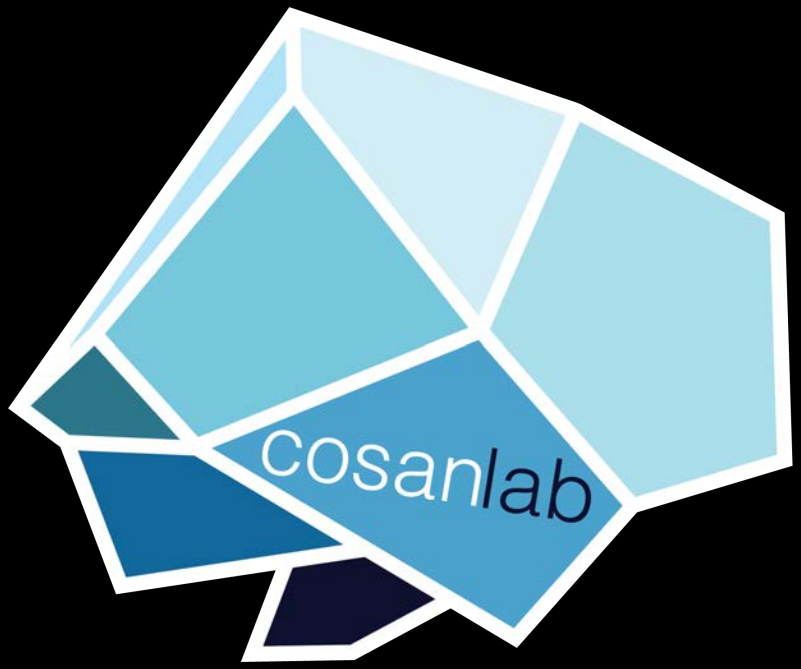
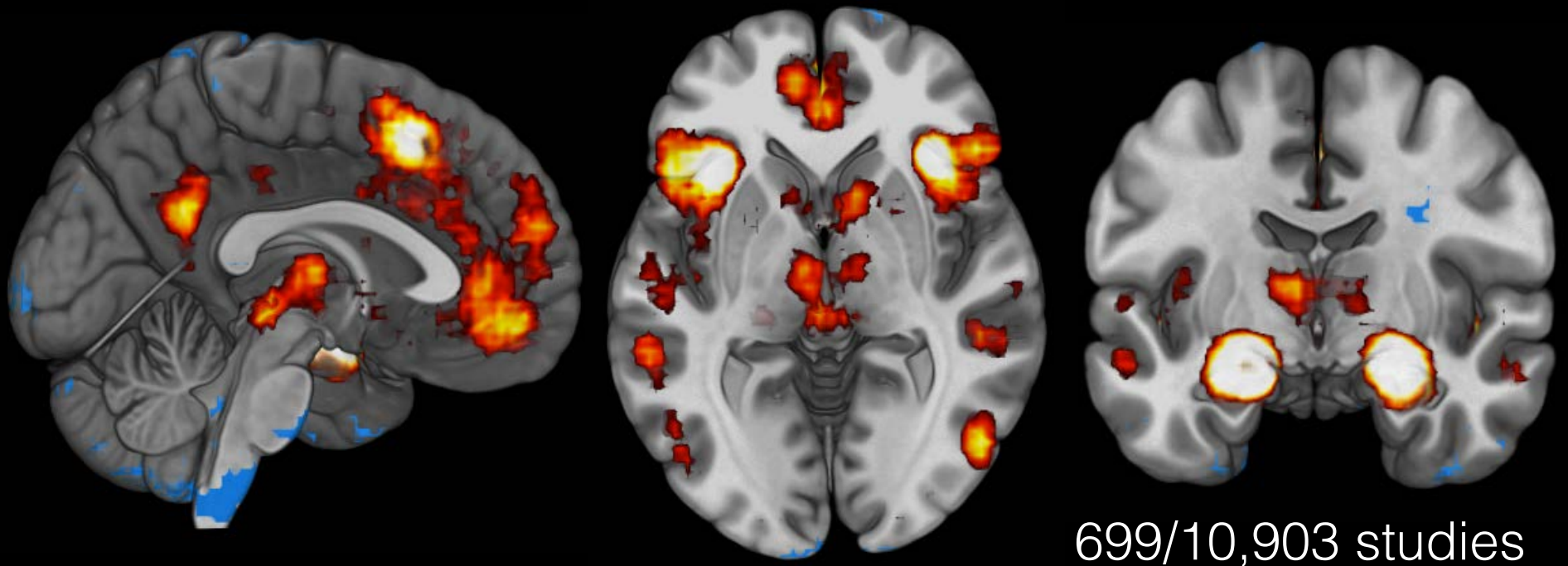


Construct Validity of Brain Representations

Luke Chang, PhD
Computational Social & Affective Neuroscience Laboratory
Dartmouth College

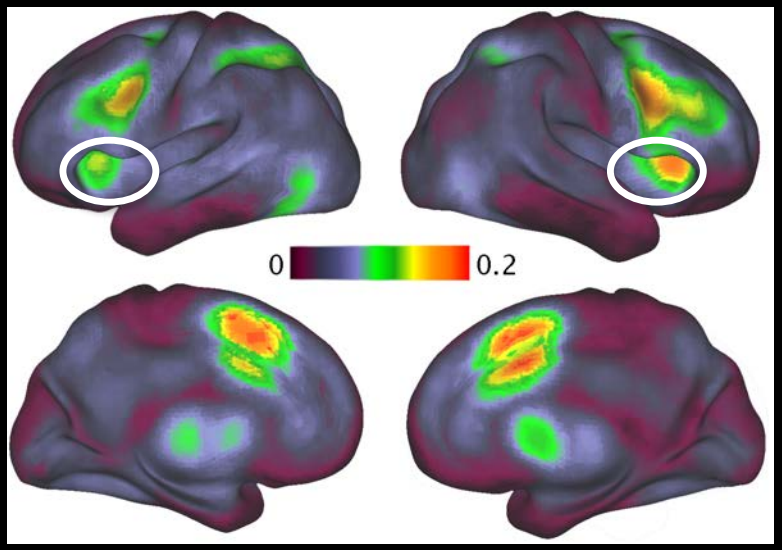
Many regions are consistently associated with emotion

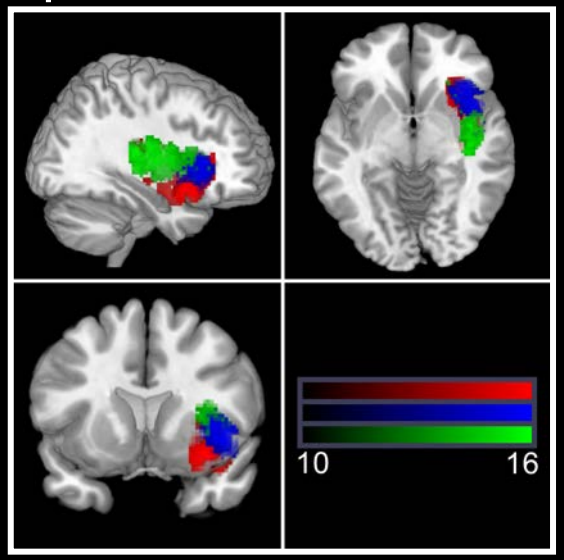


699/10,903 studies
http://neurosynth.org

Yarkoni, Poldrack, Nichols, Van Essen, Wager, 2011 Nature Methods

But, which regions specifically process emotion?



