How computational neuroscience can help untangle relationships between culture, brain, & health

SOCIAL & CULTURAL NEUROSCIENCE LABORATORY

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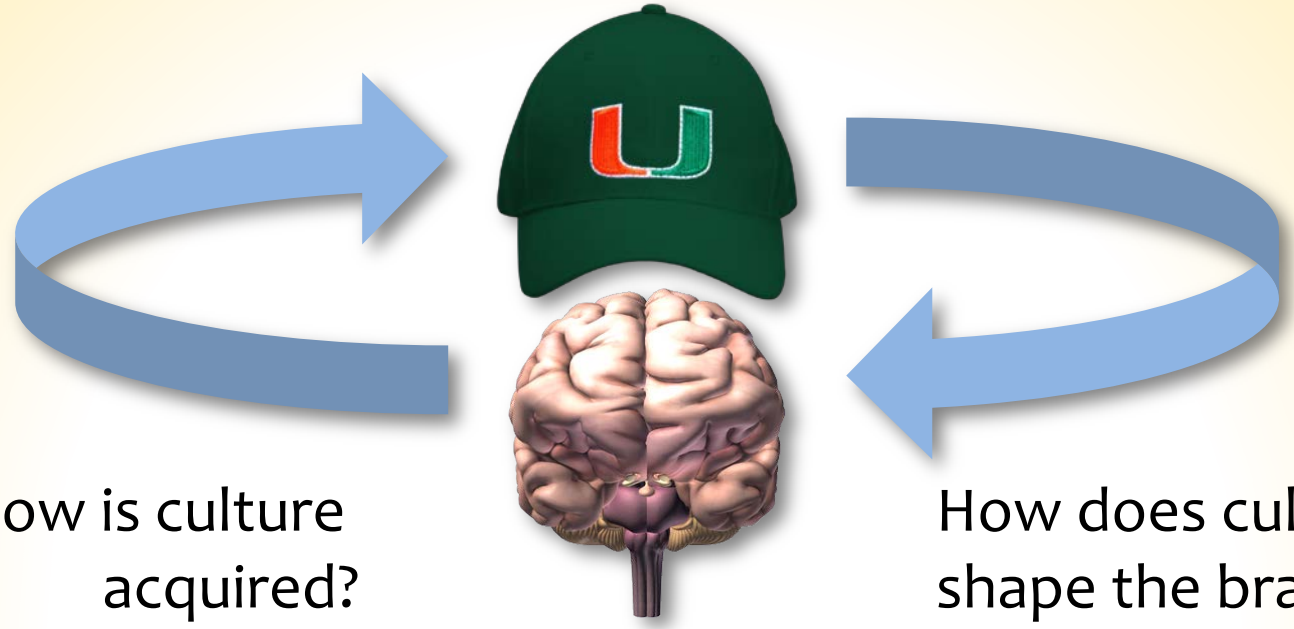
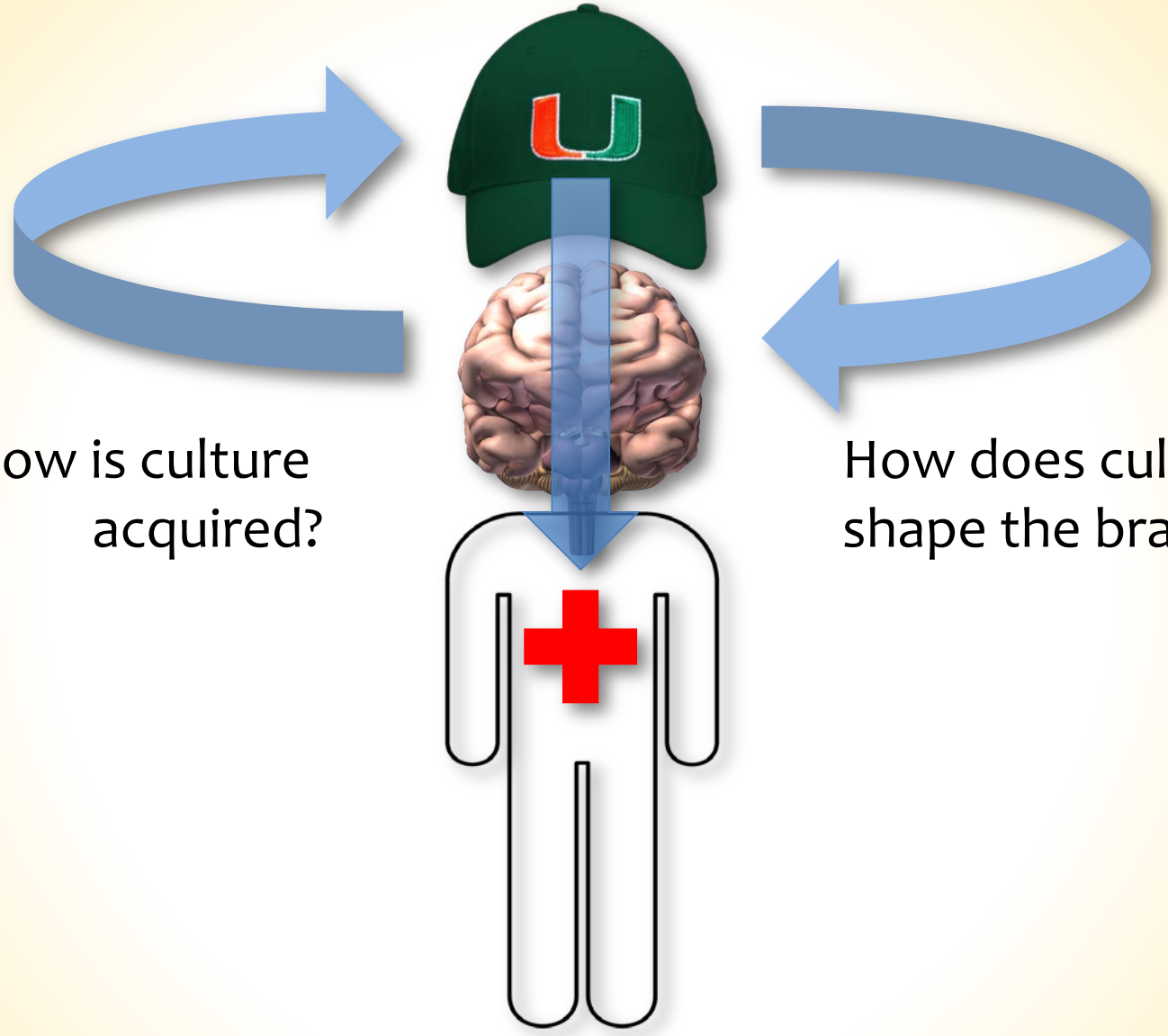


How is culture acquired?

How does culture shape the brain?



How is culture acquired?

How does culture shape the brain?

How does culture influence health(care)?

Why pain?

- Part of most major disorders

- Most common reason for seeking medical care

- Costly

(IOM, 2011)

Why pain?

- Ecological validity

Heat Pain

Cold Pain

Pressure Pain

- It really hurts!

What is Pain?

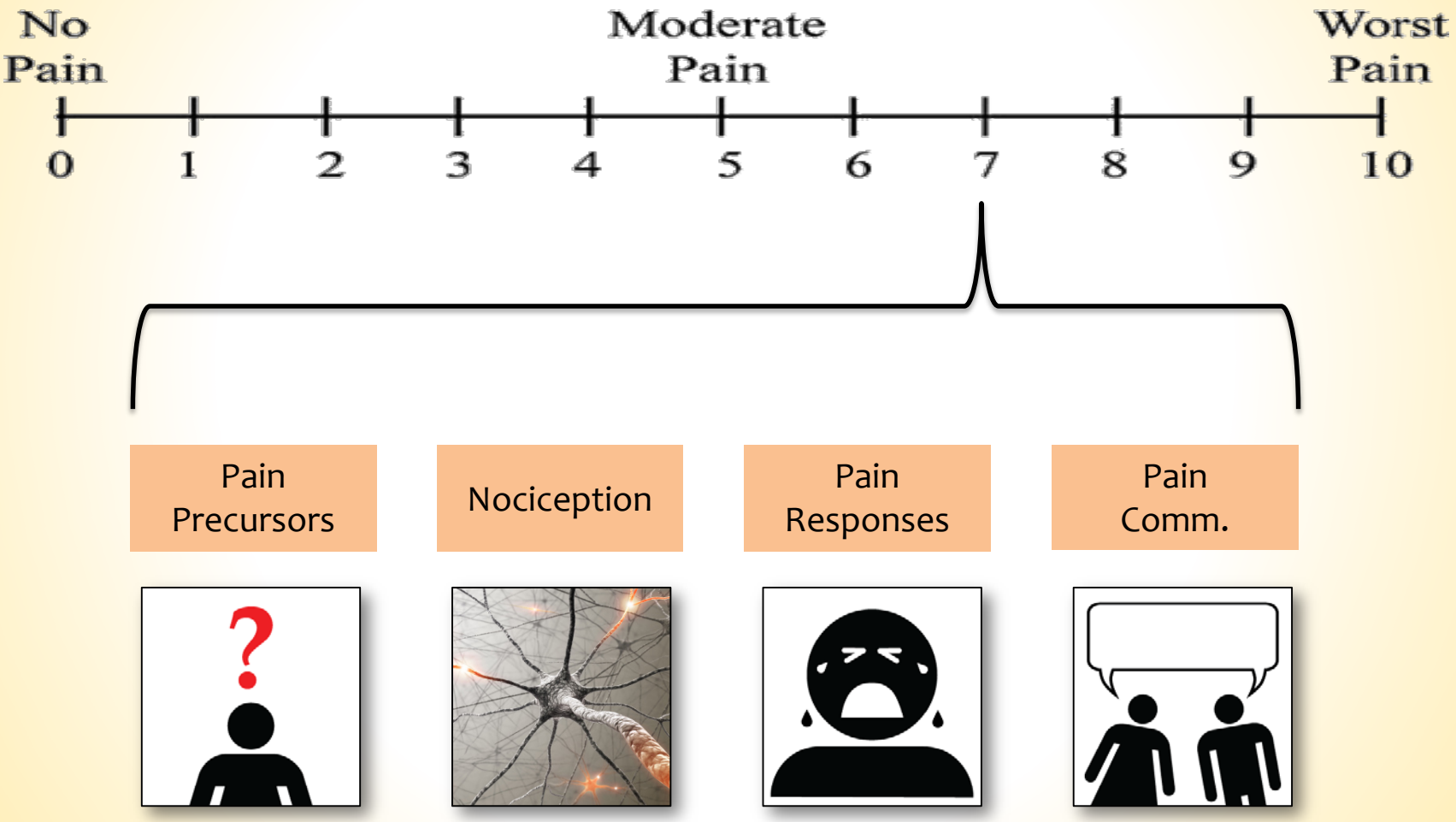
"an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage“

