

# Do early-life environments shape clinically relevant learning computations?

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## BACKGROUND

A major goal of computational psychiatry is to link clinical phenomena to underlying cognitive computations. Numerous psychiatric conditions emerge during development, suggesting a significant role for the early-life environment in the etiology of these disorders. However, many relationships between early life environments and cognitive computations have yet to be characterized.

To address this gap, we had 216 participants (planned sample size = 1000) aged 10-25 years old complete three learning and decision-making tasks and a self-report questionnaire on their childhood experiences.

## QUESTION

Are learning and decision-making computations optimized to early life environments? Can this explain individuals' vulnerability or resilience to mental illness?

## METHODS

### Measuring dimensions of early life experience

Participants completed a questionnaire on their social and emotional experiences during childhood. We assigned each of the questionnaire's 89 items to one of four dimensions a priori.

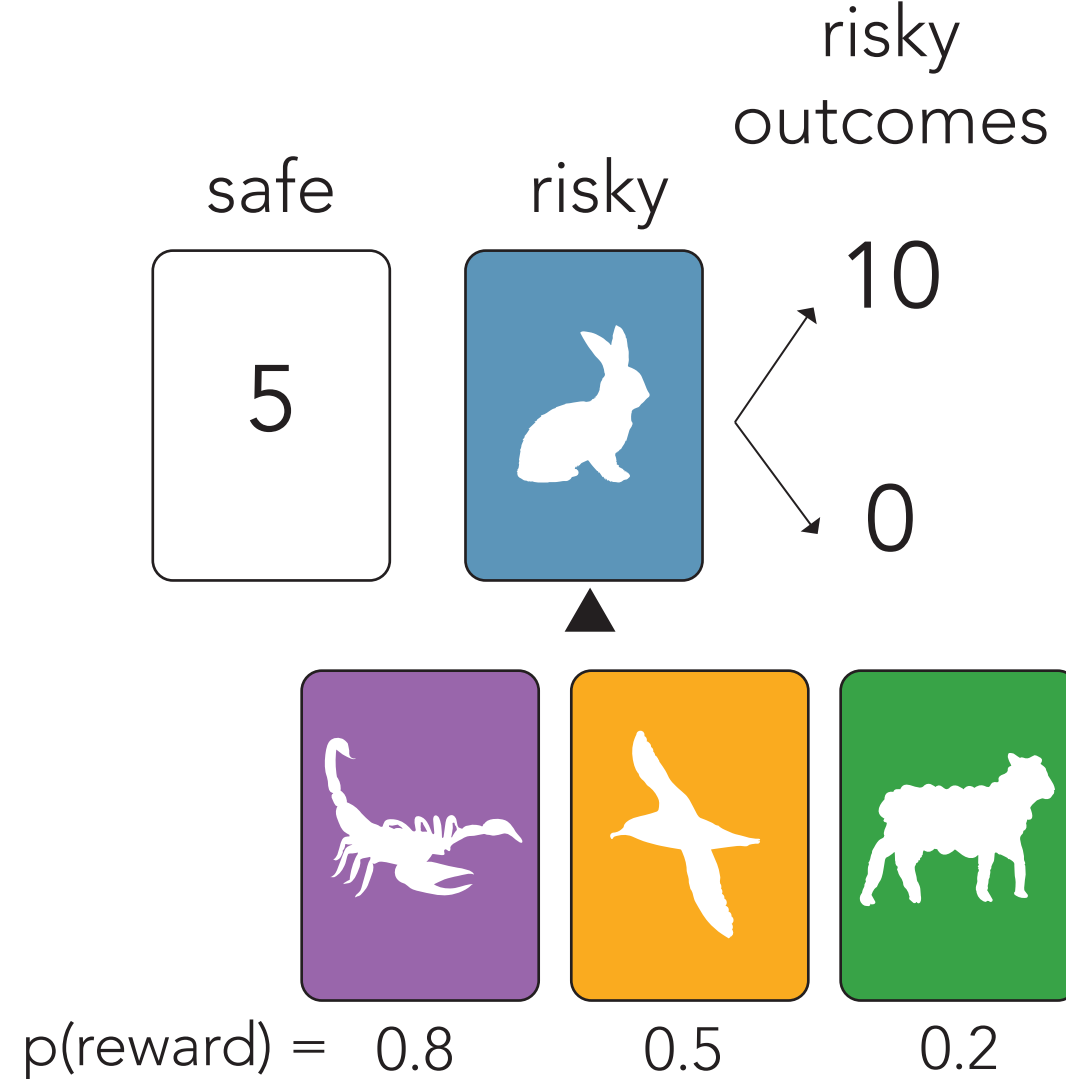
Factor analysis identified four latent dimensions of experience that partially overlapped with those we initially selected. All dimensions from the factor analysis were included in our analyses of model parameters.