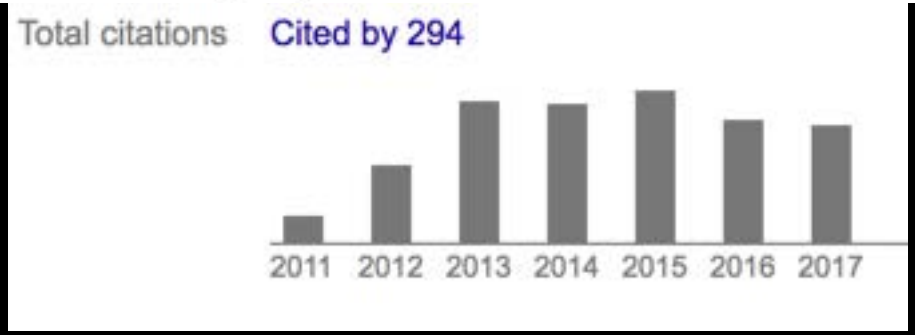


Chang, Yarkoni, Khaw & Sanfey (2013) Cerebral Cortex

LPT: Don't worry about being scooped (You don't need to be first)

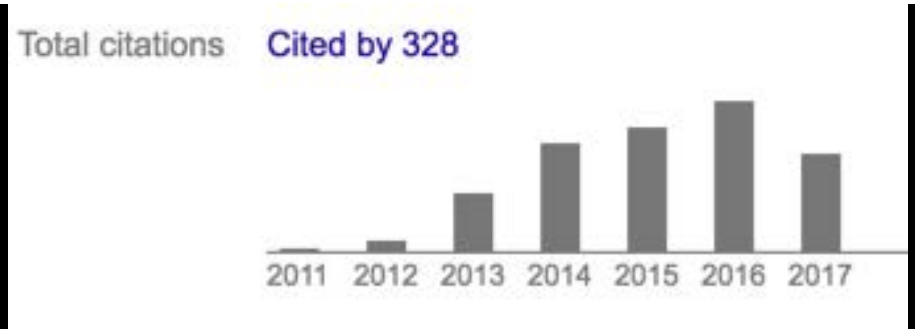
Three Systems of Insular Functional Connectivity Identified with Cluster Analysis

Ben Deen, Naomi B. Pitskel and Kevin A. Pelphrey

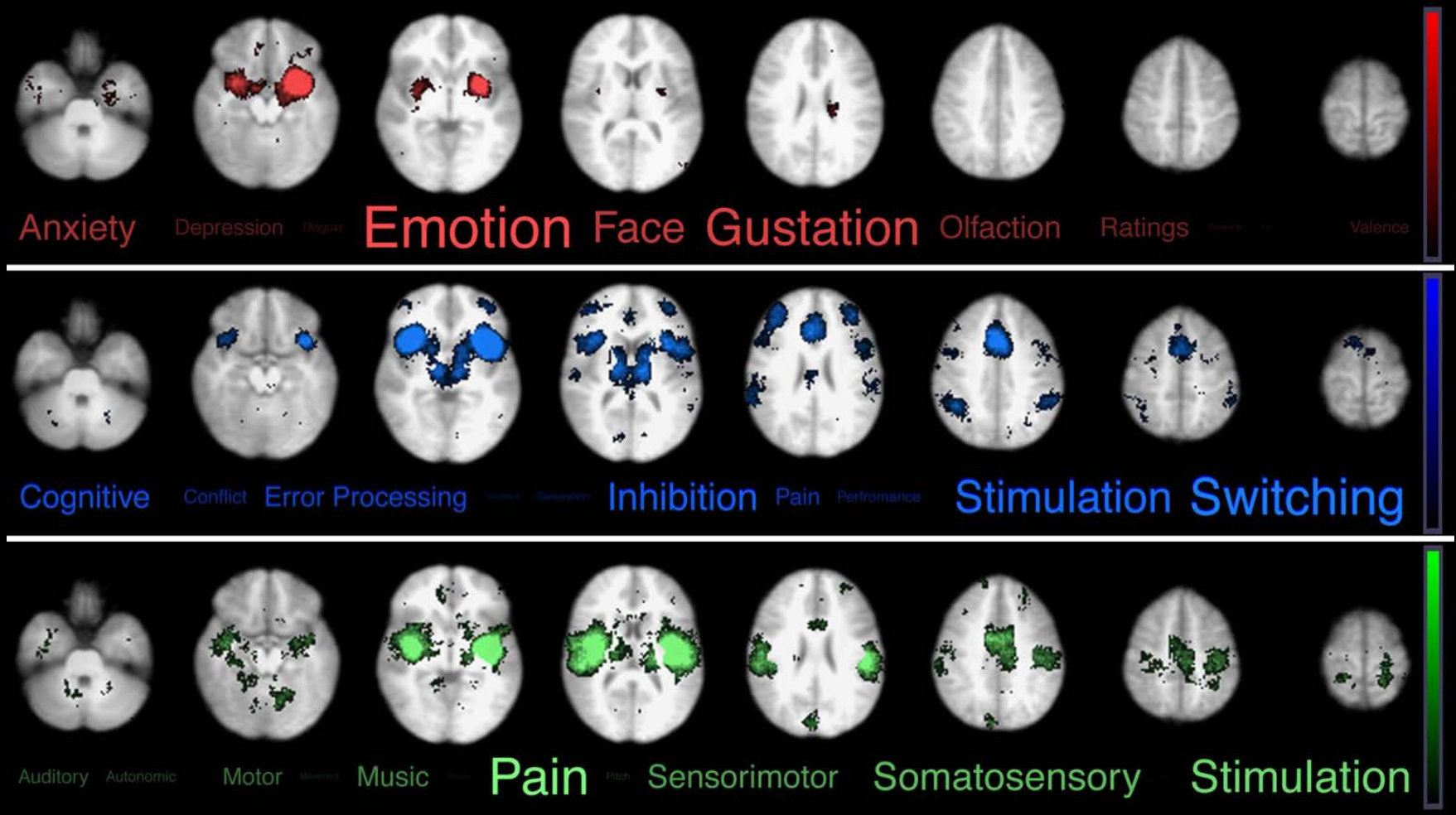


Decoding the Role of the Insula in Human Cognition: Functional Parcellation and Large-Scale Reverse Inference

Luke J. Chang[1,2], Tal Yarkoni[3], Mel Win Khaw[4] and Alan G. Sanfey[1,5,6]