--IASP, 1979

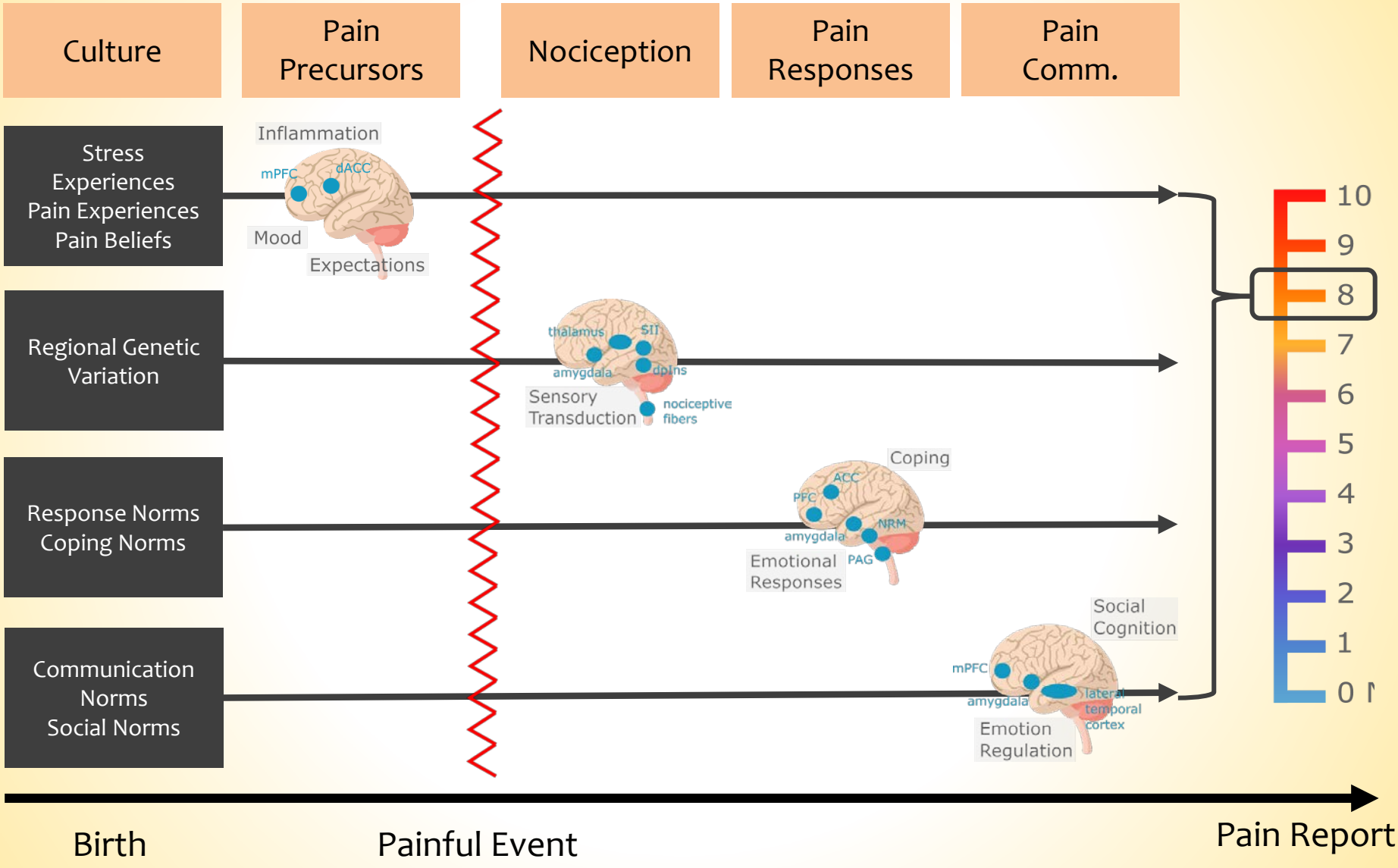
Pain is not the same for everyone

- **Differences in Pain:** Minorities report greater pain for the same medical condition or stimulation
- **Differences in Treatment:** Minorities receive lower doses of analgesics
- Causes of pain disparities remain unclear

Measurement of pain



Neurocultural Model of Pain



Anderson & Losin (2016)

Computation is key!

An example study

nature human behaviour

ARTICLES

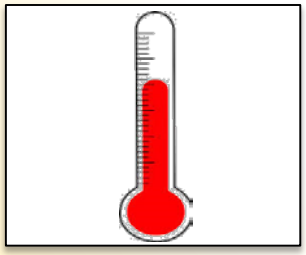
https://doi.org/10.1038/s41562-020-0819-8

There are amendments to this paper

Neural and sociocultural mediators of ethnic differences in pain

Elizabeth A. Reynolds Losin[1*], Choong-Wan Woo[2,3], Natalia A. Medina[1], Jessica R. Andrews-Hanna[4], Hedwig Eisenbarth[5] and Tor D. Wager[6*]

