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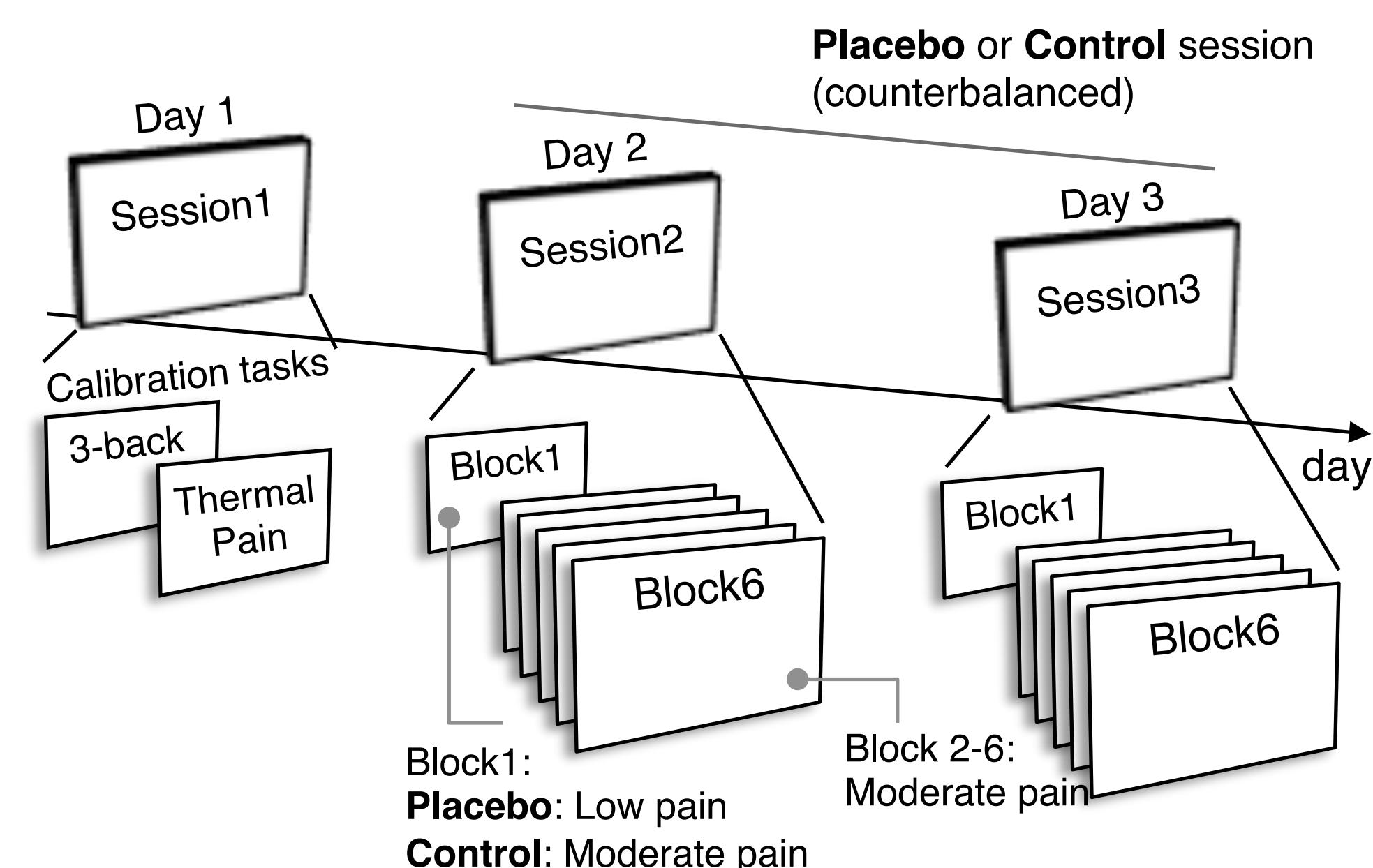
Contacts: [choongwan.woo@colorado.edu](mailto:choongwan.woo@colorado.edu) <http://wanirepo.github.io> [@clipsywoo](https://clipsywoo) [@wanirepo](https://wanirepo)