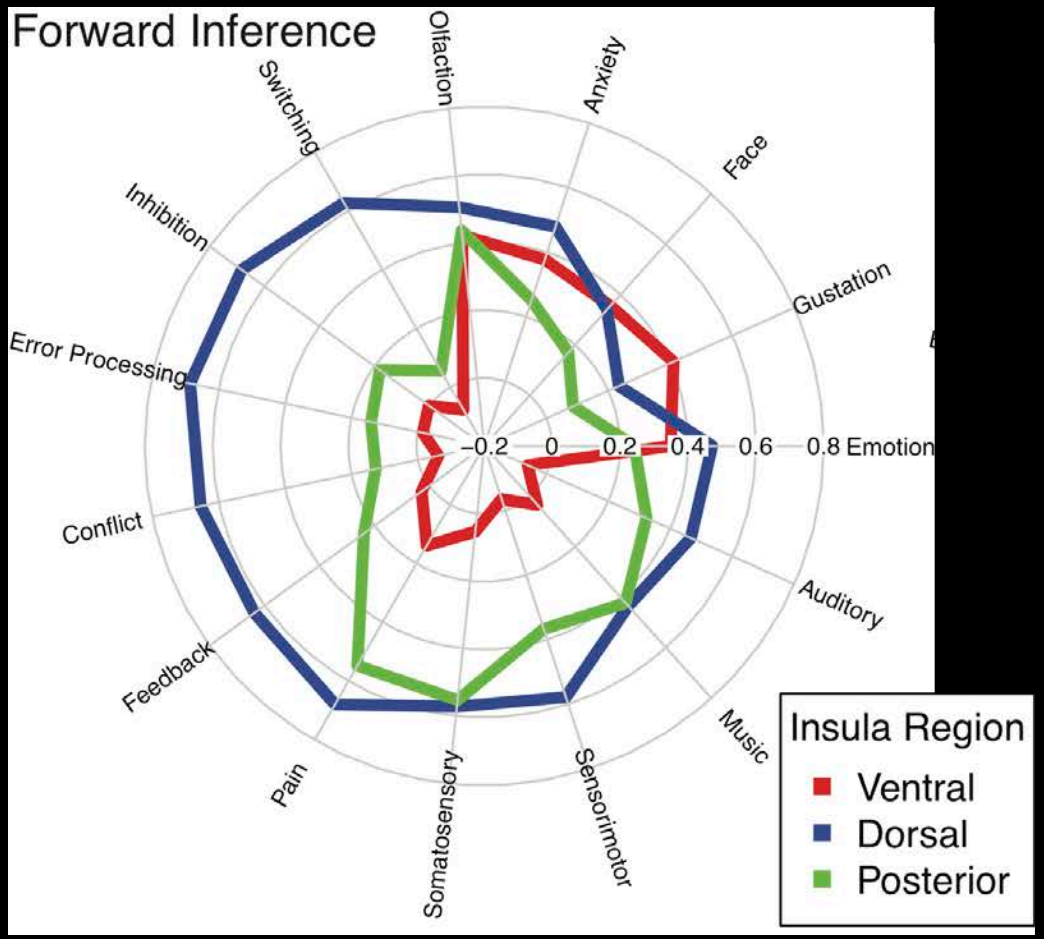


Meta-Analytic Decoding



Chang, Yarkoni, Khaw, & Sanfey (2012) Cerebral Cortex

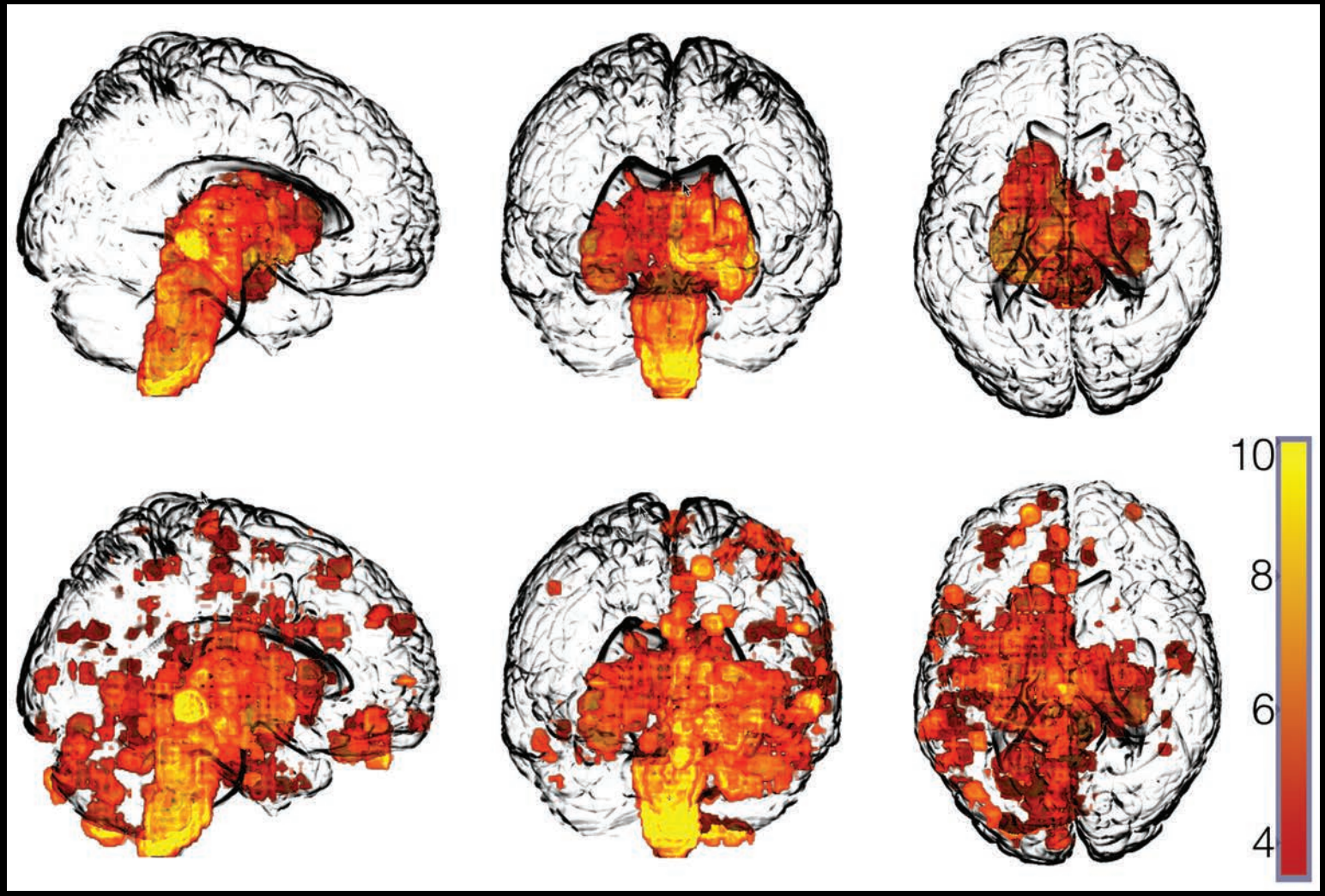
Consistency & Specificity



Chang, Yarkoni, Khaw, & Sanfey (2012) Cerebral Cortex

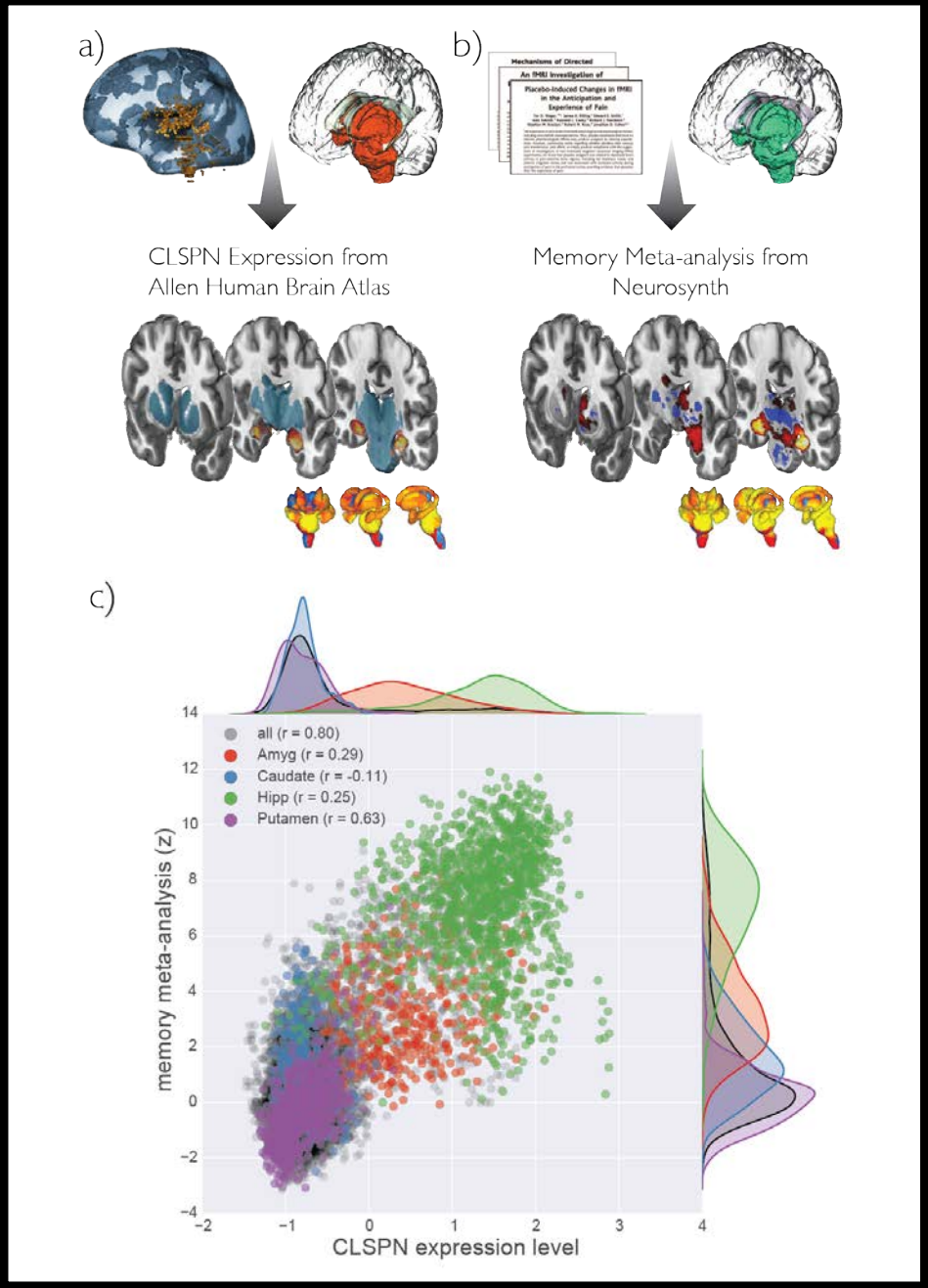
Other Decoding Applications