	Factor 1	Factor 2	Factor 3	Factor 4
Representative Question	Uncontrollable harshness	Adult support	Peer support	Resource unpredictability
How often did an adult shake, pinch, or slap you?	0.76			
My caregiver(s) was/were always trying to change me.	0.59			
When you got punished, how often did it seem like it was for no good reason at all?	0.49			
How often did a caregiver help you learn more about things you were interested in (e.g., dinosaurs, nature, outer space, etc.)?		0.70		
How often did a caregiver show an interest in your thoughts and feelings?		0.58		
My teacher(s) noticed when I was doing a good job and let me know about it.		0.39		
I felt comfortable being myself around my close friend(s).			0.81	
My close friend(s) regularly made plans to spend time with me.			0.65	
How often did you participate in structured activities outside of class (e.g., playing on a sports team, music lessons, etc.)?			0.37	
How often was your electricity, heat, or water turned off?				0.58
How often did you not have a permanent place to live?				0.37
How worried were you about having something of yours stolen or damaged?				0.46

a priori dimensions

- reward prevalence
- threat prevalence
- unpredictability
- controllability

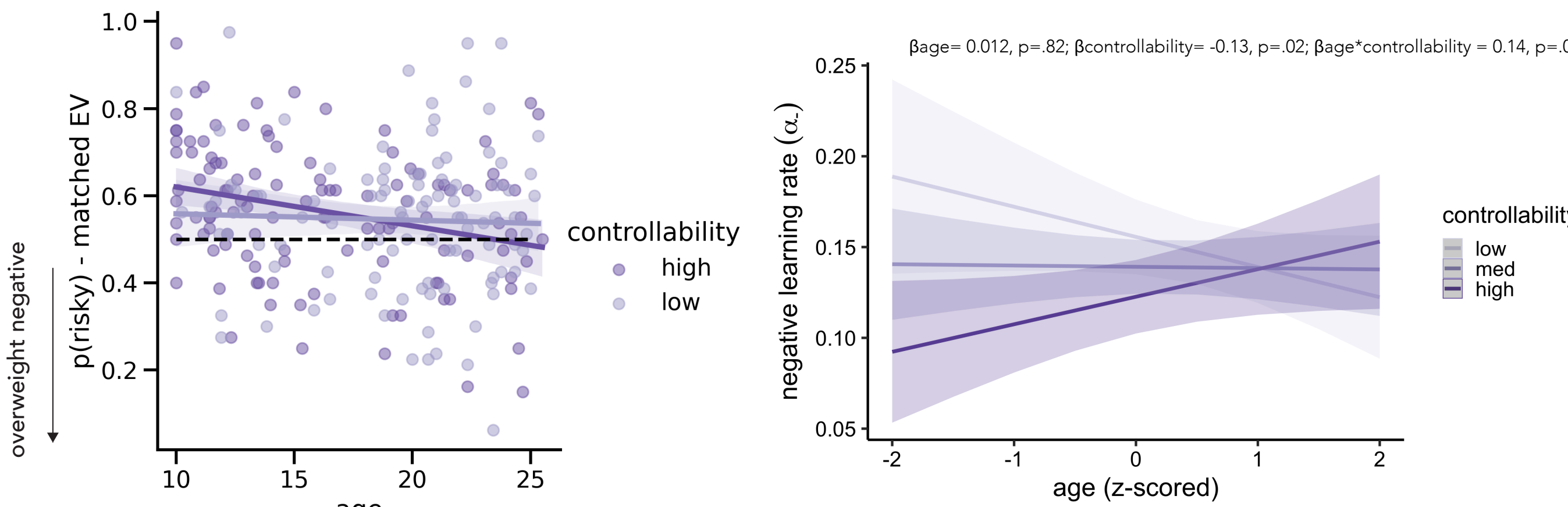
### Valence asymmetries in learning



We examined participants' risk preferences to identify asymmetries in how they weighed positive versus negative outcomes during learning.

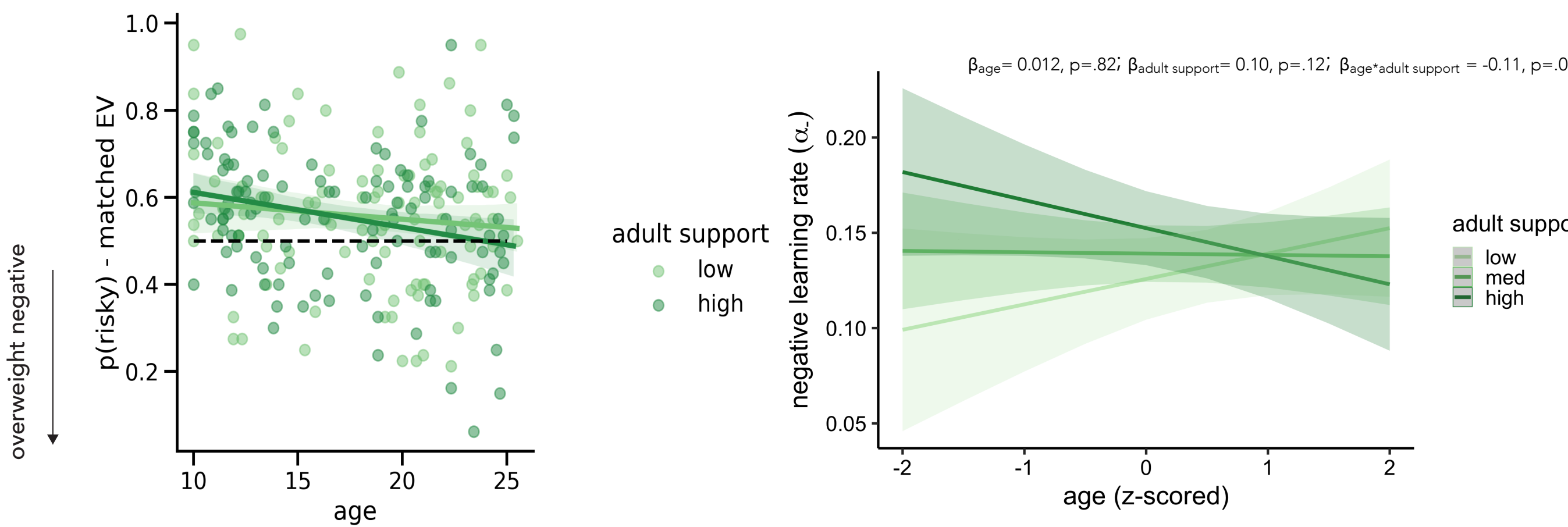
### H1: Less controllability will predict greater weighting of recent negative outcomes

Motivation: Anxiety, a disorder often preceded by early-life adversity, is associated with greater weighting of recent negative outcomes (Pike and Robinson, 2022).