## Introduction

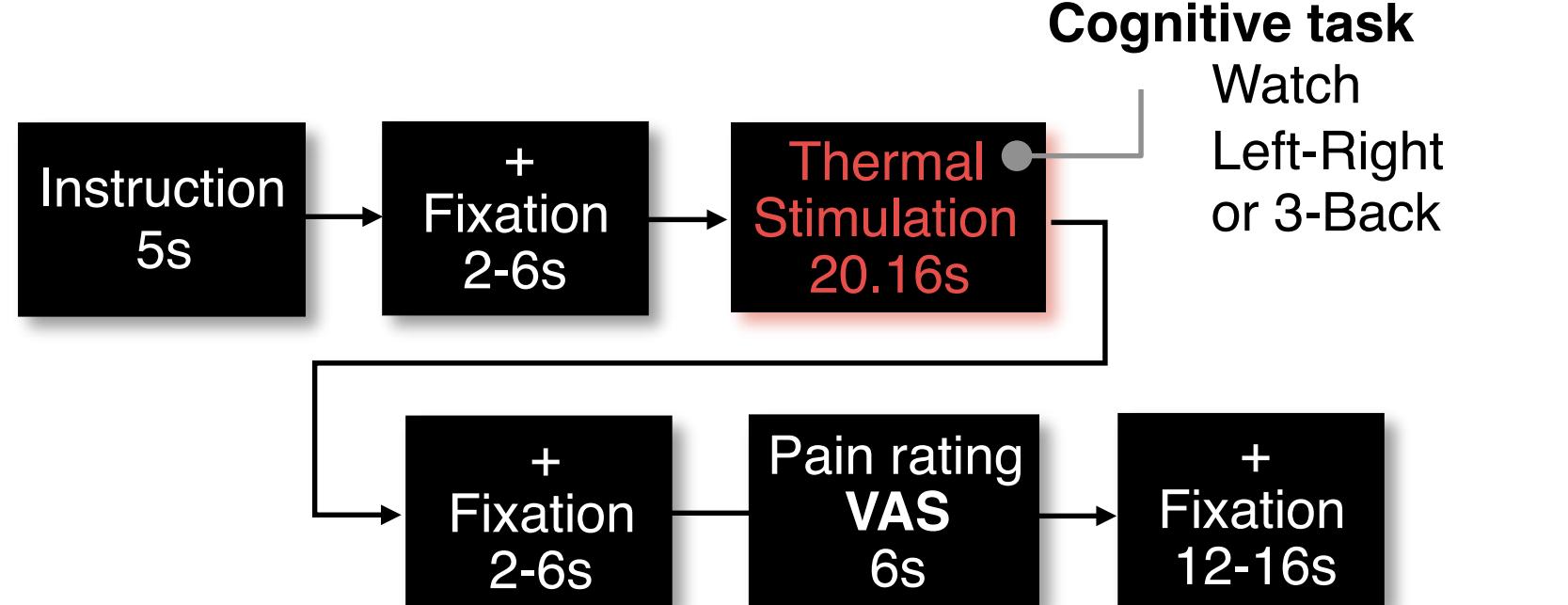
- **Distraction** and **placebo** are two effective psychological methods to alleviate pain.
- Our recent behavioral study<sup>1</sup> showed that **distraction** and **placebo** had additive, not interactive, effects on pain, suggesting that two distinct neural mechanisms underlie the effects of **distraction** and **placebo** on pain.
- Here, we examined whether there were separate neural mechanisms for **distraction** and **placebo** by answering the following questions:
  - Do **distraction** and **placebo** influence pain by affecting brain regions that mediate nociceptive pain?
  - What are the neural systems mediate the effects of **distraction** and **placebo**?
  - How do these systems interact with the primary nociceptive brain processes to reduce pain?

## Methods

- $N = 20$ , three experimental sessions on separate days
- In Session 2 and 3, we crossed a **distraction task** with an **expectancy-based placebo treatment** in the MRI scanner while participants experienced thermal pain on their left volar forearm.