Thermal Pain Task

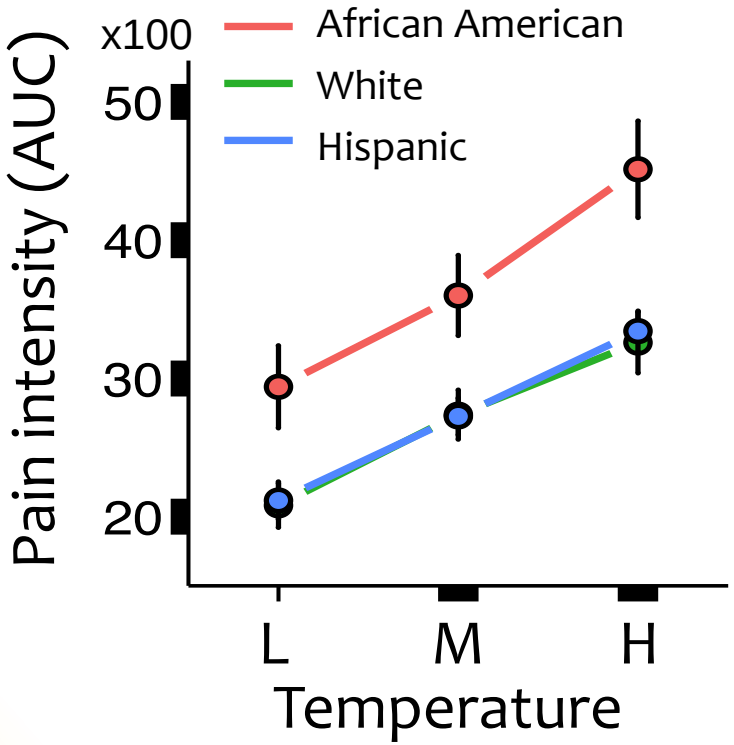


fMRI During Pain

Questionnaires pain precursors and reactions

30 Hispanic, 30 Non-Hispanic white, 28 African Americans

African American participants reported feeling more pain



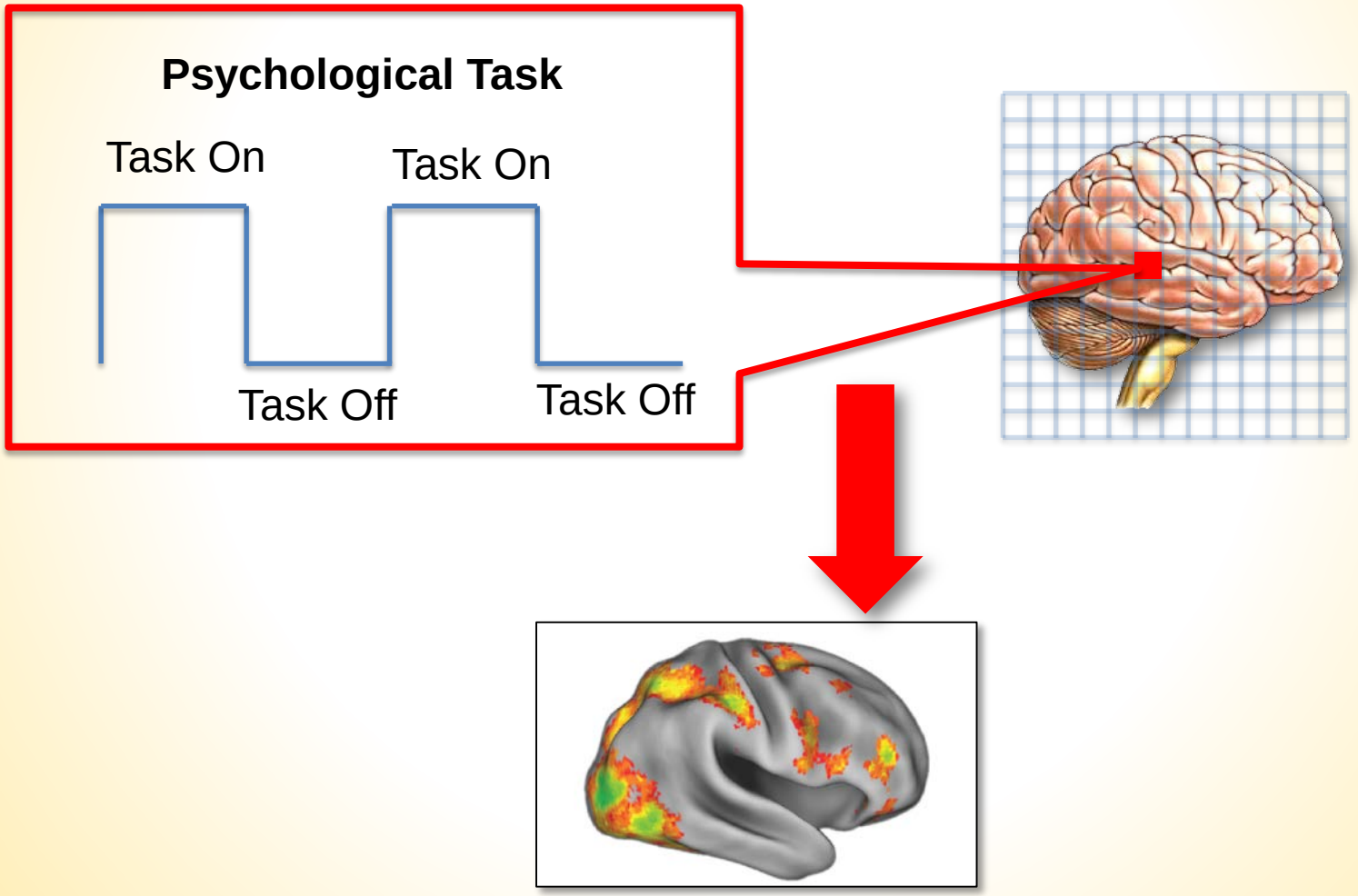
Average response **

Temperature response *

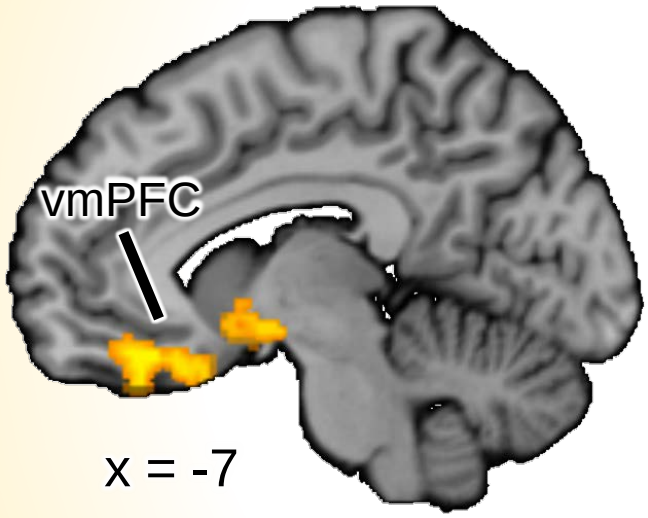
Replicated prior findings. But why?

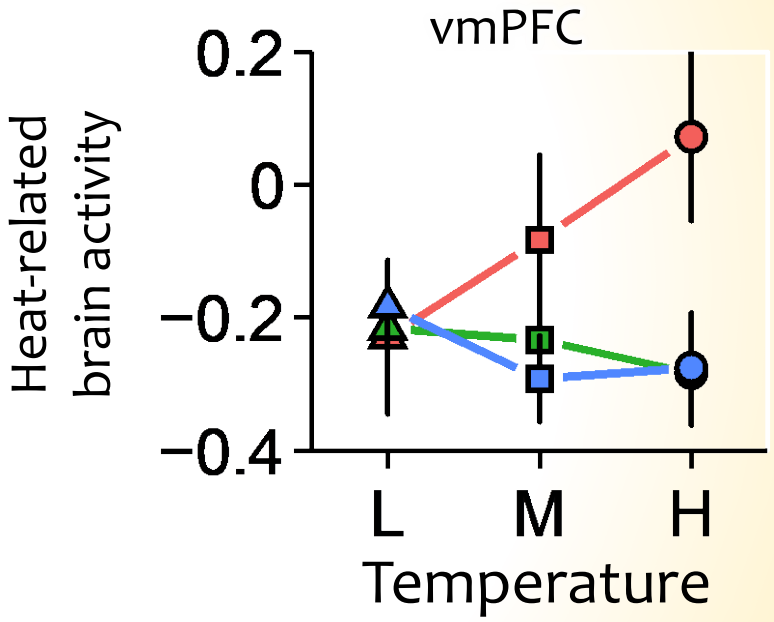
Losin et al. (2020)

Traditional brain imaging analysis



African Americans have greater frontostriatal responses to pain





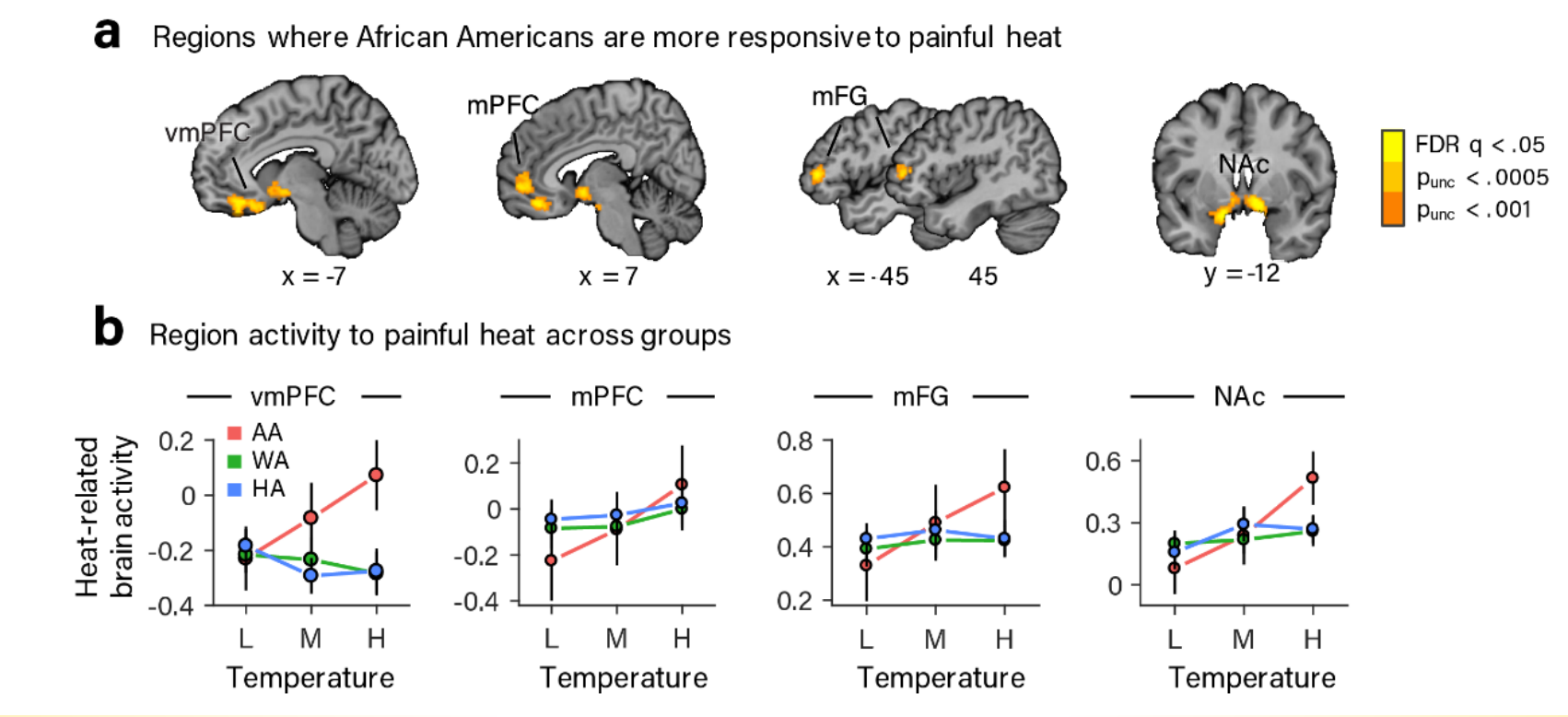
FDR $q < .05$

$p_{unc} < .0005$

$p_{unc} < .001$

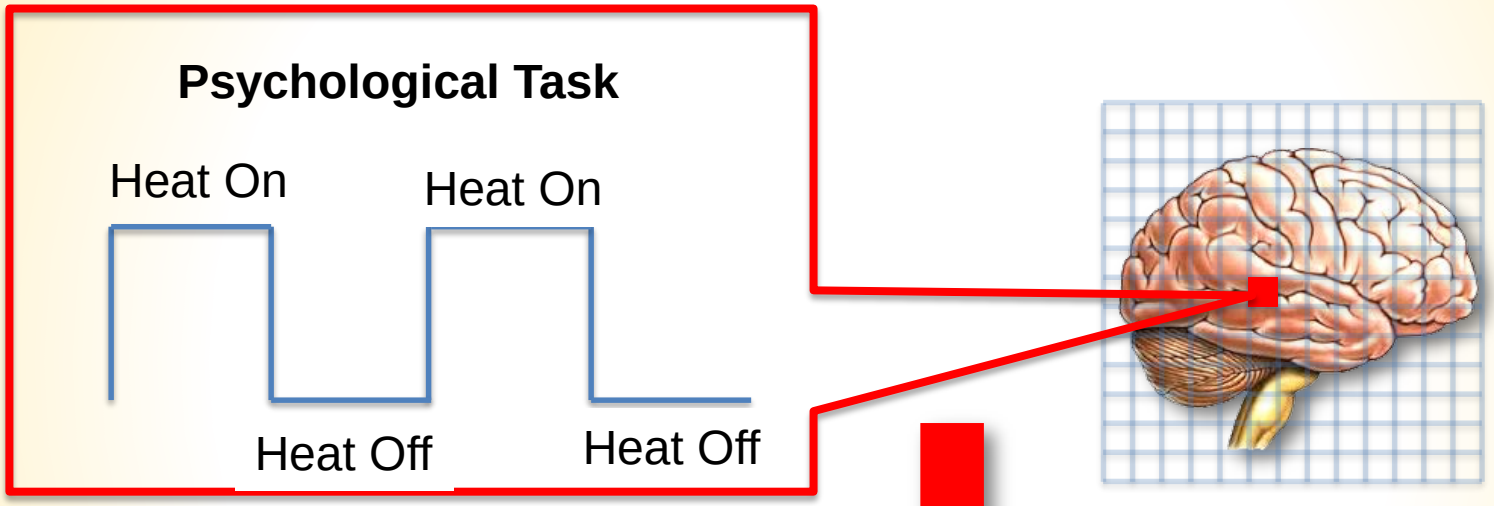
Losin et al. (2020)

