

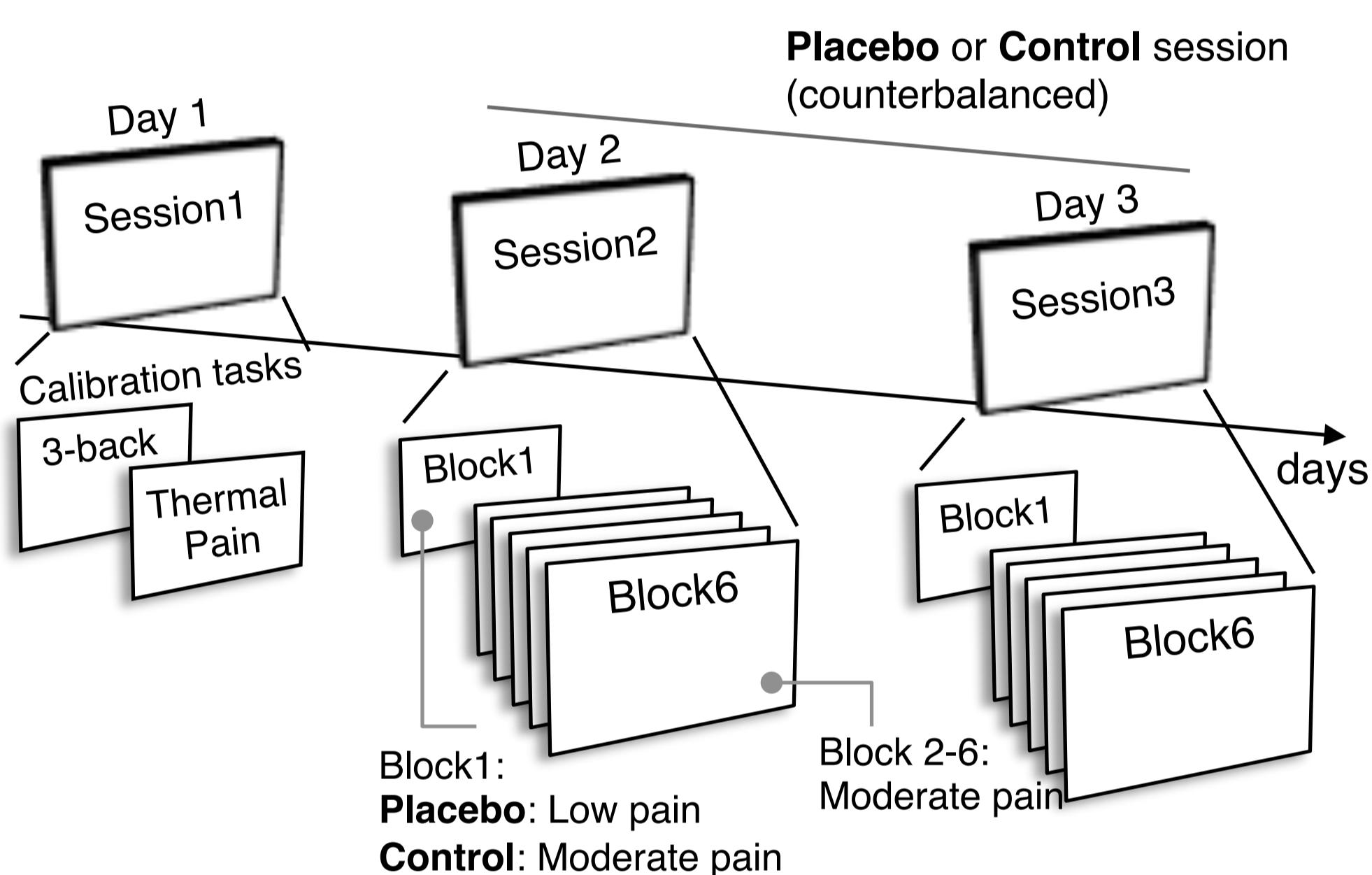
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## Introduction