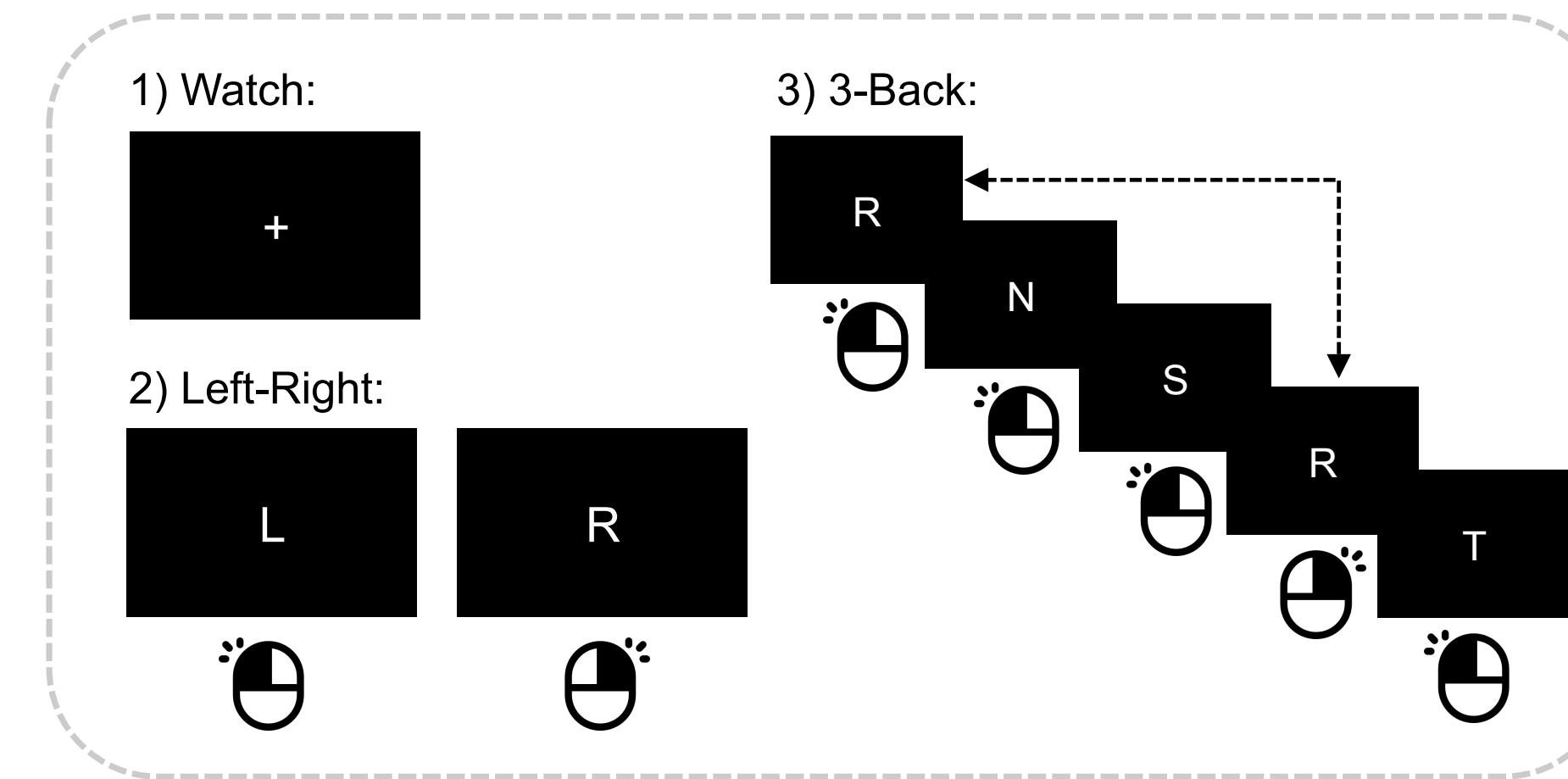


### Trial structure

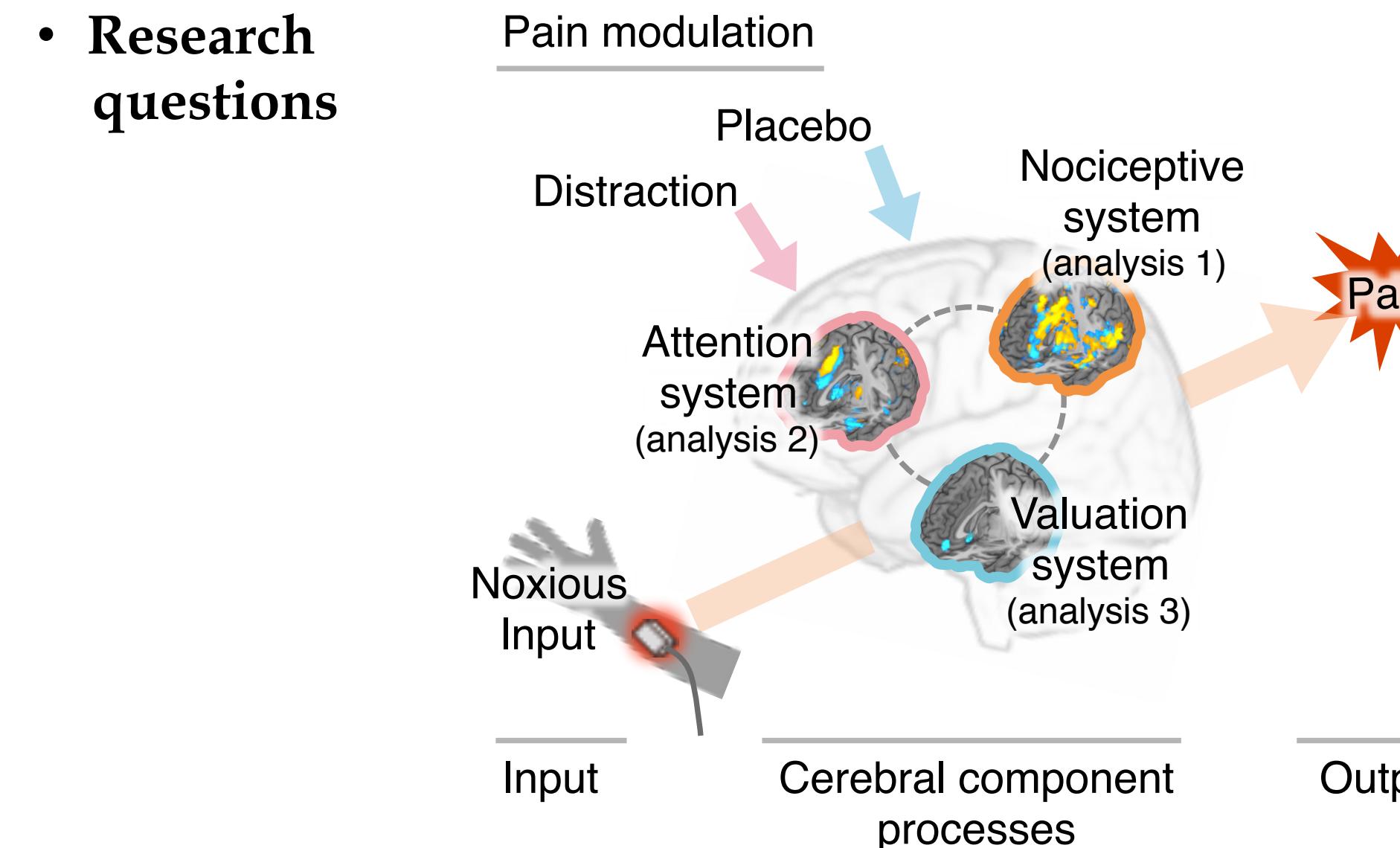