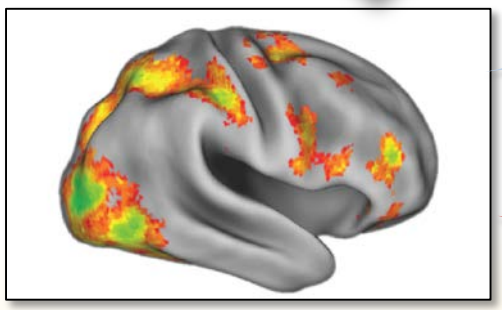
African Americans have greater frontostriatal responses to pain



Losin et al. (2020)

Traditional Brain Imaging Analysis





Somatosensation

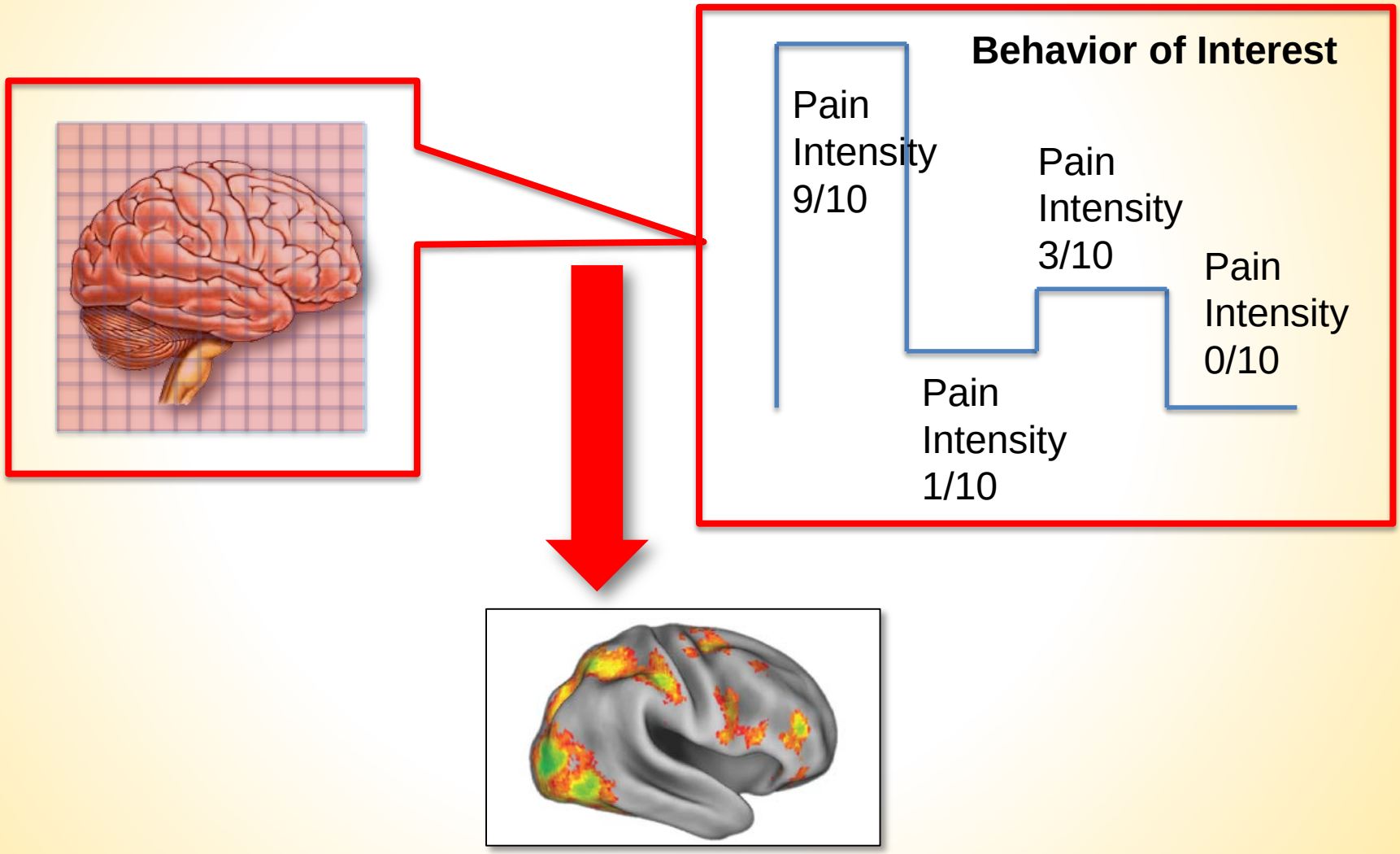
Pain

Anxiety

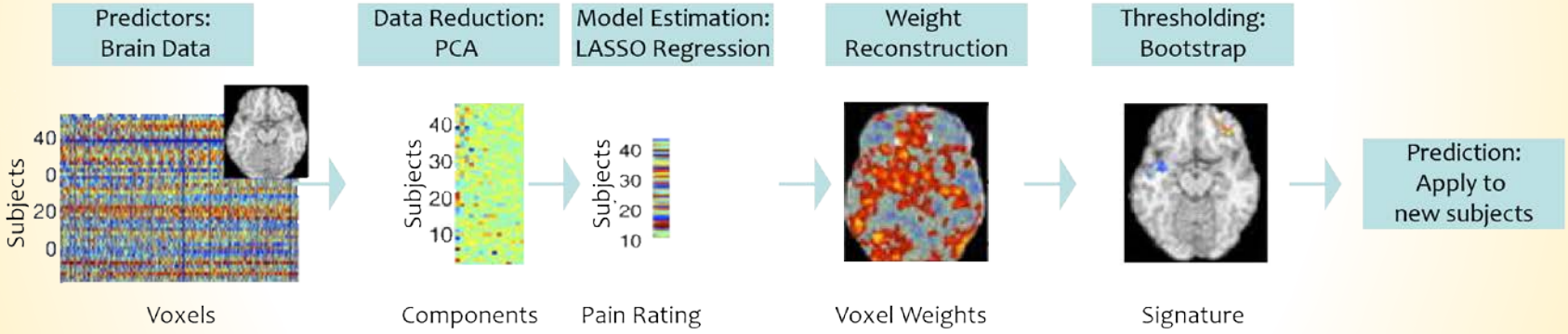
Attention

New Computational Approaches to the Rescue!

Machine Learning: MVPA

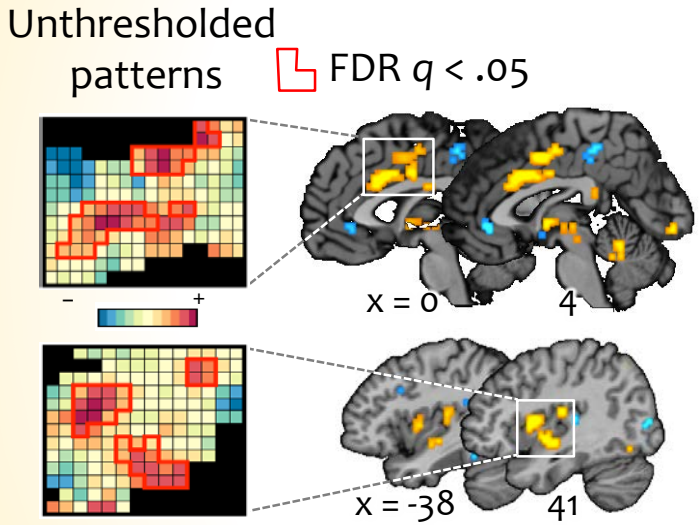


Machine Learning Approach to Creating Neural Signatures LASSO - PCR

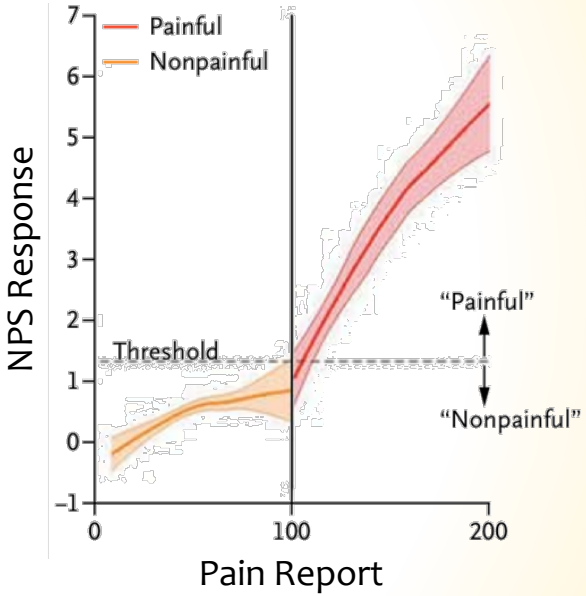


Neural Signature Example: Pain

Neurologic Pain Signature (NPS)

