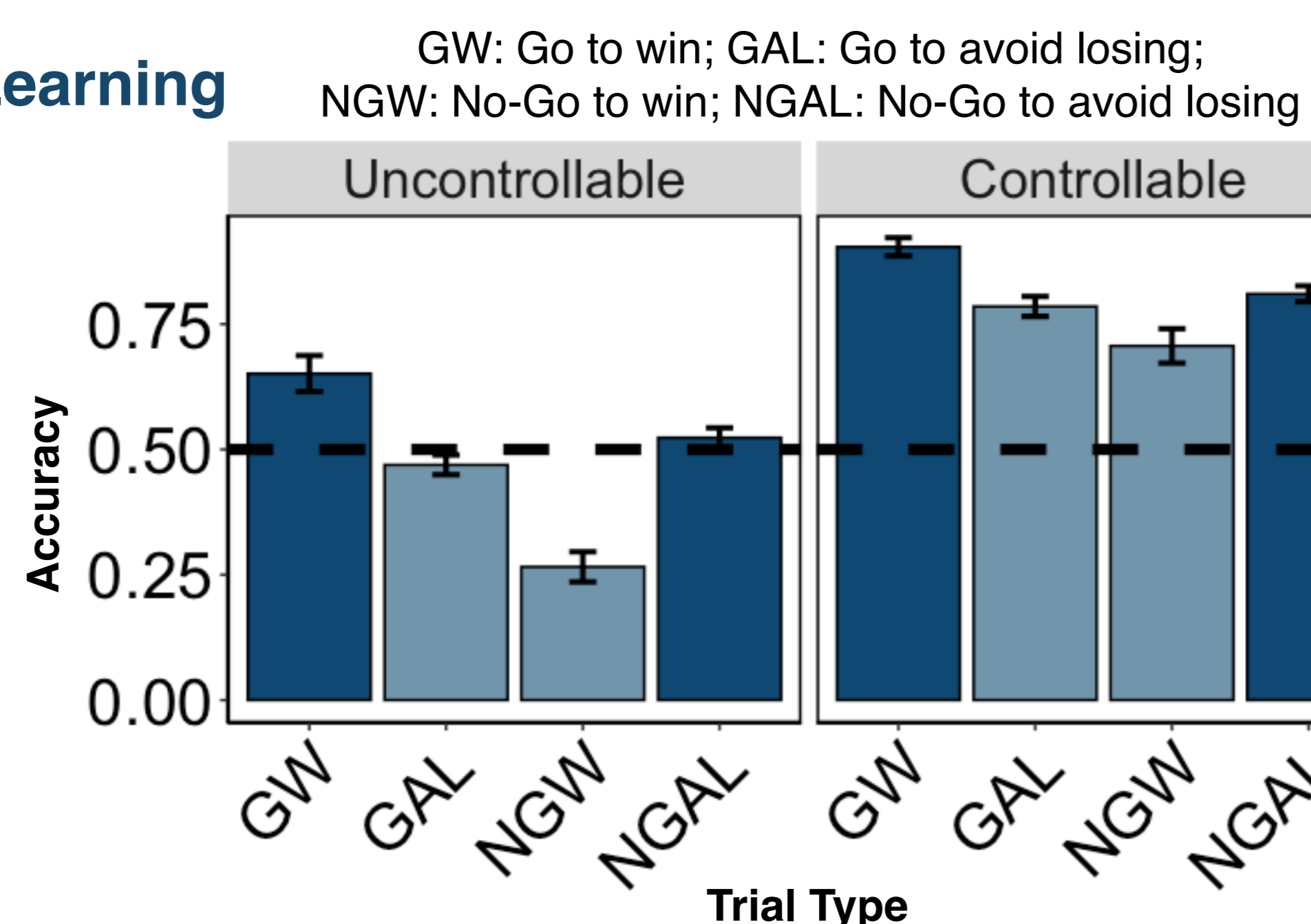
## Results

### Model-based and Model-free Learning



Participants employed a mixture of model-free and model-based choice strategies.