## Methods (cont.)

### Cognitive tasks for distraction



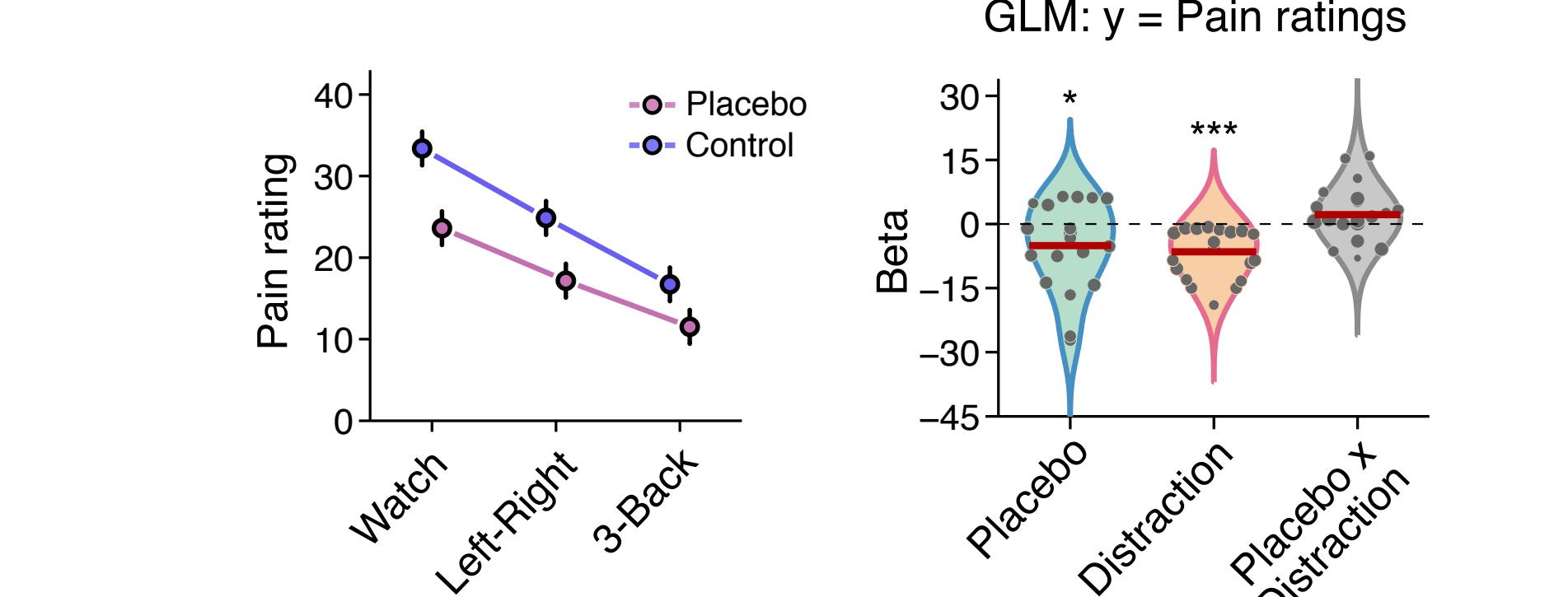
### Research questions