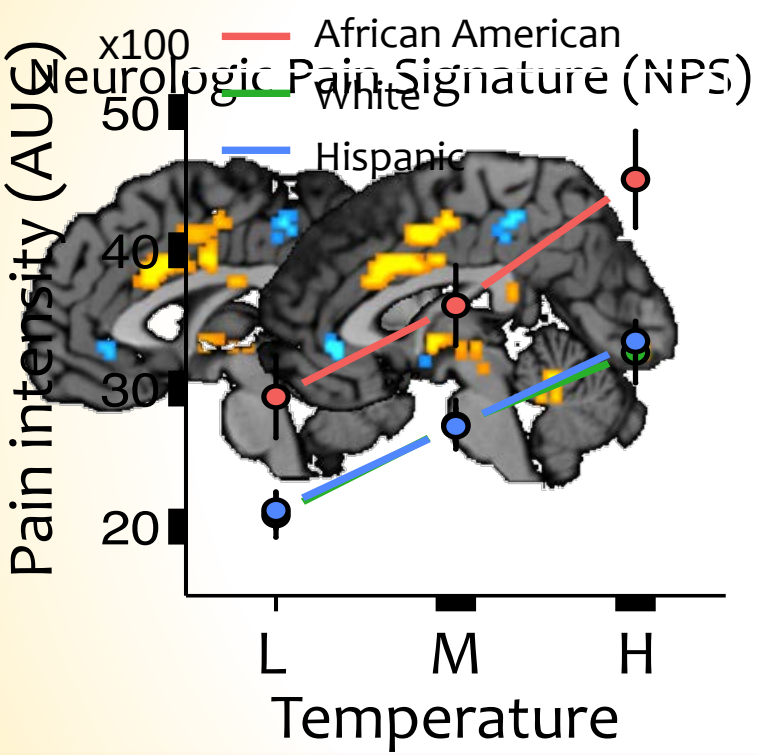


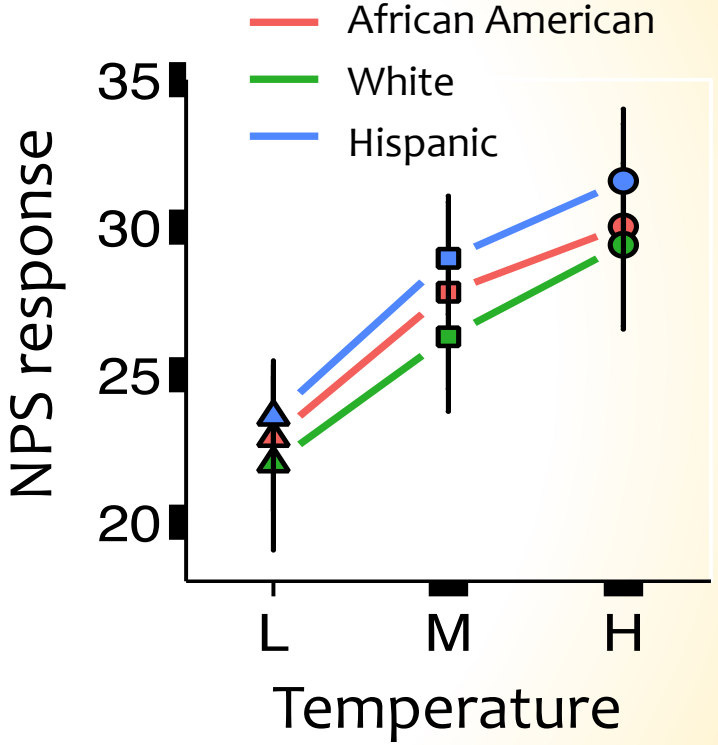
NPS Response vs. Pain Report



Wager et al., (2013) *NEJM*

No ethnic differences in NPS

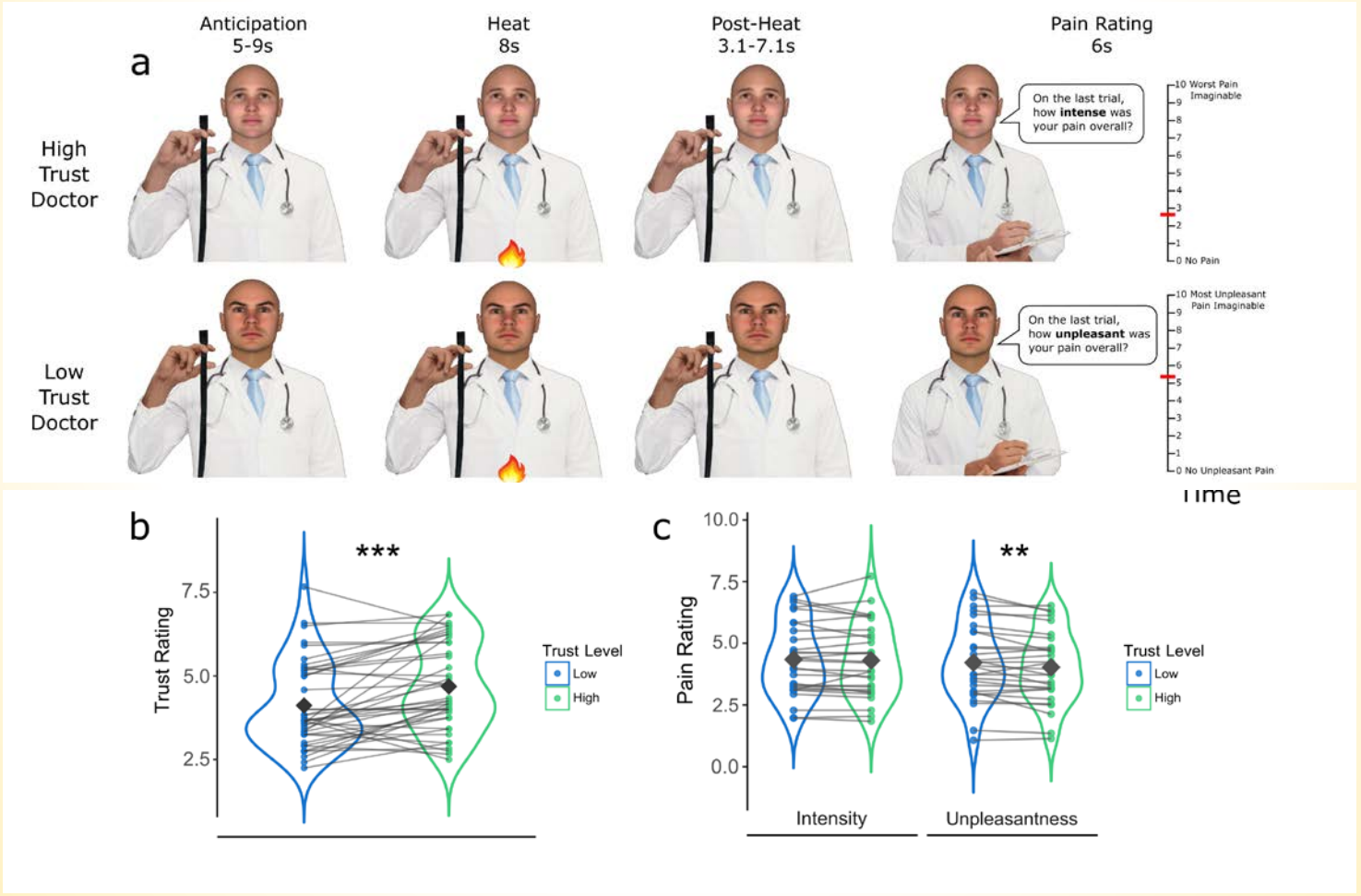




Pain-specific neural processes are similar across ethnic groups

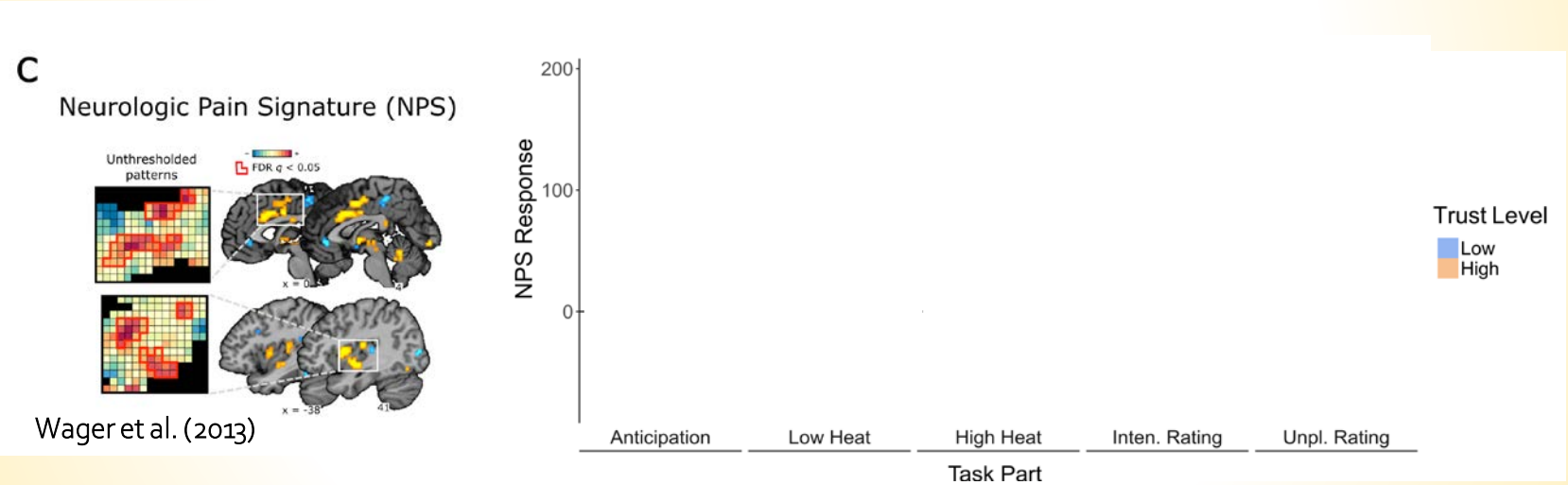
Losin et al. (2020)

Another NPS Example: Doctor Trustworthiness decreases pain



Anderson, Gianola, Medina, Perry, Wager, & Losin (in prep)

Doctor trustworthiness decreases NPS response during pain



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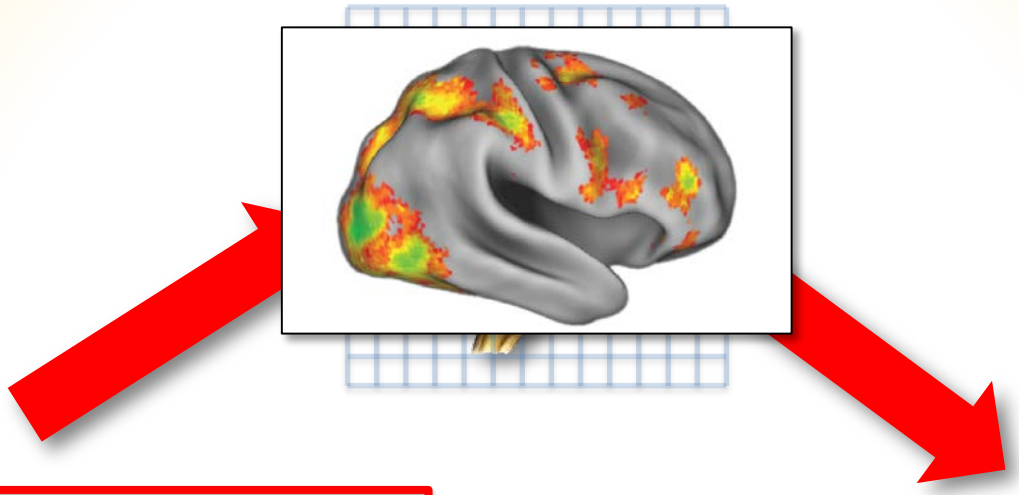
Brain Mediation