3,702 tissue samples across 6 human postmortem brains with 58,000 gene probes



Fox, Chang, Gorgolewski, & Yarkoni (Under Revision) Nature Neuro

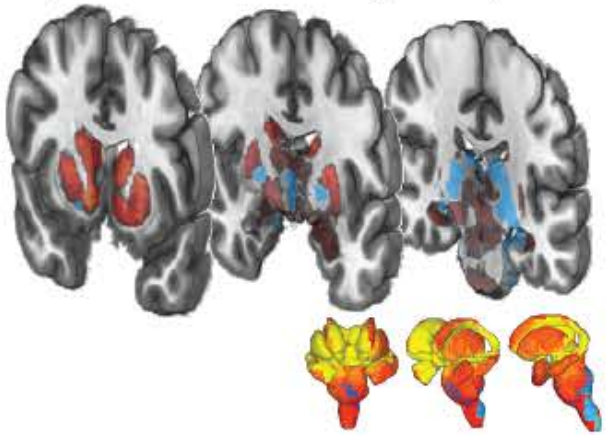
The Concept



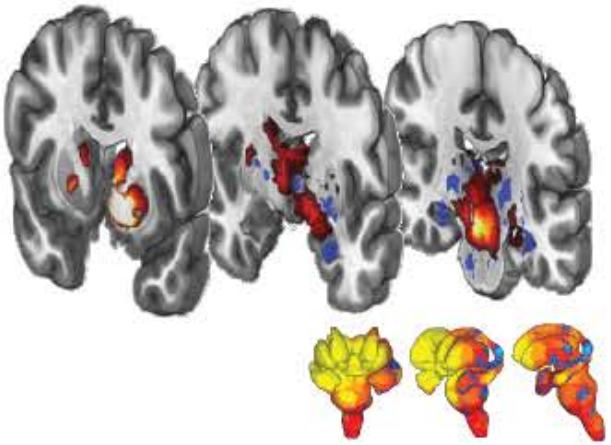
Fox, Chang, Gorgolewski, & Yarkoni (Under Revision) Nature Neuro

How do we know if it works?