## Results

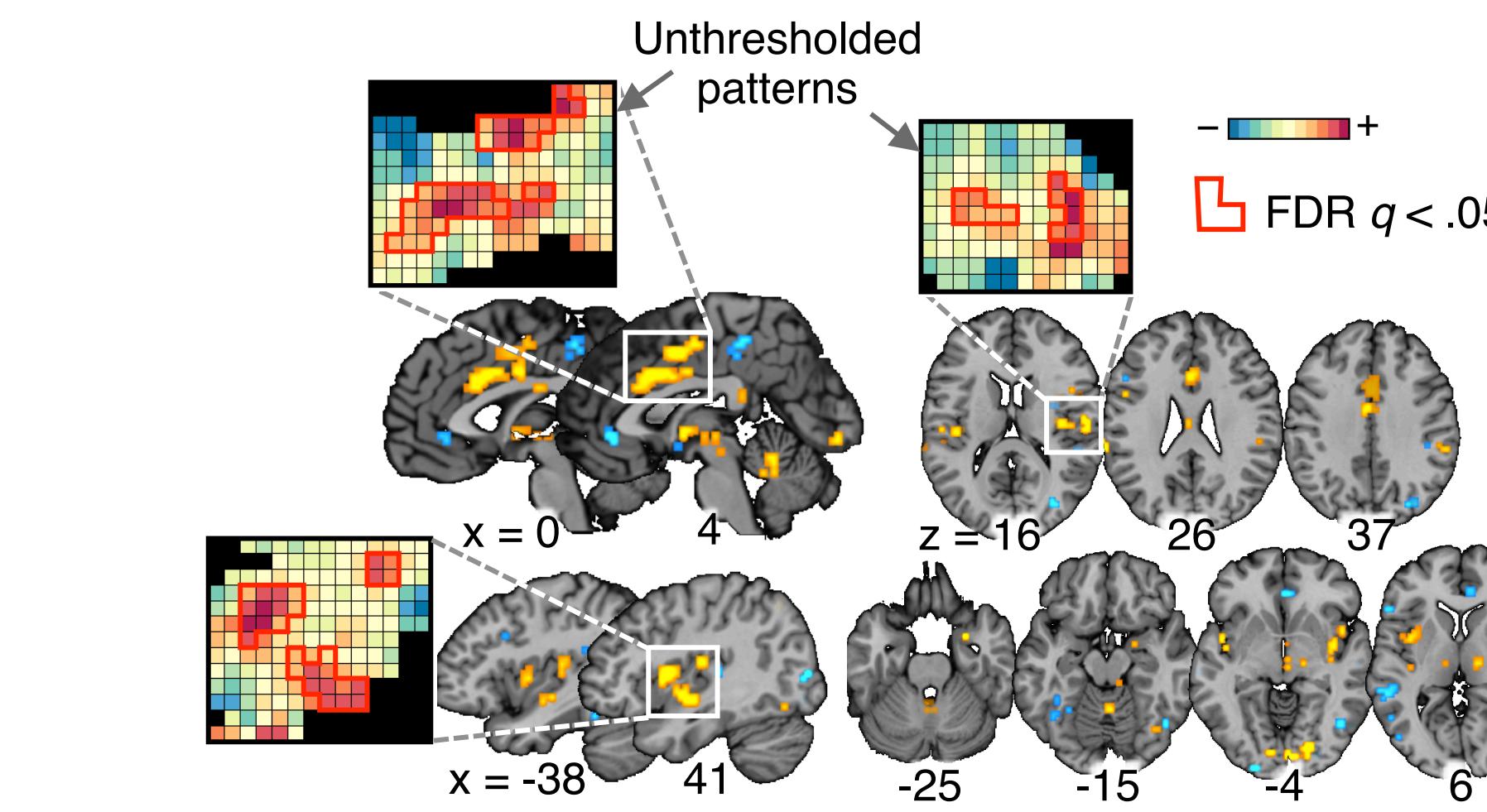
### Analysis 1: Effects on the nociceptive brain system