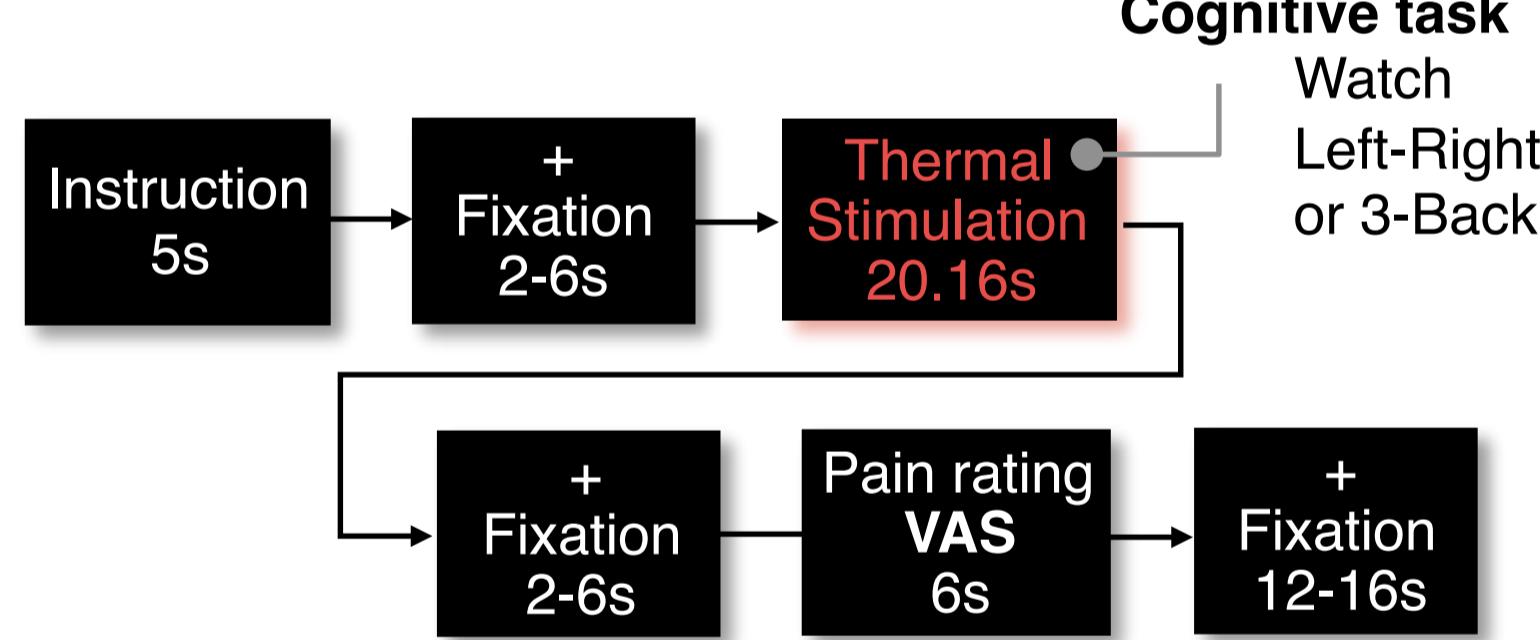
- **Distraction** and **placebo** are two effective psychological methods to alleviate pain.
- Our recent behavioral study<sup>1</sup> showed that **distraction** and **placebo** had additive, not interactive, effects on pain, suggesting that two distinct neural mechanisms underlie the effects of **distraction** 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 responsible for **distraction** and **placebo**?
  - How do these systems interact with the primary nociceptive brain processes to reduce pain?