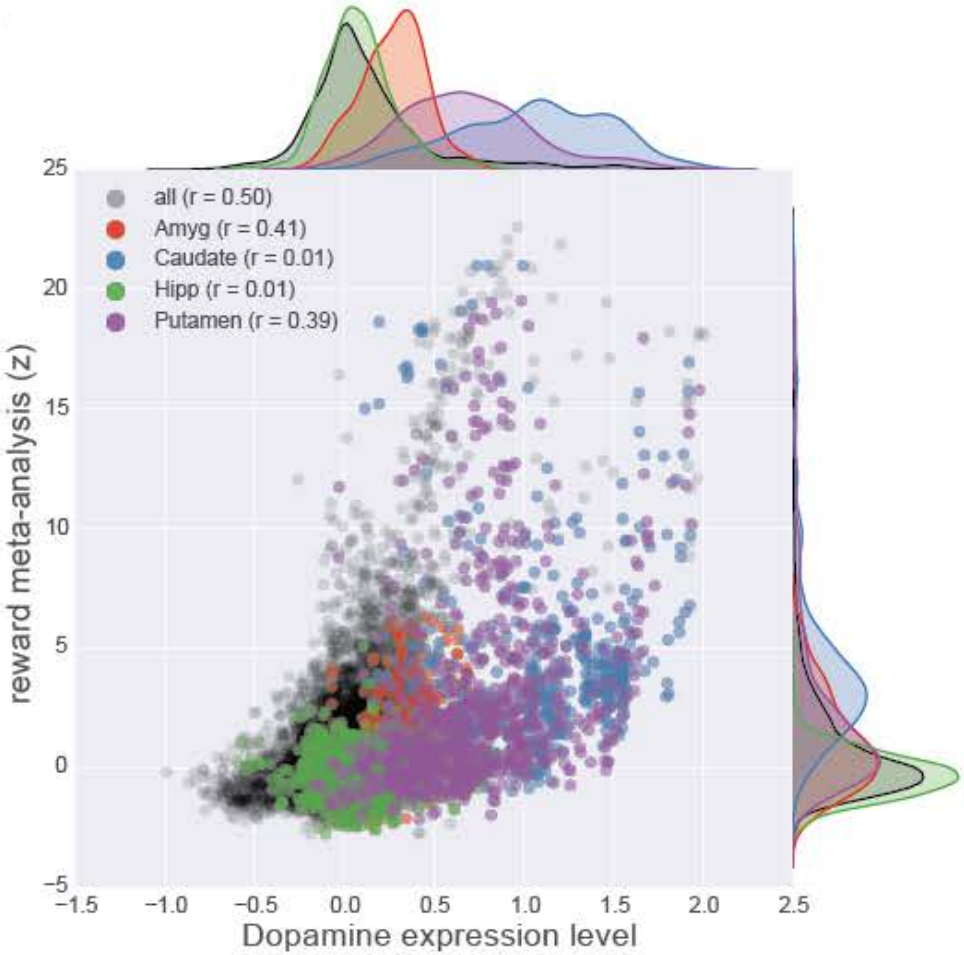
b) Dopamine-family Expression



c) Reward topic meta-analysis

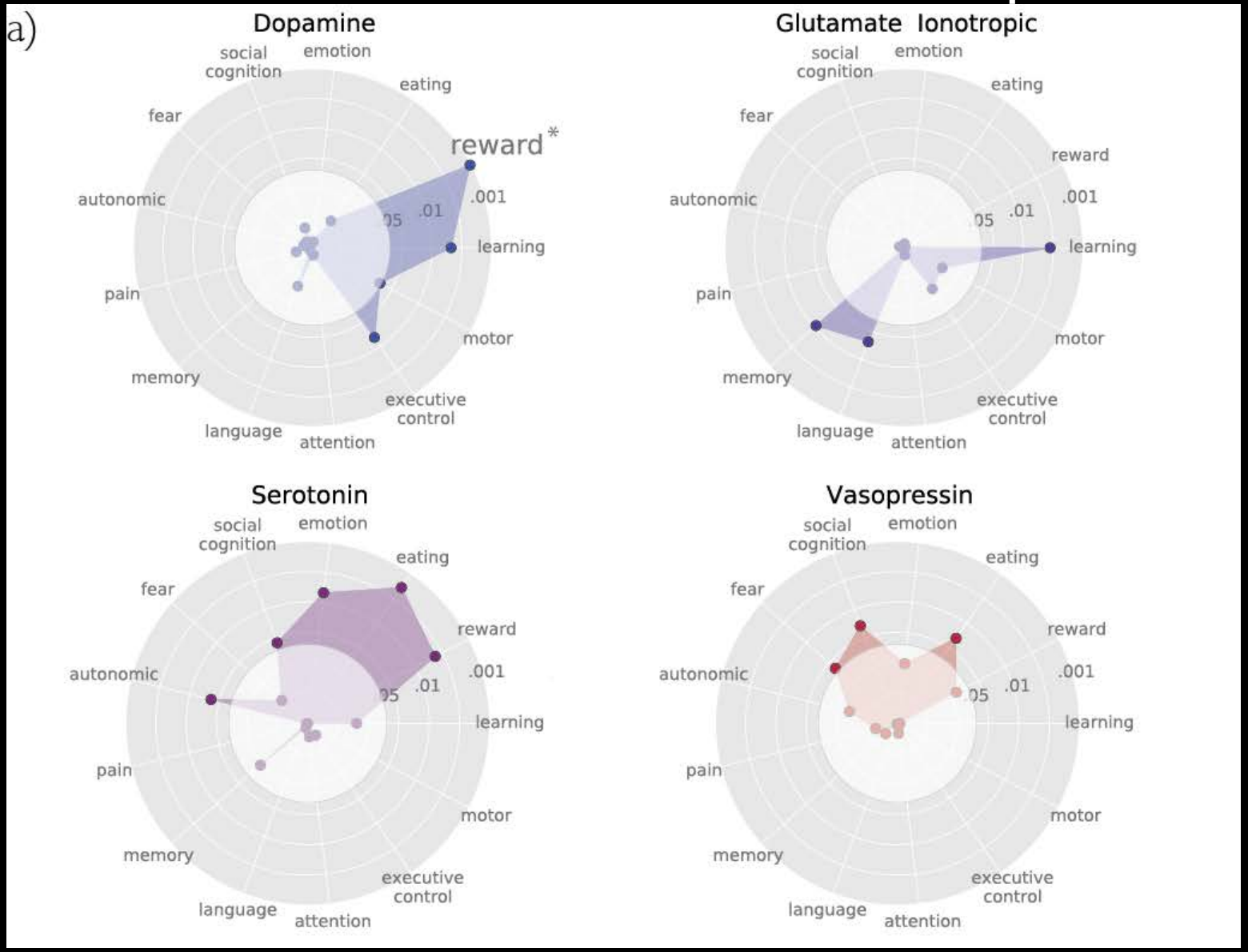


d)