#### Effects on pain ratings



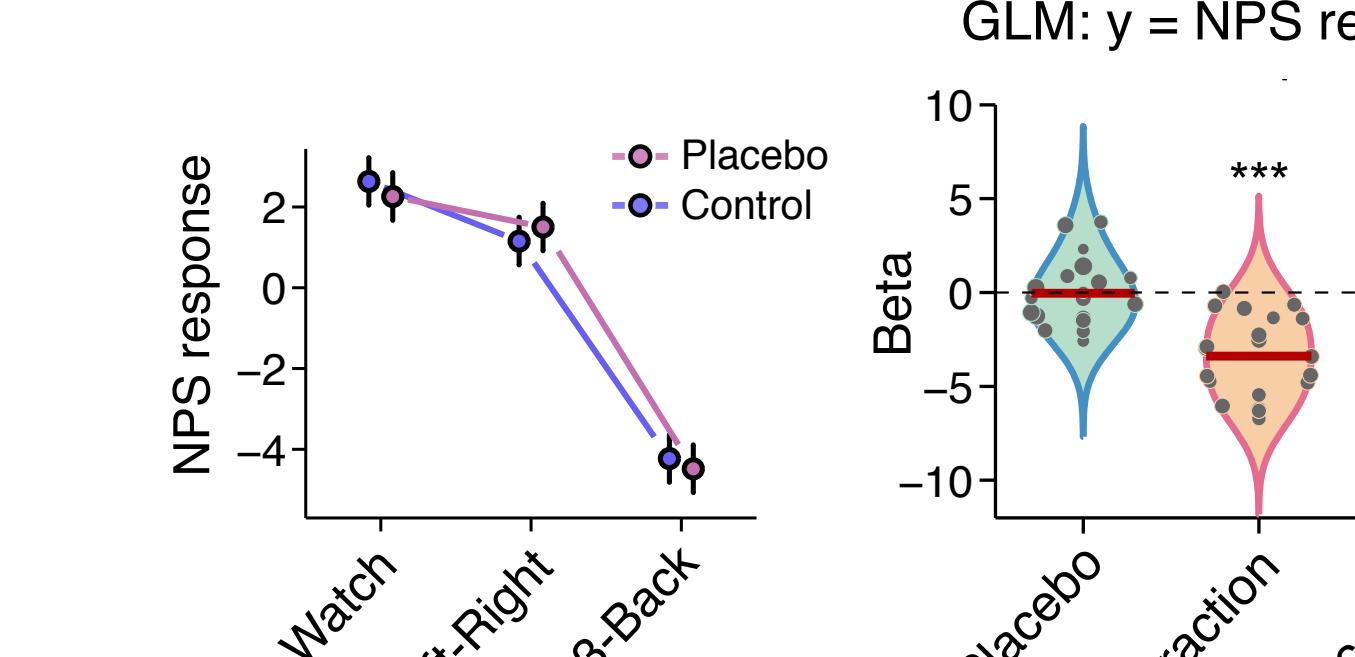
#### Examining the effects on the Neurologic pain signature (NPS)<sup>2</sup>

NPS 101: The NPS has shown to be sensitive and specific to nociceptive pain experience through multiple previous studies. It is activated by noxious heat, pressure, and electric shock. It does not respond to emotional picture, vicarious pain, social pain, pain anticipation, pain memory, warmth, and cognitive reappraisal of pain.