## Methods

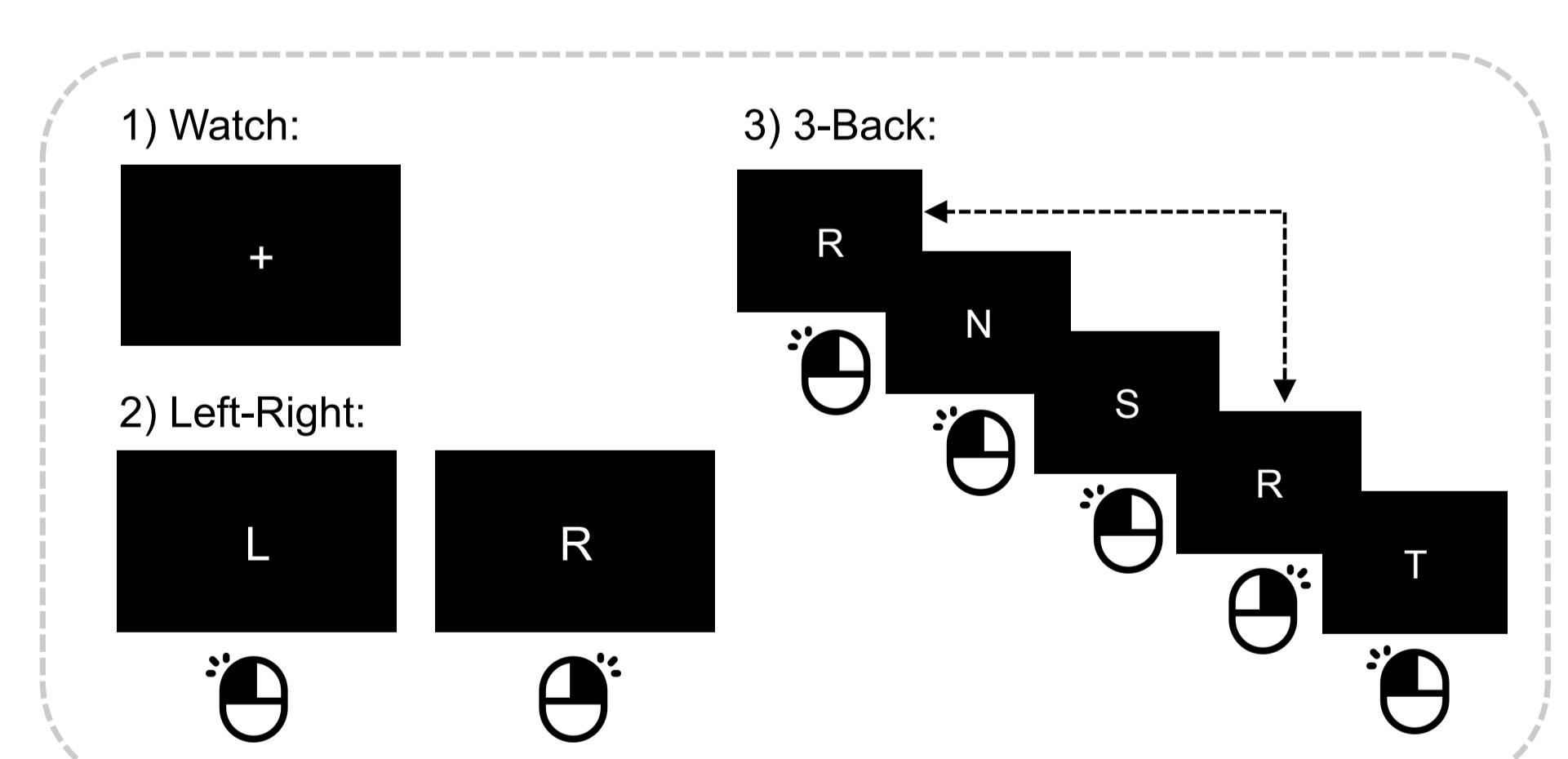
- $N = 20$ , three experimental sessions on separate days
- In Session 2 and 3, we crossed a **distraction task** with an **expectancy-based placebo treatment** in the MRI scanner while participants experienced thermal pain on their left volar forearm.