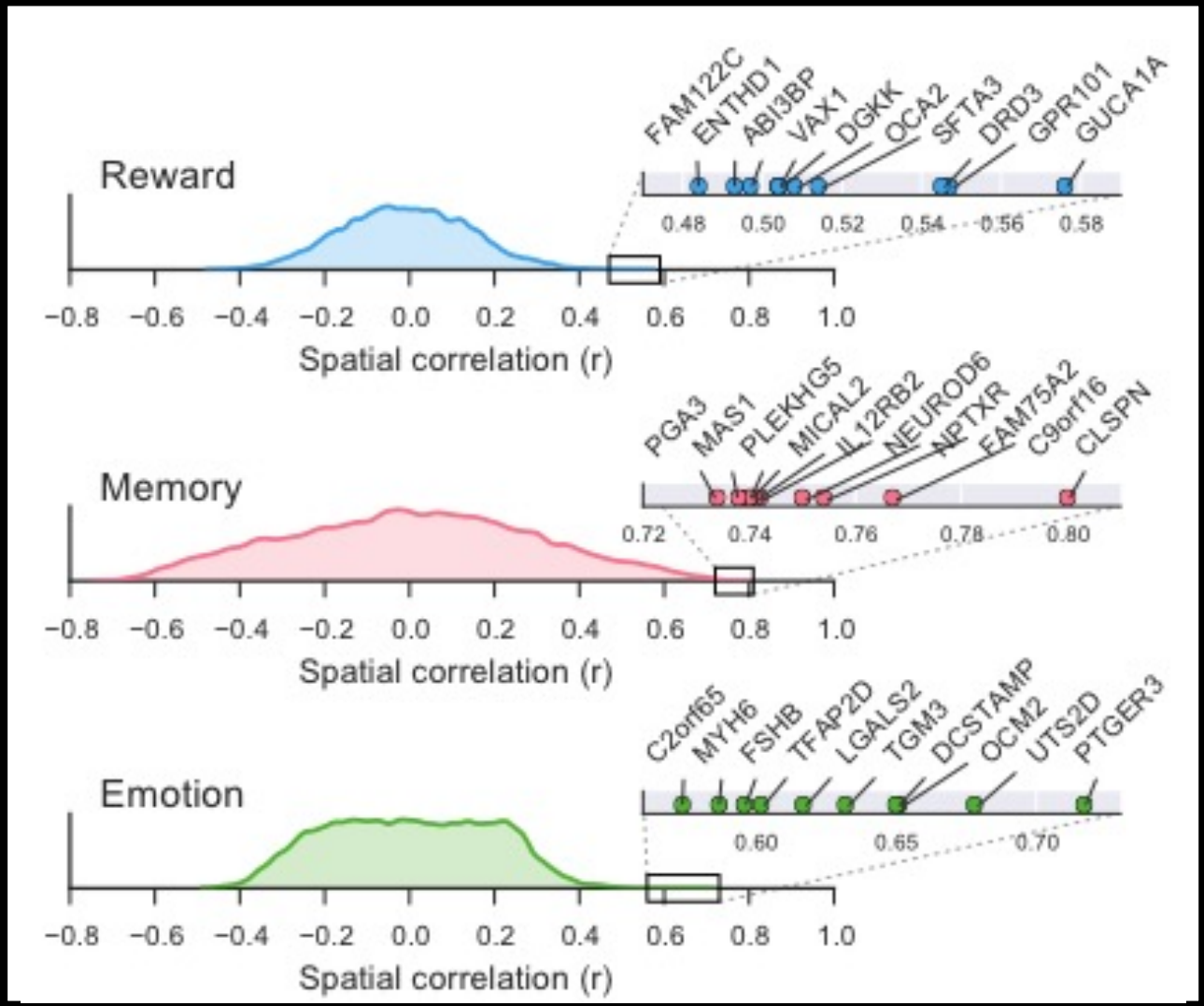
Fox, Chang, Gorgolewski, & Yarkoni (Under Revision) Nature Neuro

Neurotransmitter Groups



Fox, Chang, Gorgolewski, & Yarkoni (Under Revision) Nature Neuro

Which genes are good candidates?



Fox, Chang, Gorgolewski, & Yarkoni (Under Revision) Nature Neuro

Decoding can be misused

The dorsal anterior cingulate cortex is selective for pain: Results from large-scale reverse inference

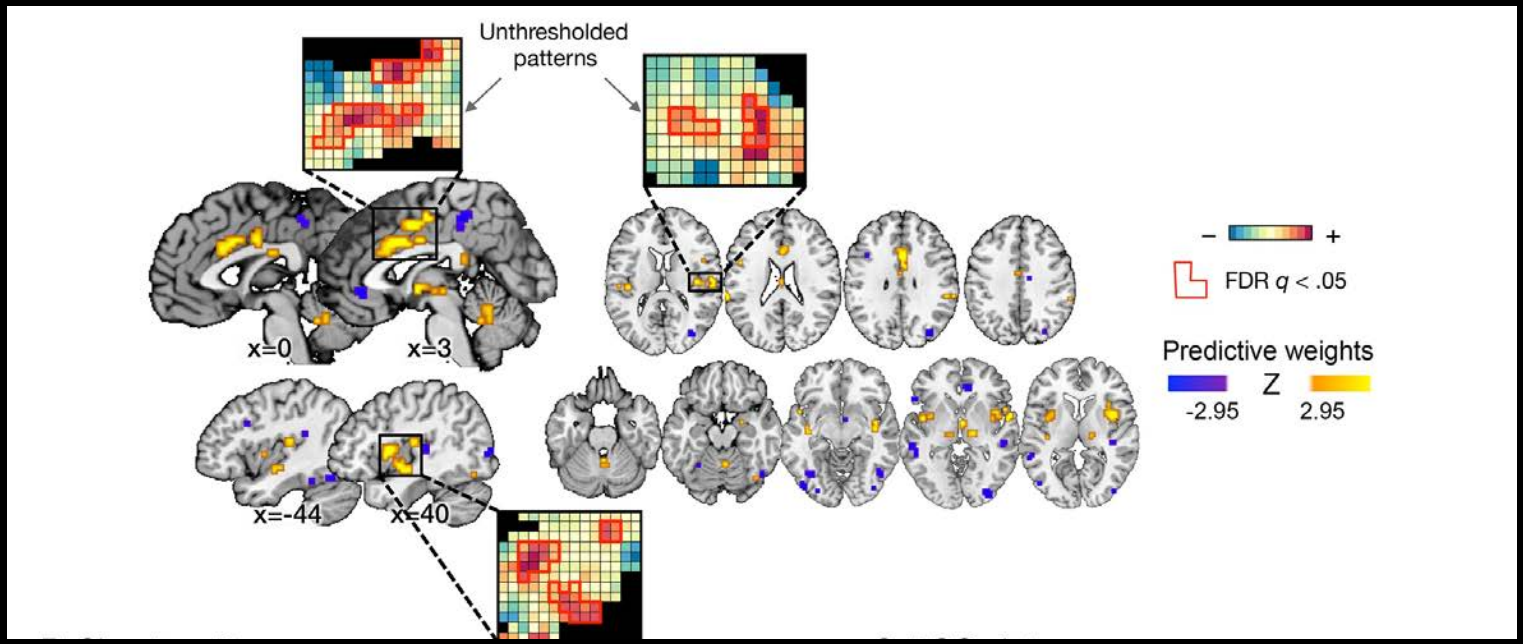
Matthew D. Lieberman[1] and Naomi I. Eisenberger

Pain in the ACC?