Psychological Task

Heat On

Heat On

Heat Off

Heat Off

Behavior of Interest

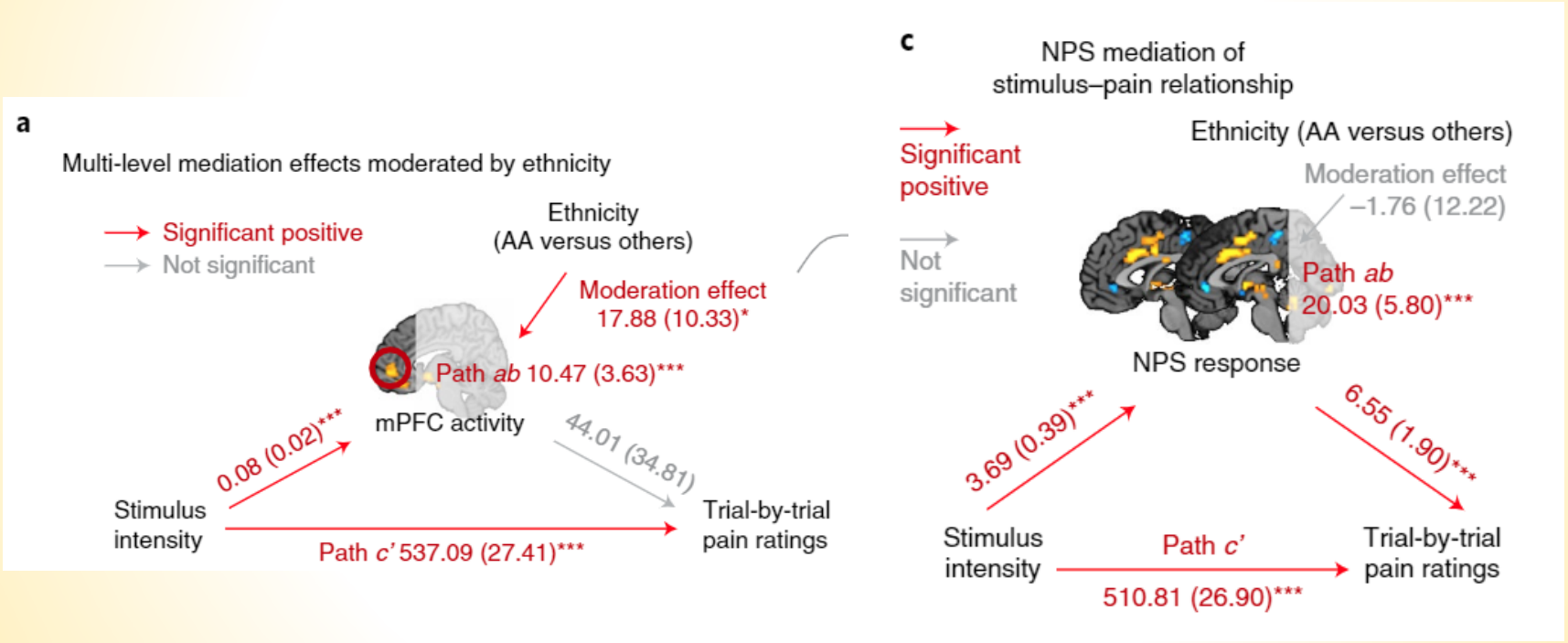
Pain Intensity 9/10

Pain Intensity 1/10

Pain Intensity 3/10

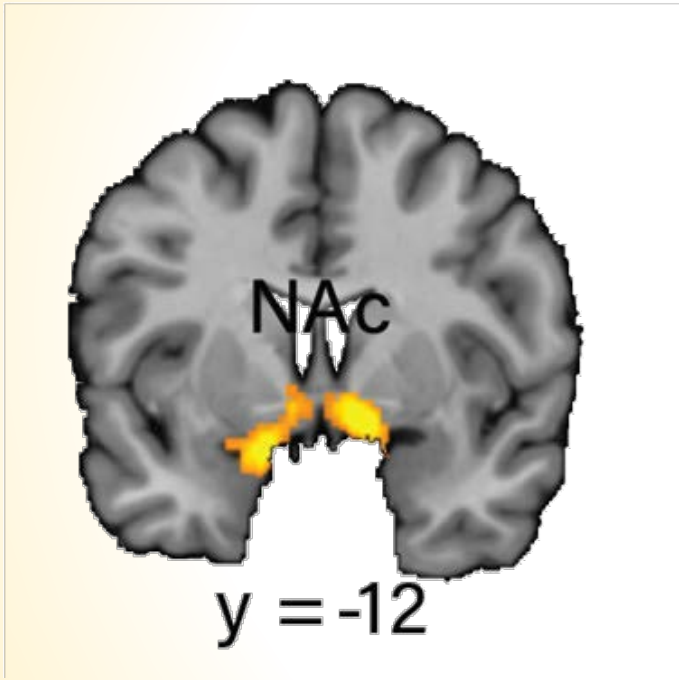
Pain Intensity 0/10

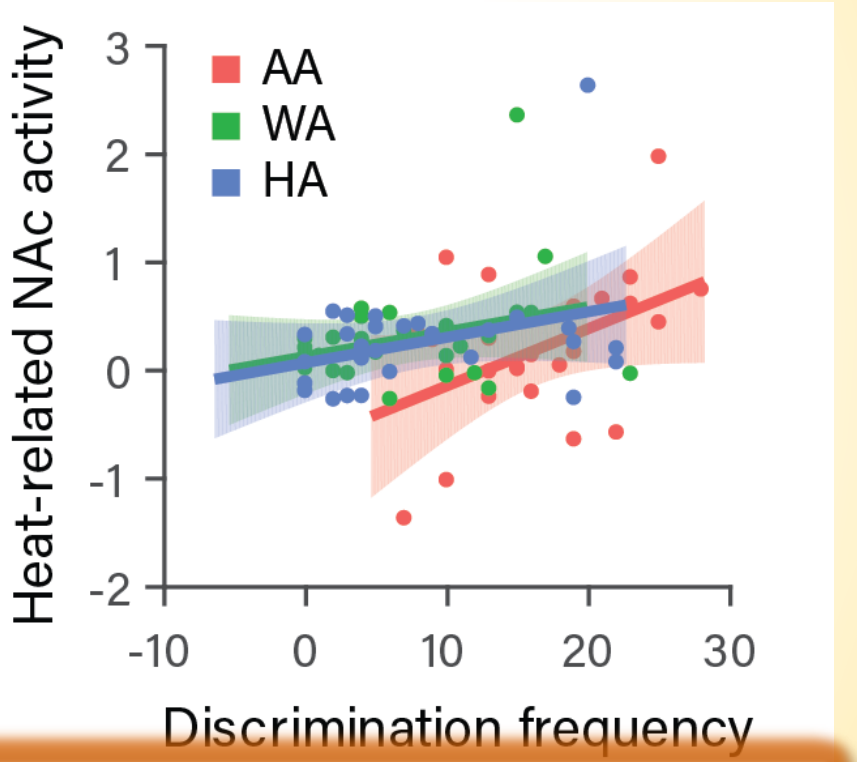
Mediators of higher pain in African Americans



Losin et al. (2020)

NAc more responsive to pain in those who report more discrimination

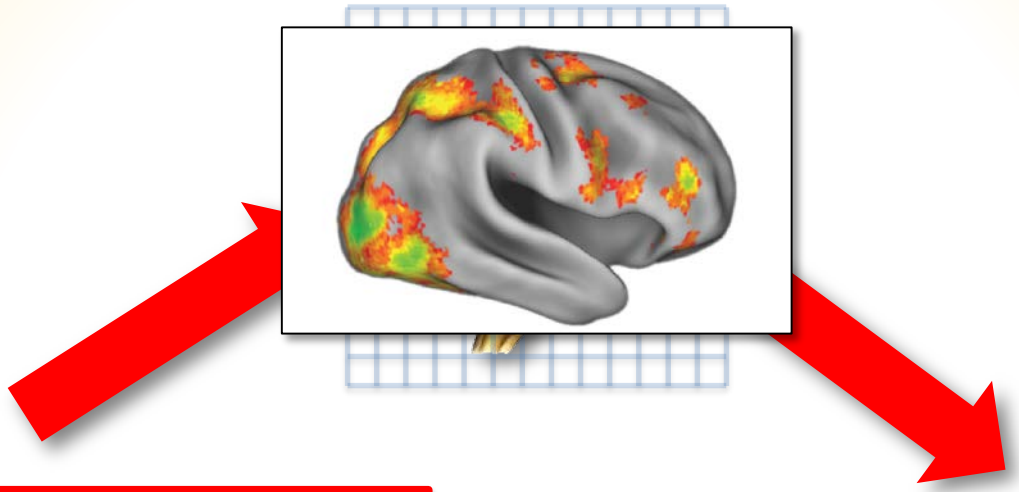




History of discrimination may sensitize frontostriatal regions to pain, similar to effects in chronic pain

Losin et al. (2020)