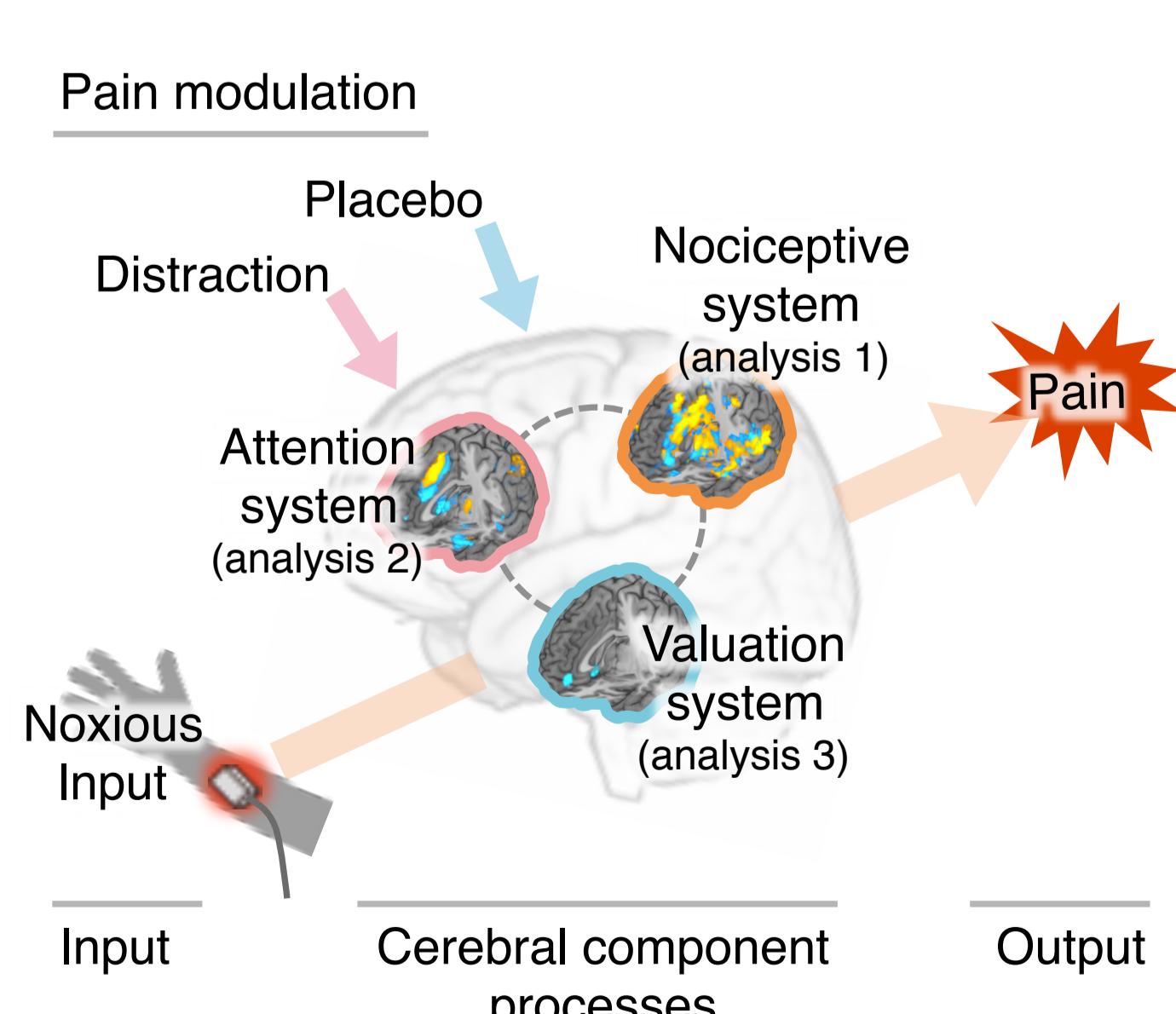
### Trial structure



### Cognitive tasks for distraction



### Research questions

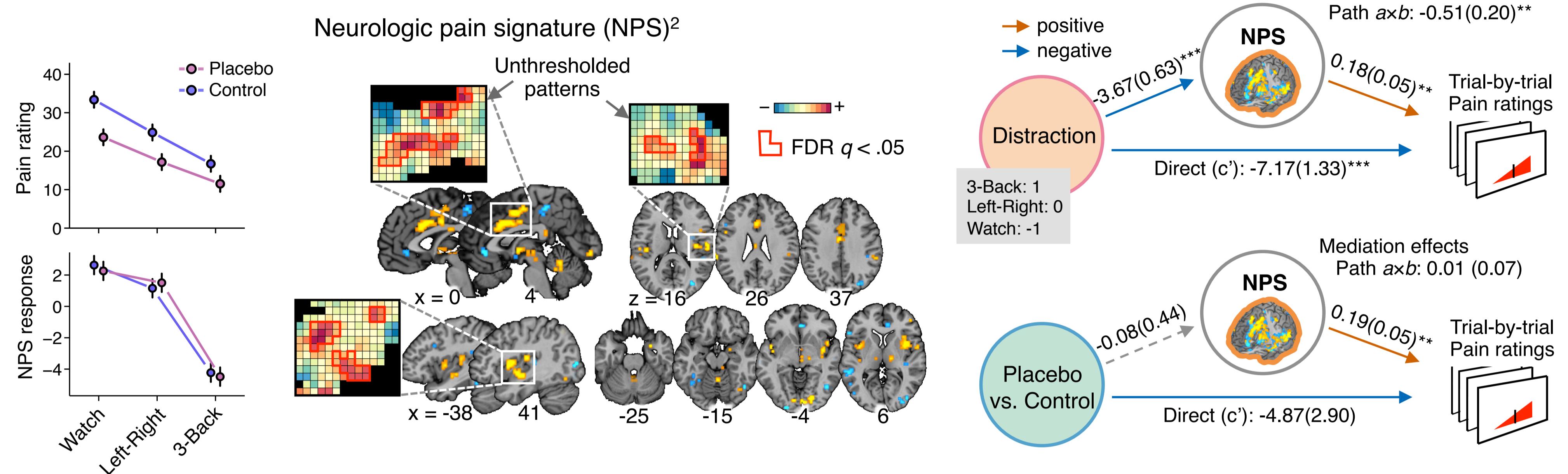


## References

- 1 Buhle et al., *Psychological Science*, **23**, 246-253
- 2 Wager et al., *The New England Journal of Medicine*, **368**, 1388-1397
- 3 Woo et al., *PLoS Biology*, **13**, e1002036