Tor D. Wager[a,b,1], Lauren Y. Atlas[c,d], Matthew M. Botvinick[e], Luke J. Chang[f], Robert C. Coghill[g], Karen Deborah Davis[h,i,j], Gian Domenico Iannetti[k], Russell A. Poldrack[l], Alexander J. Shackman[m,n,o], and Tal Yarkoni[p]

Neuroscientists Identify a Brain Signature of Pain

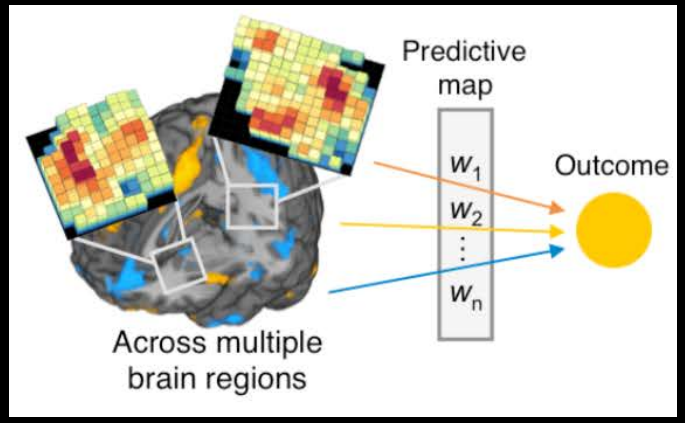
Brain scanning homes in on a neural signature for physical pain

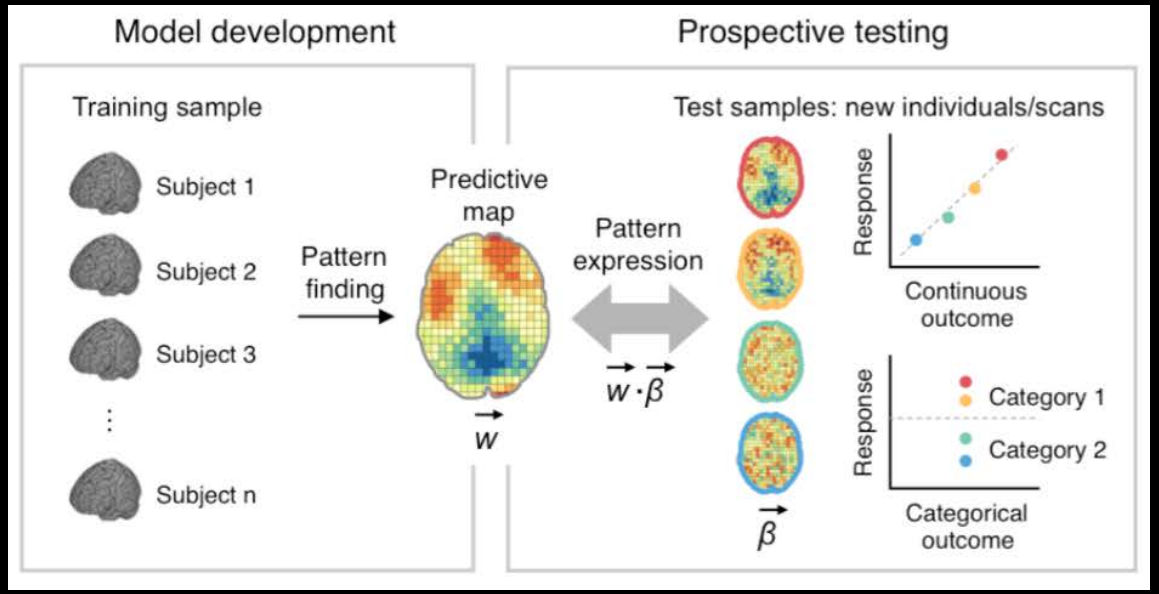


Wager et al., (2013) NEJM

Towards Predictive Models

- Precise model
- Sensitivity & Specificity at the individual person level
- Generalizability





Woo, Chang, Lindquist, & Wager (2017) Nat Neuro

Can this approach work for other affective states?

A Sensitive and Specific Neural Signature for Picture-Induced Negative Affect

Luke J. Chang[1]*, Peter J. Gianaros[2], Stephen B. Manuck[2], Anjali Krishnan[1], Tor D. Wager[1]*

Somatic and vicarious pain are represented by dissociable multivariate brain patterns

Anjali Krishnan[1,2,3]*, Choong-Wan Woo[1,2†], Luke J Chang[1,2,4†], Luka Ruzic[1,2,5], Xiaosi Gu[6,7], Marina López-Solà[1,2], Philip L Jackson[8], Jesús Pujol[9], Jin Fan[10,11], Tor D Wager[1,2]*

Multivariate Brain Prediction of Heart Rate and Skin Conductance Responses to Social Threat

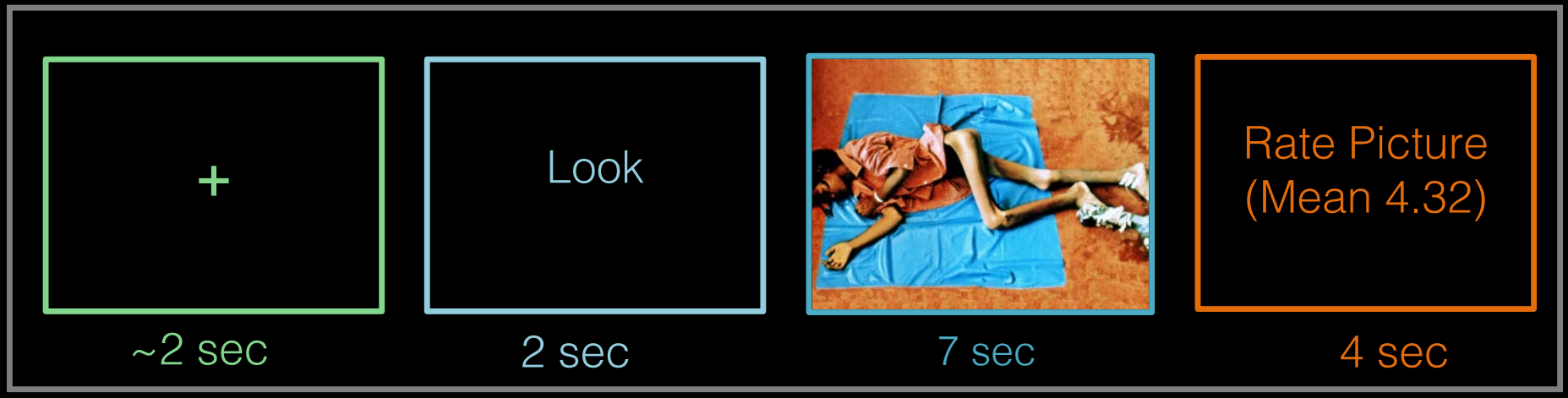
Hedwig Eisenbarth,[1,2] Luke J. Chang,[3] and Tor D. Wager[1]

https://github.com/canlab/Neuroimaging_Pattern_Masks/tree/master/Multivariate_signature_patterns