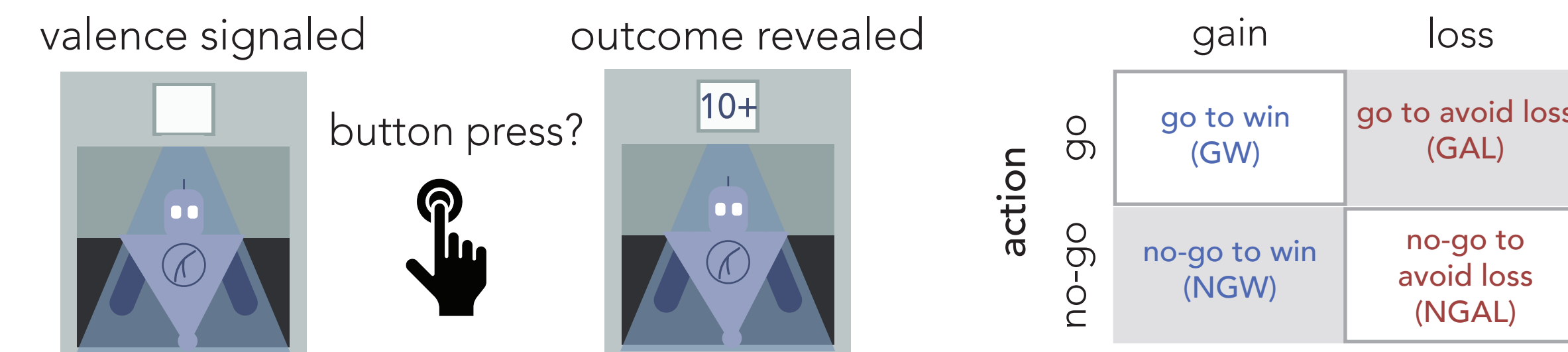


### H2: Greater reward prevalence will predict greater weighting of recent negative outcomes

Motivation: Theoretical work suggests that negative outcomes should be more heavily weighted when the average reward rate is high because these outcomes are relatively rare (Cazé & van der Meer, 2013).



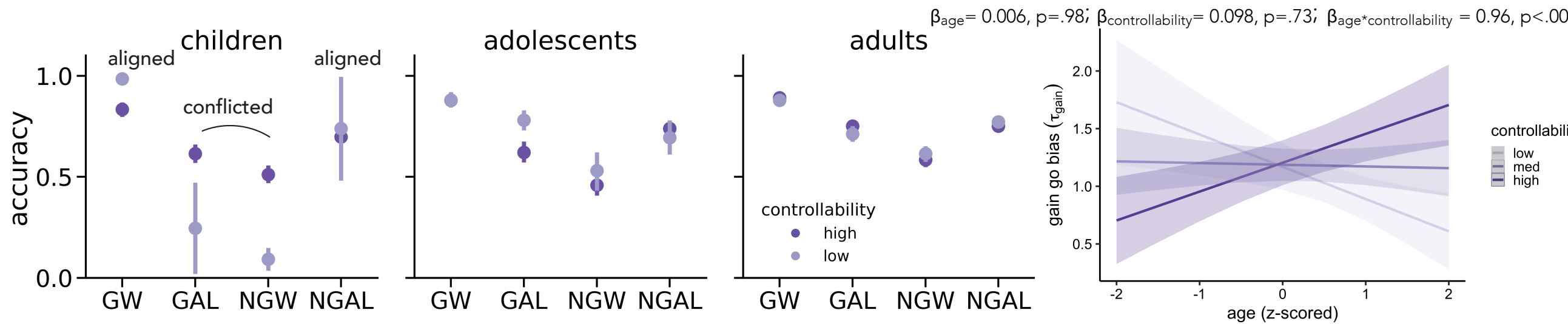
### Pavlovian bias



To quantify Pavlovian bias, we examined how performance differed between trials in which Pavlovian and instrumental values aligned (GW, NGAL) versus conflicted (NGW, GAL).