Brain Mediation



Psychological Task

Heat On

Heat On

Heat Off

Heat Off

Behavior of Interest

Pain Intensity 9/10

Pain Intensity 1/10

Pain Intensity 3/10

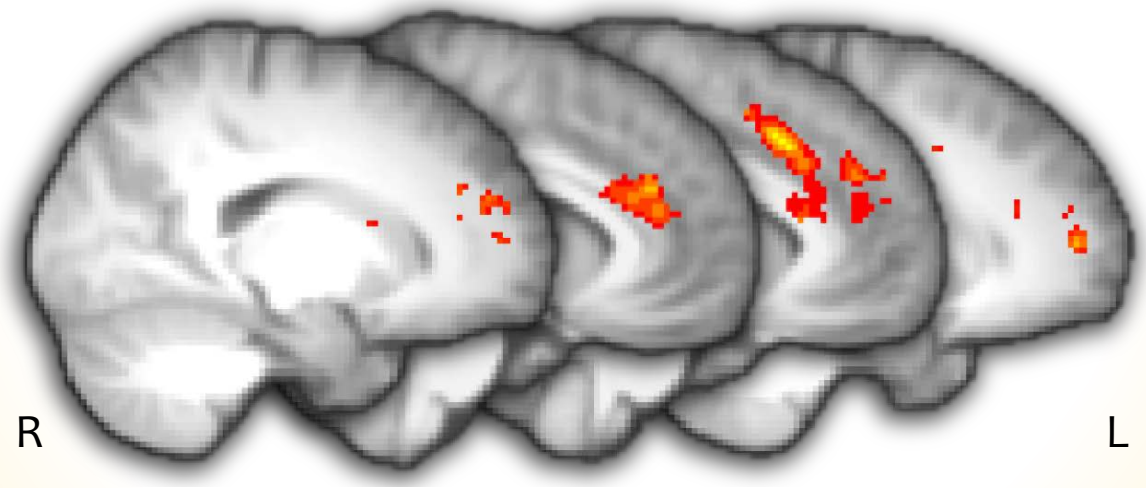
Pain Intensity 0/10

Whole-brain mediation example

Imitative learning

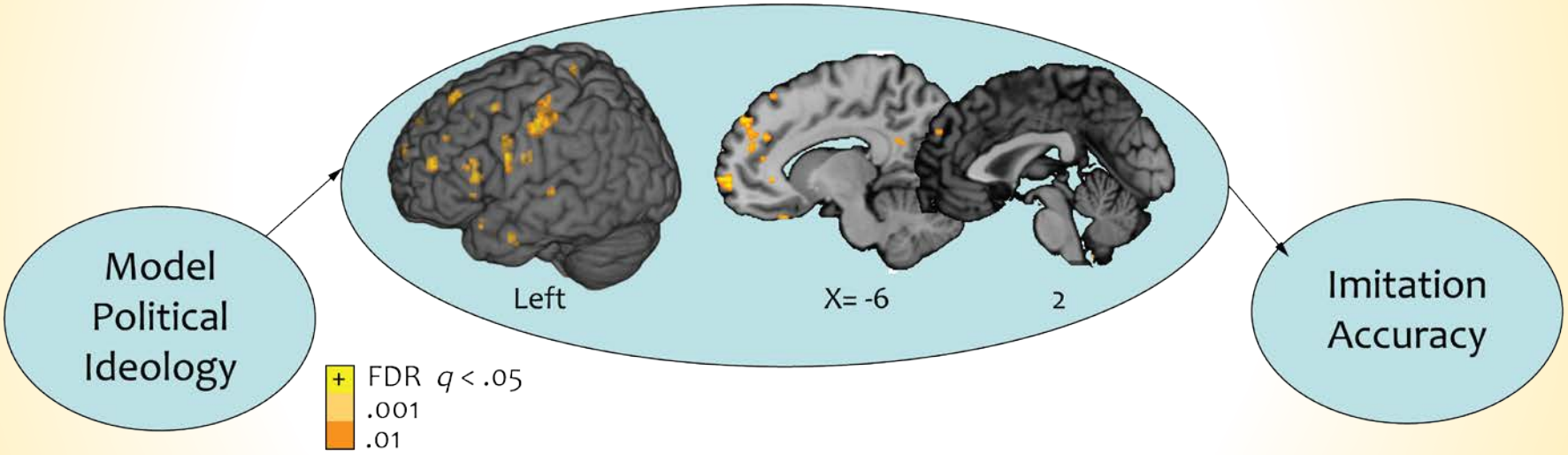
Medial frontal cortex differentiates ideology during imitation

Imitate Political Outgroup > Imitate Political Ingroup



Losin et al., (2015)

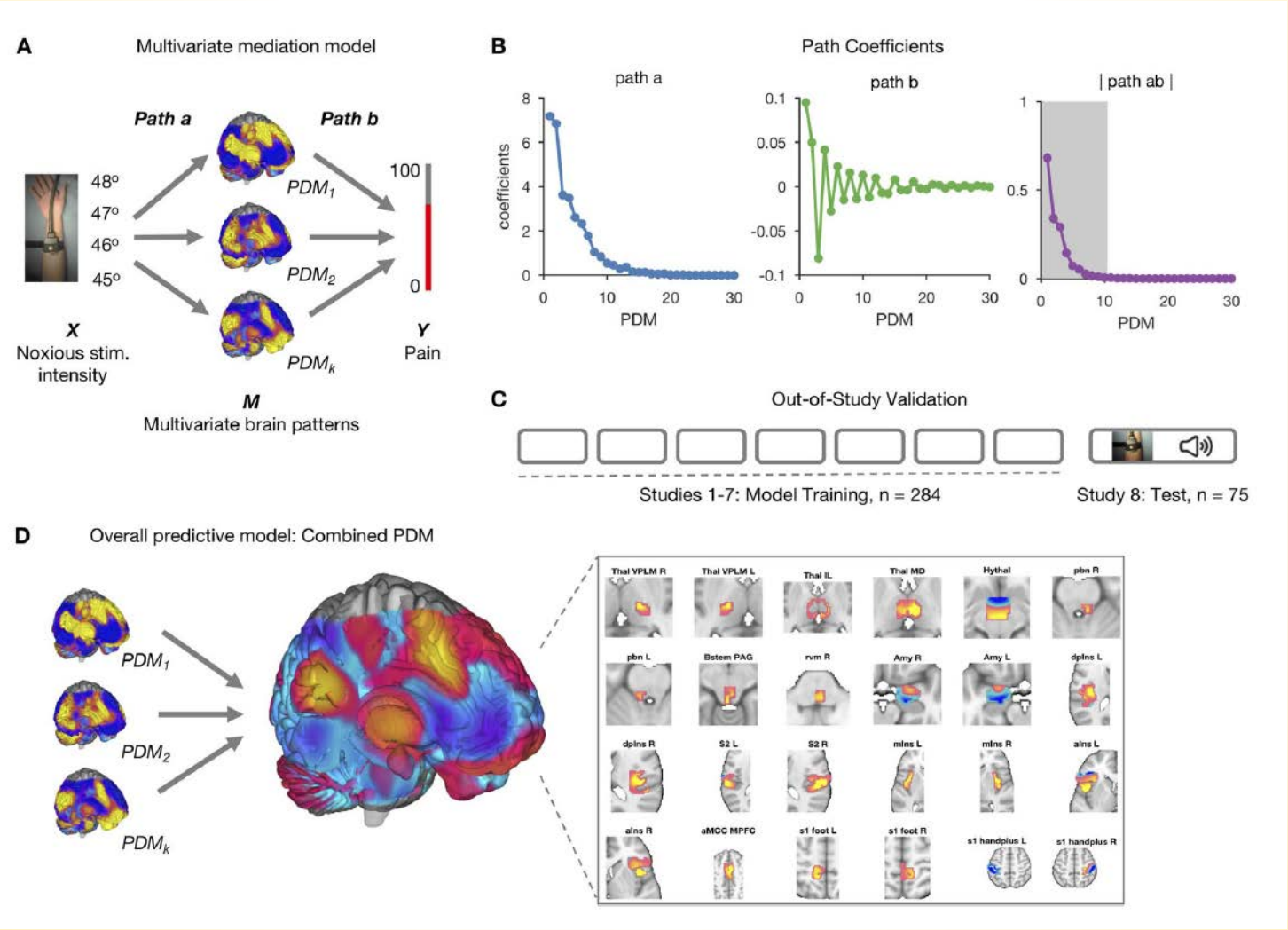
Whole-brain mediation example



Medial prefrontal cortex mediates relationship between political ideology and imitation accuracy

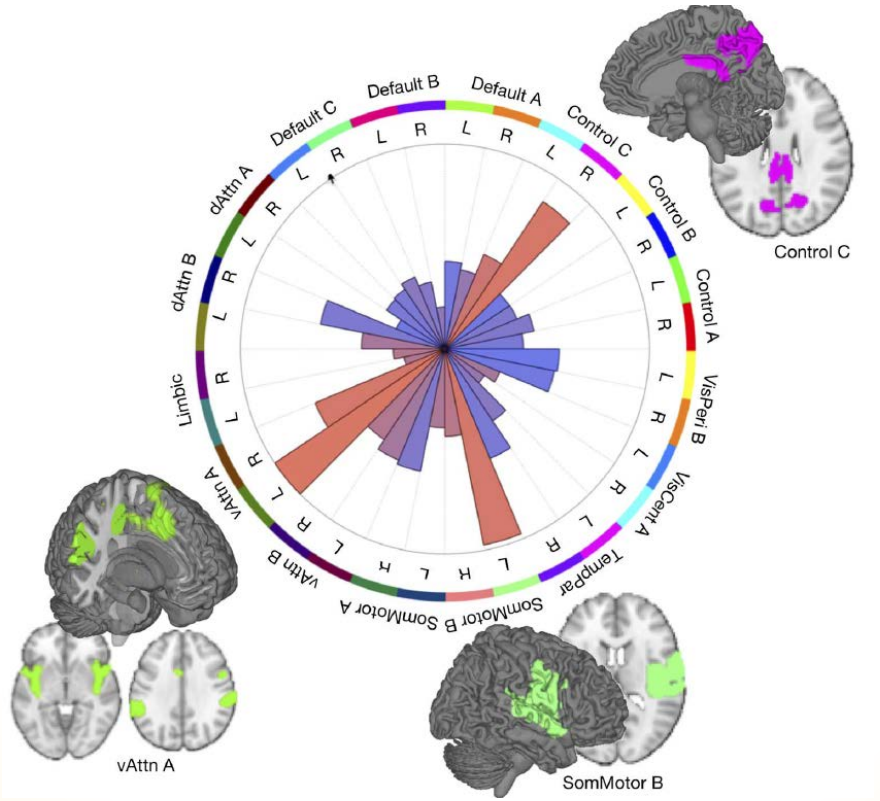
Losin et al. (2015)