## Results (cont.)

### Effects on the NPS

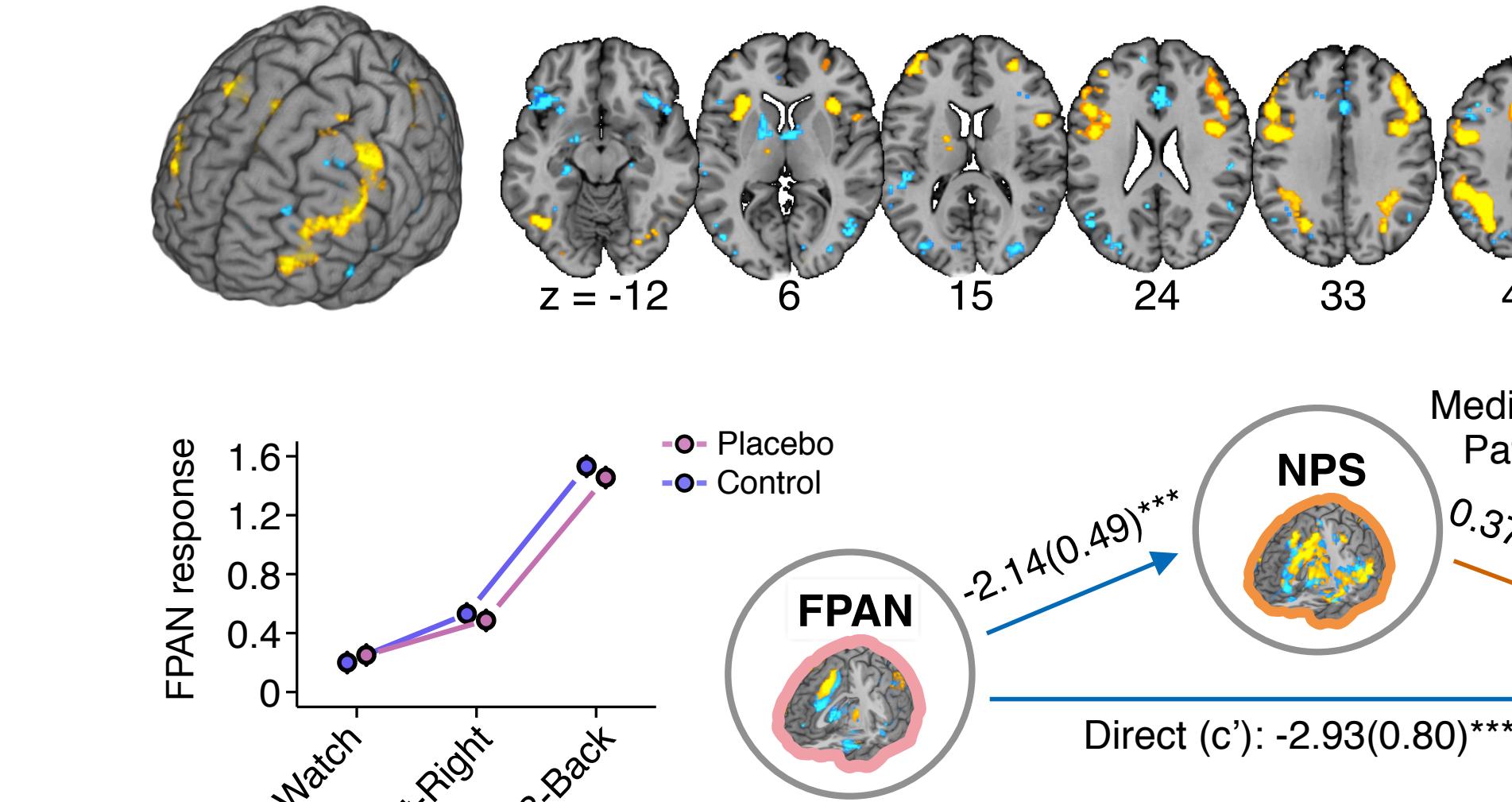


#### Take-home:

1. Both distraction and placebo produced significant, additive reductions in pain ratings, replicating previous work.
2. NPS mediated the distraction effects on pain, but not the placebo effects.