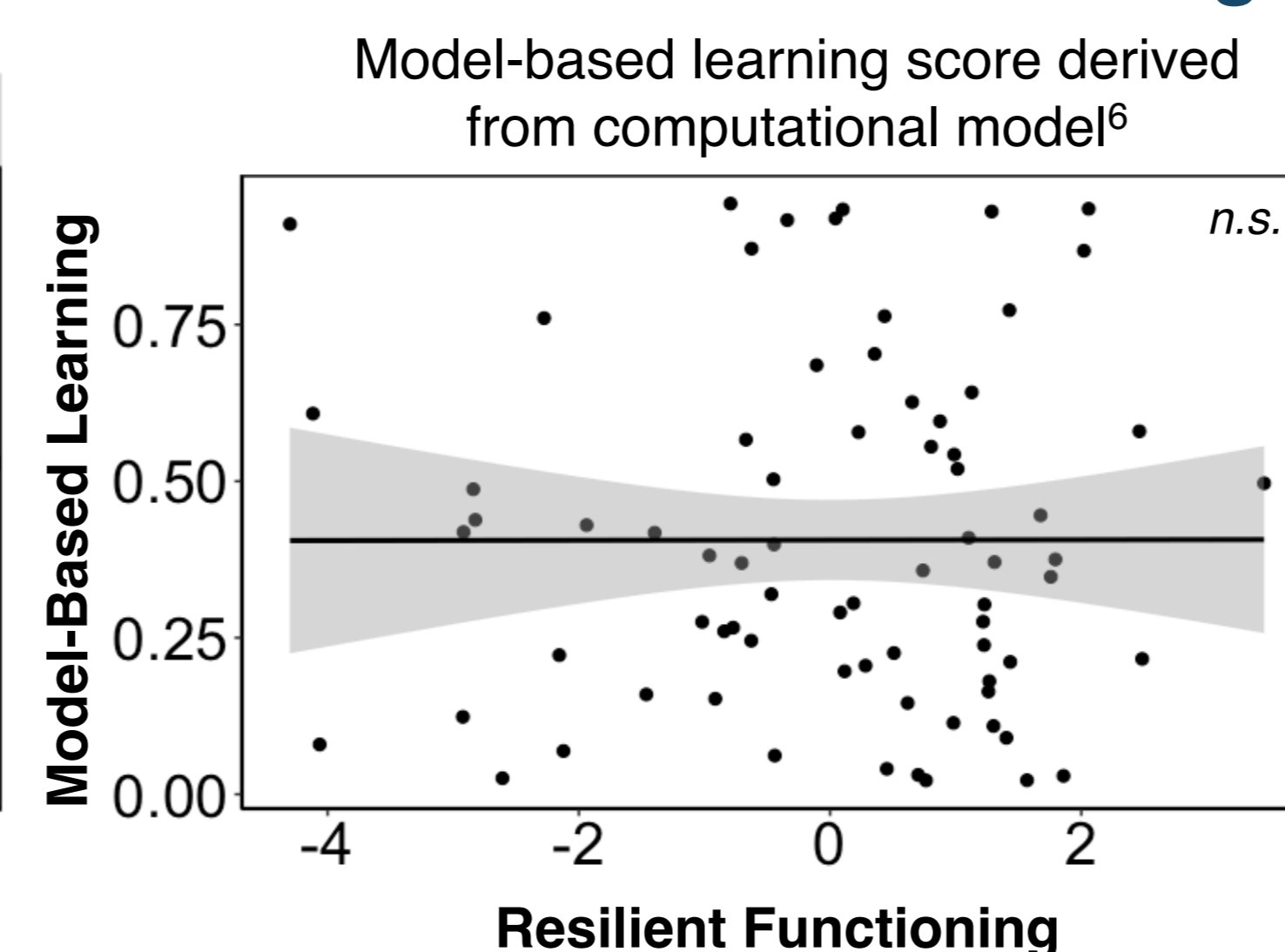
### Pavlovian Bias



Accuracy was reduced when Pavlovian tendencies conflicted with optimal instrumental response, demonstrating Pavlovian bias. Under lack of control, bias was enhanced.