Multivariate Mediation



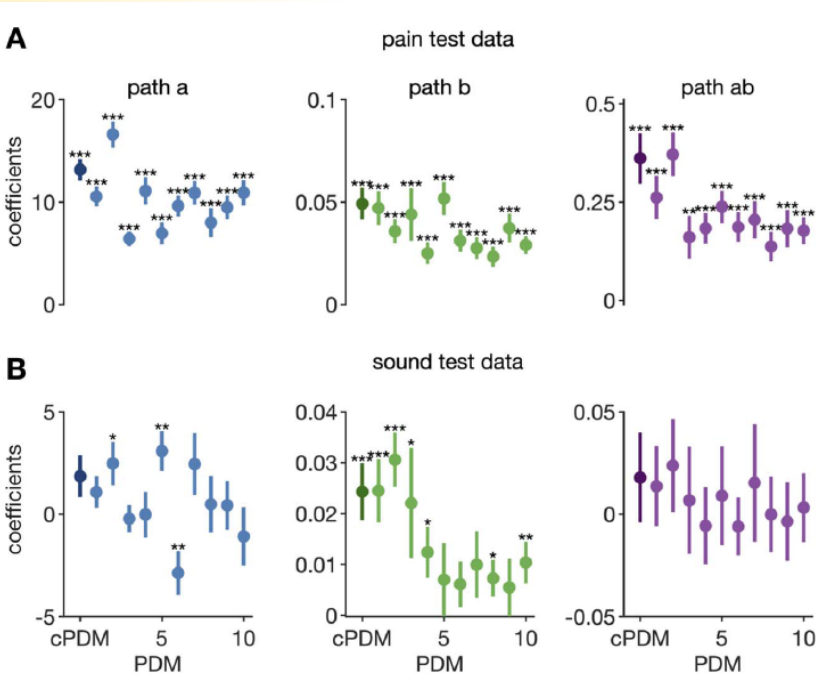
Geuter, Losin, et al. (2020)

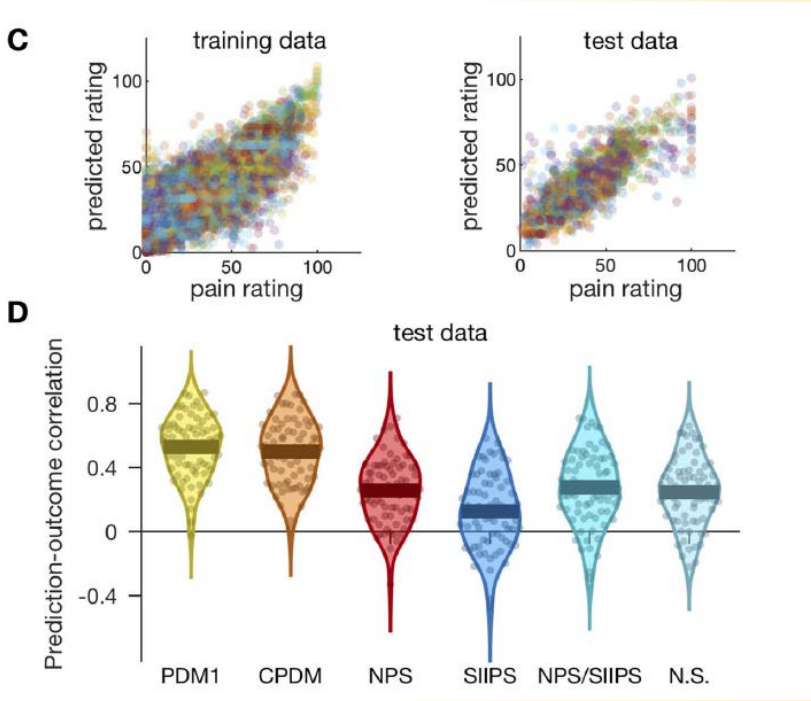
Multivariate mediator of pain cortical network profile



Geuter, Losin, et al. (2020)

Test in new data and comparison with other pain signatures





Geuter, Losin, et al. (2020)

Meta-analysis

Attention

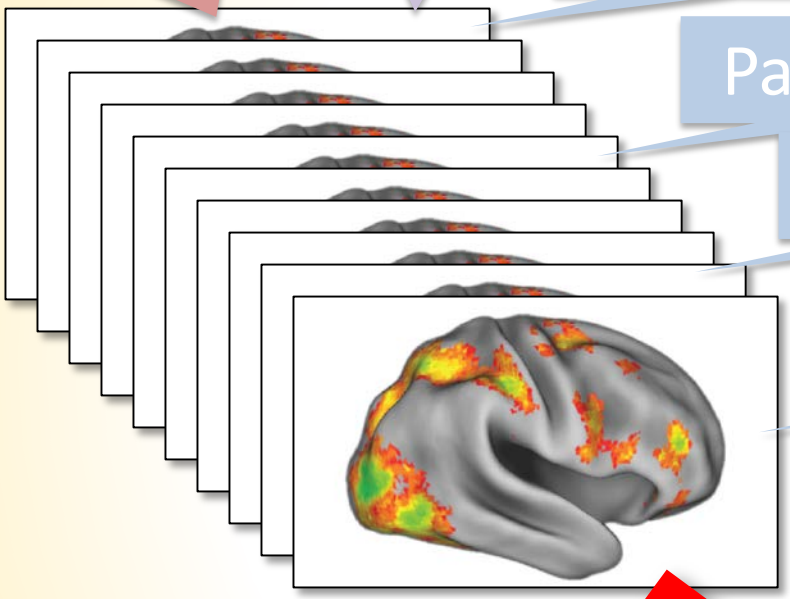
Anxiety

Pain (heat)

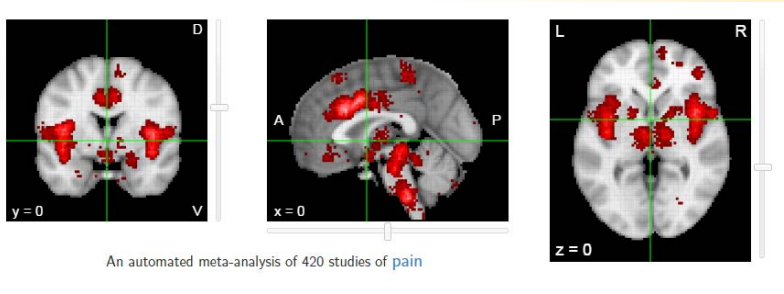
Pain (shock)

Pain (hand)

Pain (foot)



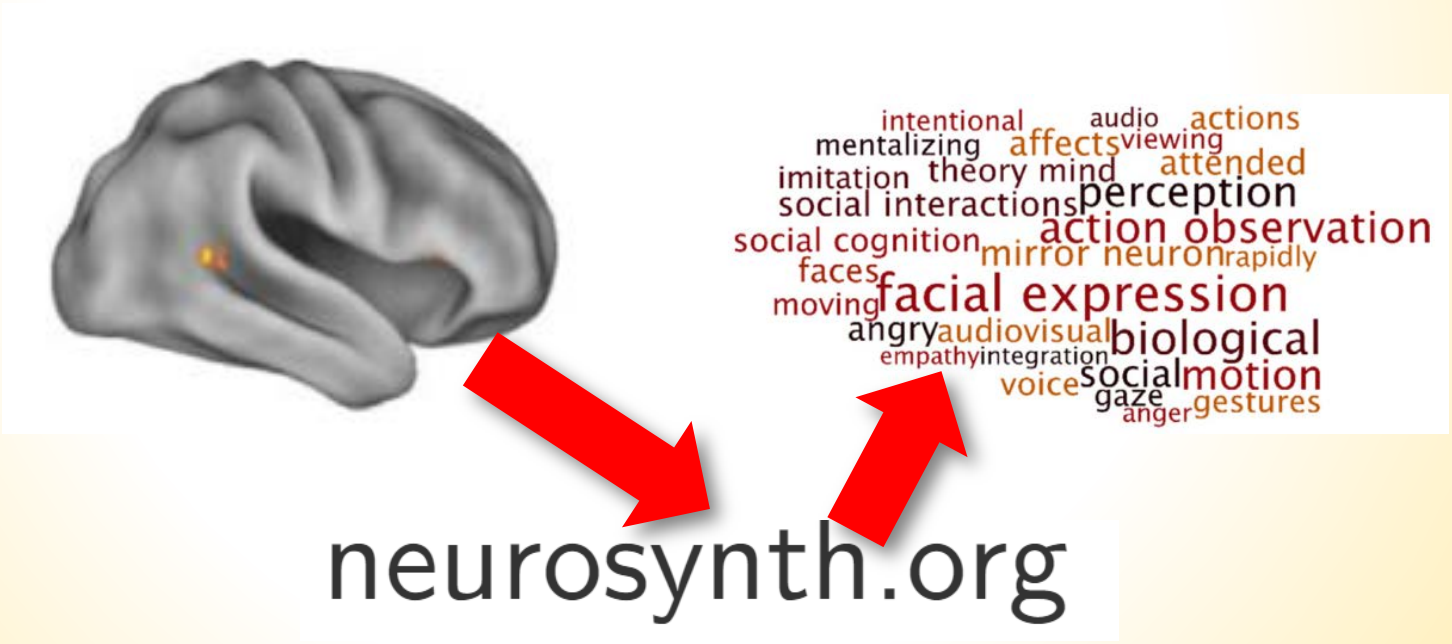
neurosynth.org



Meta-Analytic Mind Reading

Brain Region from Analysis

Associated Psychological Functions



Take home points

- Traditional brain imaging analyses: brain as outcome limited by reverse inference
- Machine learning can be used to create brain based biomarkers
- Univariate and multivariate brain mediation can be used to find brain mediators of known behavioral relationships
- Automated brain meta-analyses can provide a quantitative approach to reverse inference