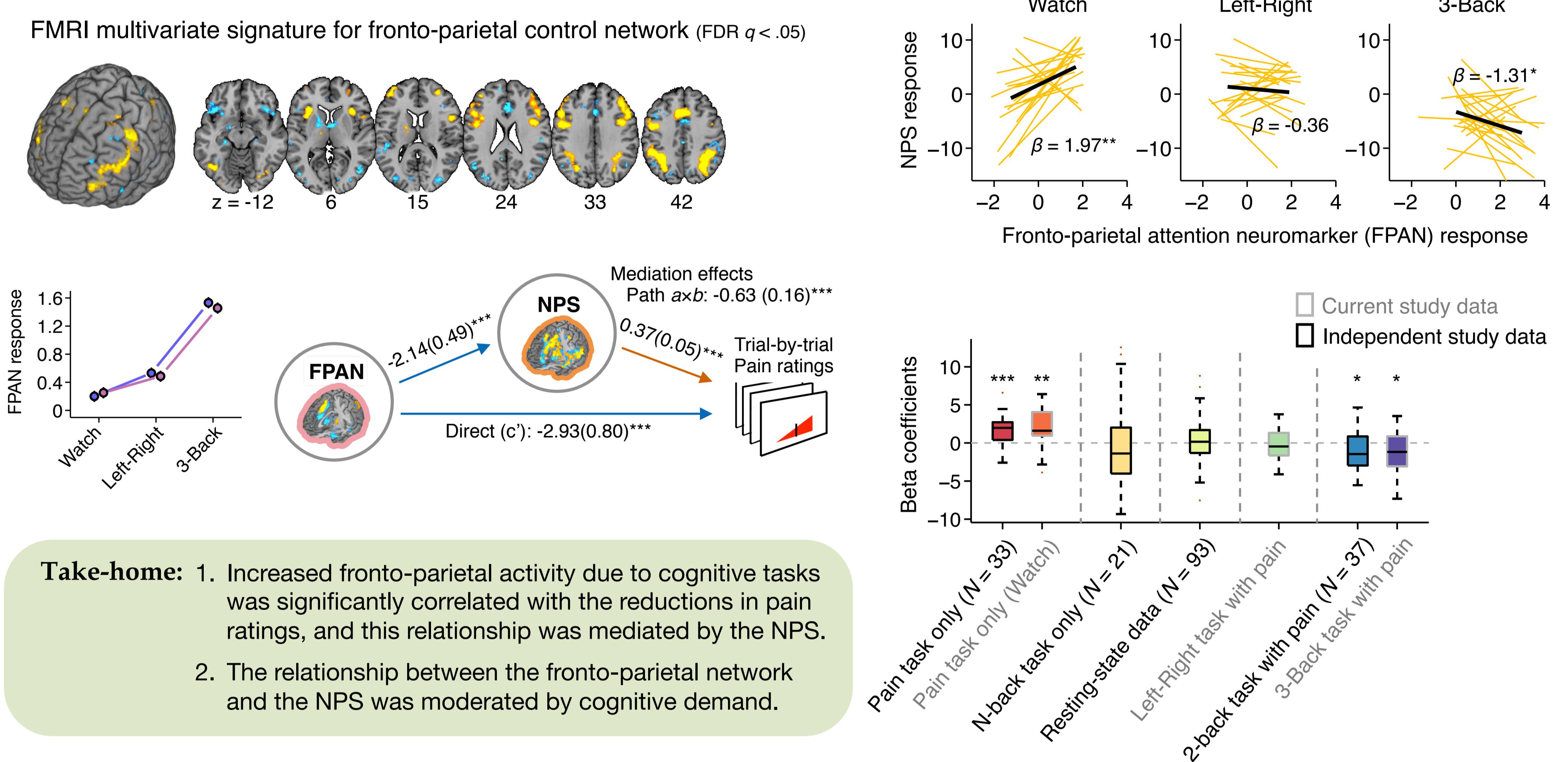
## Results

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



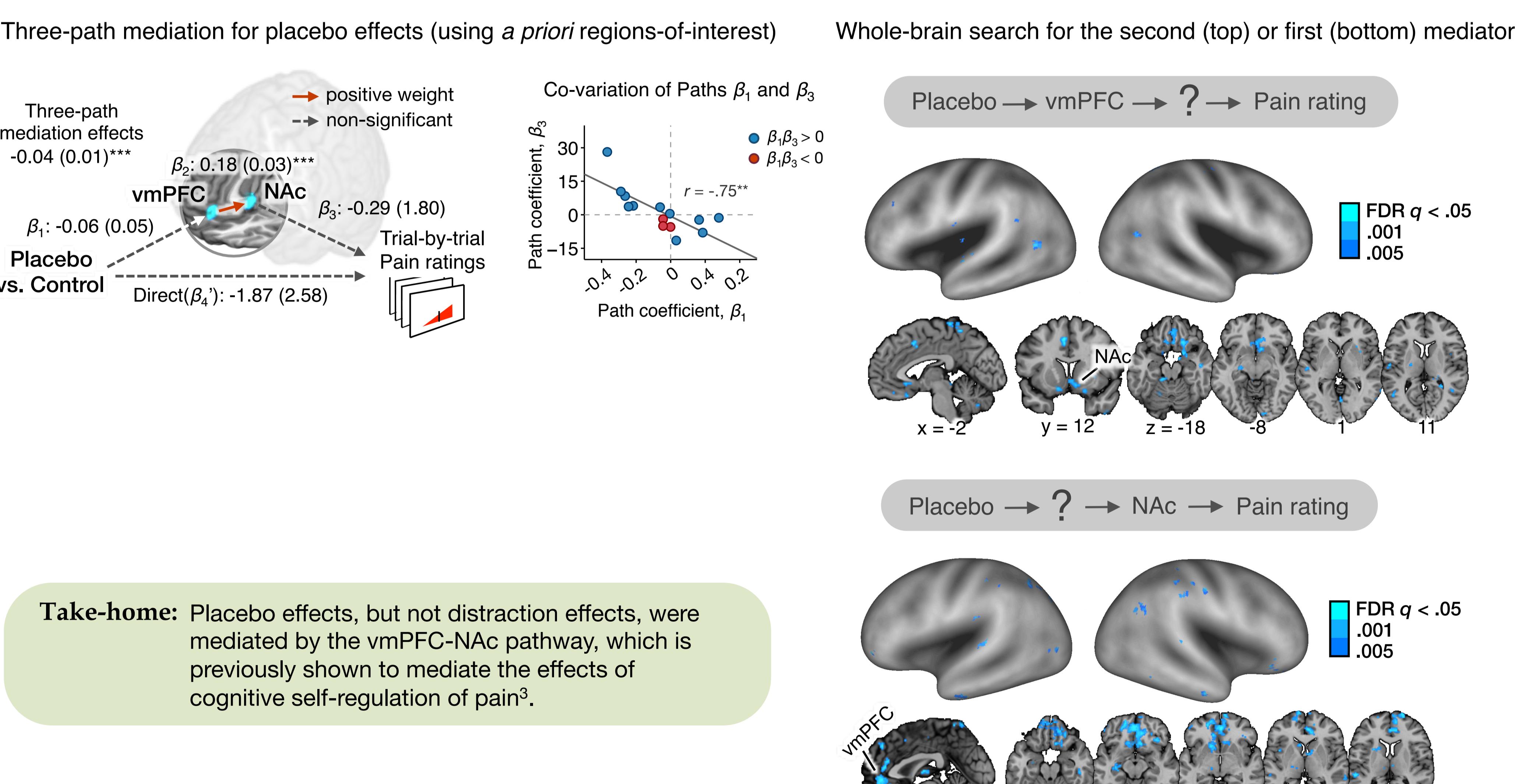
**Take-home:** 1. Both **distraction** and **placebo** produced significant, additive reductions in pain ratings, replicating previous work.  
2. NPS mediated the **distraction** effects on pain, but not the **placebo** effects.

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



**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)



**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.