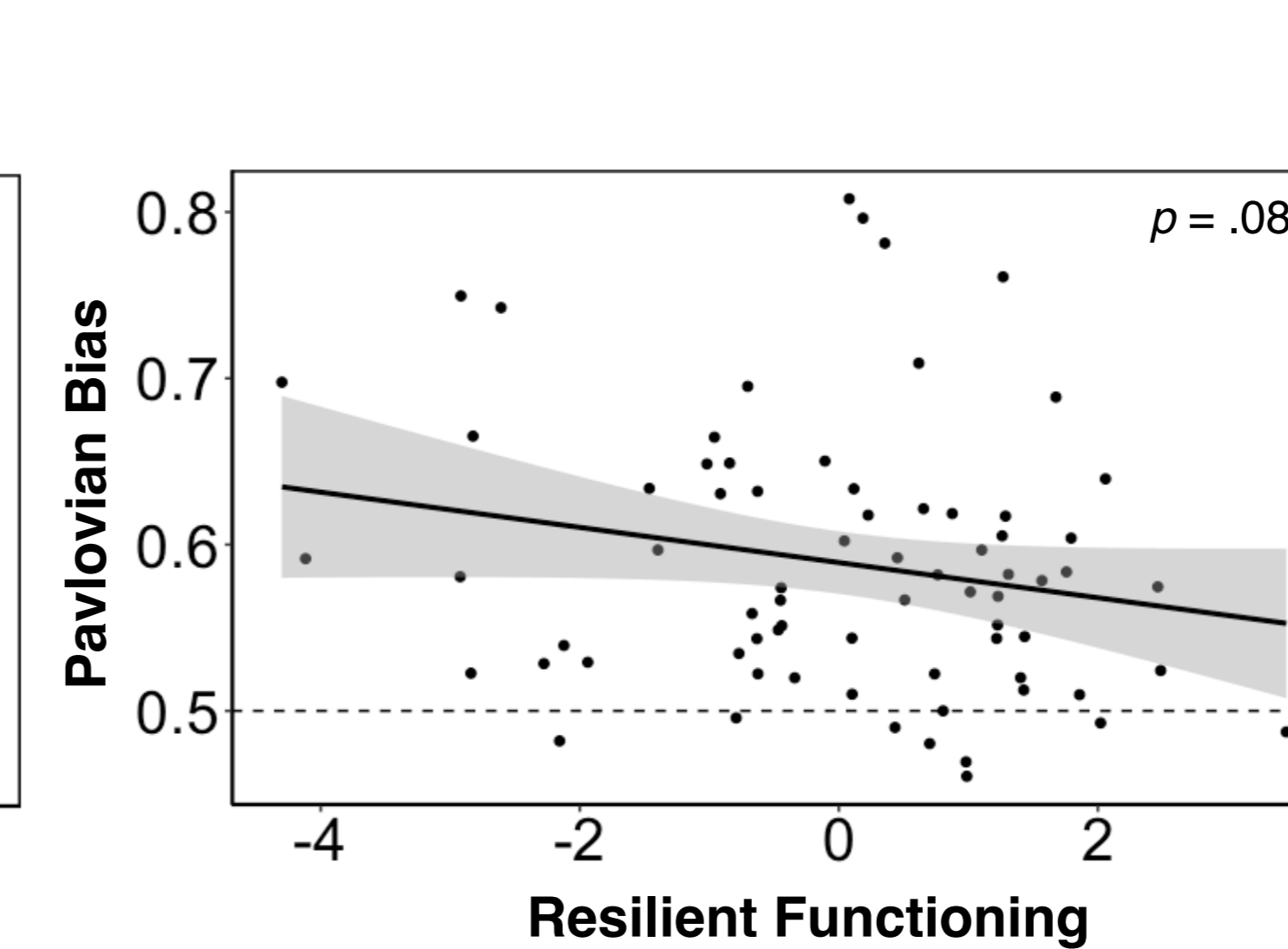
### Relating Resilience to ...

#### ... Model-based Learning



Model-based learning was not related to resilient functioning scores.

#### ... Pavlovian Bias



Lower resilient functioning was associated with overall greater Pavlovian bias, albeit not statistically significant. The difference in Pavlovian bias between conditions was not significantly moderated by resilient functioning scores.

## Discussion

- In line with prior research, participants displayed a mixture of model-based and model-free learning as well as greater Pavlovian bias under lack of control.
- Neither the degree of model-based learning, nor differences in Pavlovian bias were robustly related to resilient functioning in this sample.
- **Limitation:** stress exposure in this sample was moderate overall.

**Future Directions: computational modelling of Pavlovian and instrumental learning; investigate associations with locus of control**

<sup>1</sup>Voon et al. (2017). Model-based control in dimensional psychiatry. *Biol Psychiatry*.  
<sup>2</sup>Ousdal et al. (2018). The impact of traumatic stress on Pavlovian biases. *Psychol Med*.

<sup>3</sup>Wirz et al. (2018). Habits under stress: mechanistic insights across different types of learning. *Curr Opin Behav Sci*.  
<sup>4</sup>Dorfman & Gershman (2019). Controllability Governs the Balance Between Pavlovian and Instrumental Action Selection. *Nat Commun*.

<sup>5</sup>Van Harmelen et al. (2017). Adolescent friendships predict later resilient functioning across psychosocial domains in a healthy community cohort. *Psychol Med*.  
<sup>6</sup>Decker et al. (2016). From creatures of habit to goal-directed learners: Tracking the developmental emergence of model-based reinforcement learning. *Psychol Sci*.  
<sup>7</sup>Raab & Hartley (in press). Adolescents exhibit reduced Pavlovian biases on instrumental learning. *Sci Rep*.