### Analysis 2: Effects on the fronto-parietal control network

#### FMRI multivariate signature for fronto-parietal attention network (FPAN) (FDR $q < .05$ )

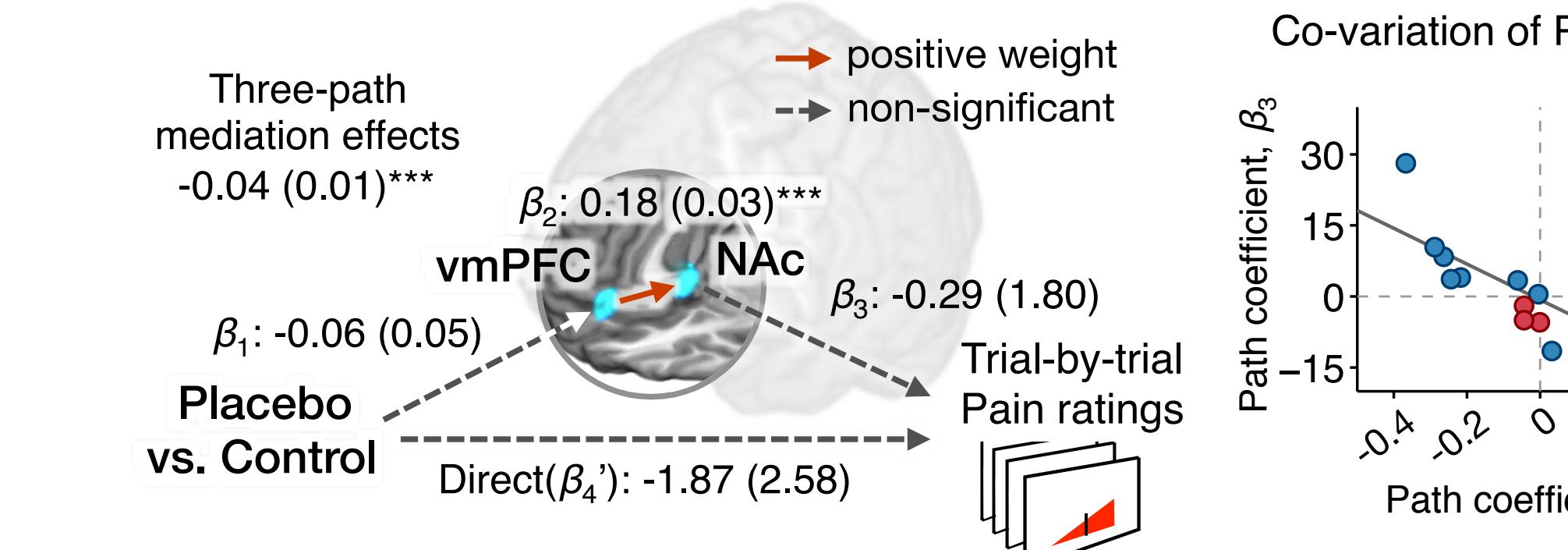


#### Take-home:

1. Increased fronto-parietal activity due to cognitive tasks was significantly correlated with the reductions in pain ratings, and this relationship was mediated by the NPS.
2. The relationship between the fronto-parietal network and the NPS was moderated by cognitive demand.

### Analysis 3: Effects on the valuation system (ventro-medial PFC and nucleus accumbens)

#### Three-path mediation for placebo effects (using *a priori* regions-of-interest)



#### Take-home:

- Placebo effects, but not distraction effects, were mediated by the vmPFC-NAc pathway, which is previously shown to mediate the effects of cognitive self-regulation of pain<sup>3</sup>.

## Conclusion

- **Distraction** and **placebo** both reduce pain, but they rely on distinct neural mechanisms.
- **Distraction** reduces pain by competing for cognitive resources in fronto-parietal systems that nociceptive pain systems also need.
- **Placebo** reduces pain through a ventromedial prefrontal-striatal pathway associated with pain valuation.
- These findings provide empirical evidence that multiple systems are involved in pain relief, and demonstrate that these systems can work together to maximize pain relief without mutual interference.