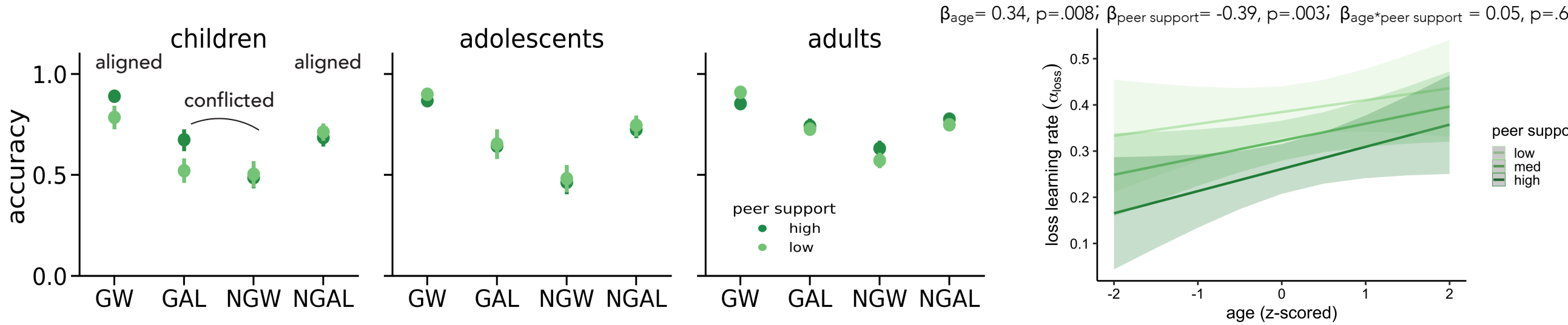
### H3: Less controllability will predict greater Pavlovian bias

Motivation: The environment's controllability should govern the reliance on passively learned Pavlovian values versus instrumental values (Huys and Dayan, 2009).

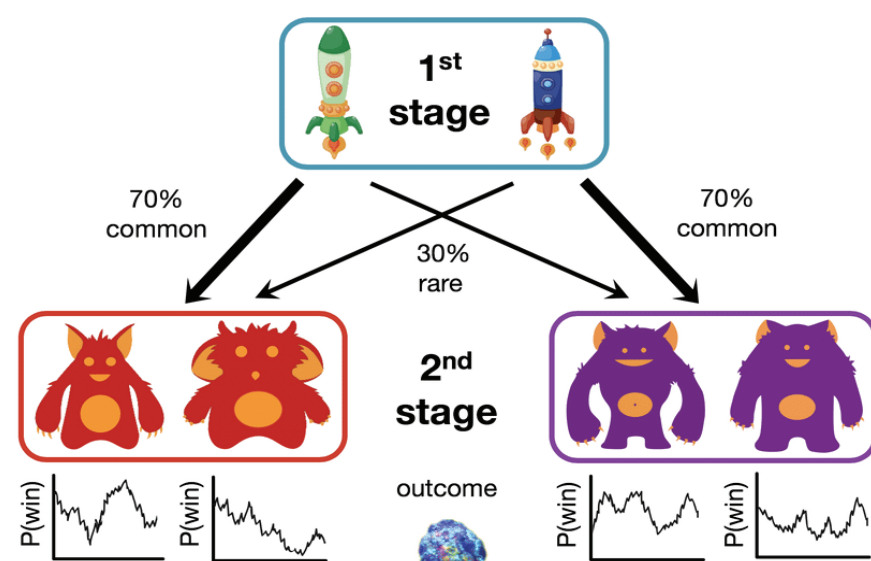


### H4: Less reward prevalence will predict less approach behavior

Motivation: Anxiety and depression, disorders often preceded by early-life adversity, are associated with reduced reward approach behavior (Trew, 2011).



### Model-based control



To measure model-based control, we examined the adjustment of first-stage decisions in response to the previous trial's transition.

Currently, we do not find any significant relationships between model-based control and the early-life environment.

### H5: Less predictability will predict less model-based control

Motivation: Unpredictability decreases the utility of long-term planning (Kool et al., 2016).

## OPEN QUESTIONS

We found that the early-life environment affects clinically relevant computations, but largely in still-developing younger individuals. How can we reconcile the developmental environment's seemingly transient effect on learning and decision-making computations with its known enduring impact on mental health?