Pete Gianaros Steve Manuck
University of Pittsburgh

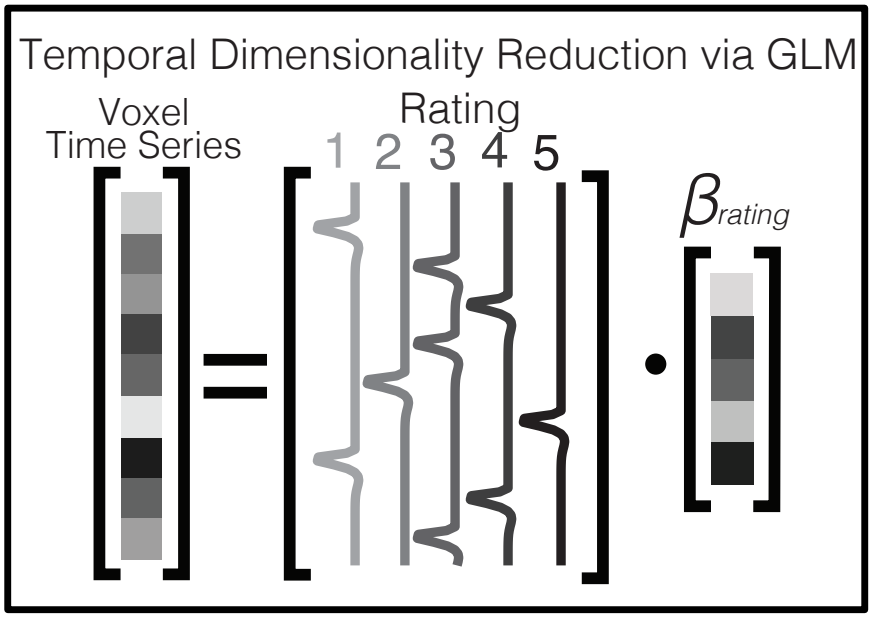
Anjali Krishnan
Brooklyn College

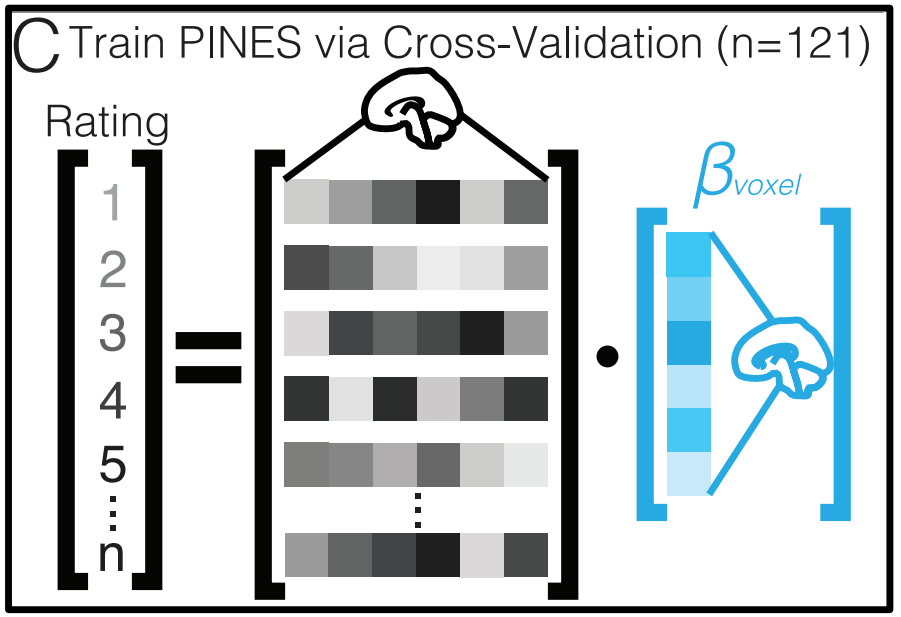
Tor Wager
University of Colorado

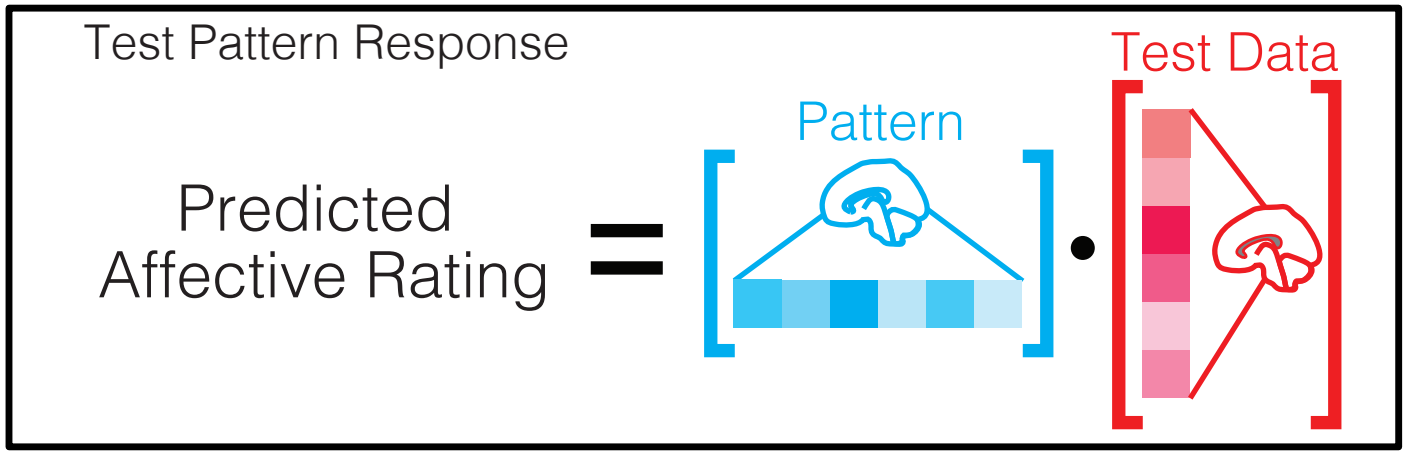


Neutral (n = 15)
Negative (n = 15)

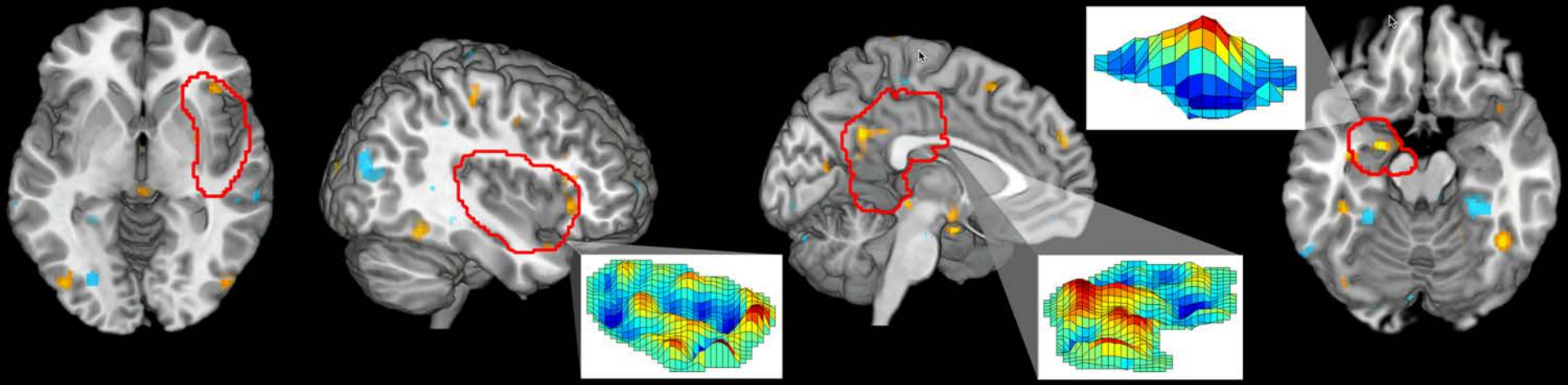
Analysis Pipeline





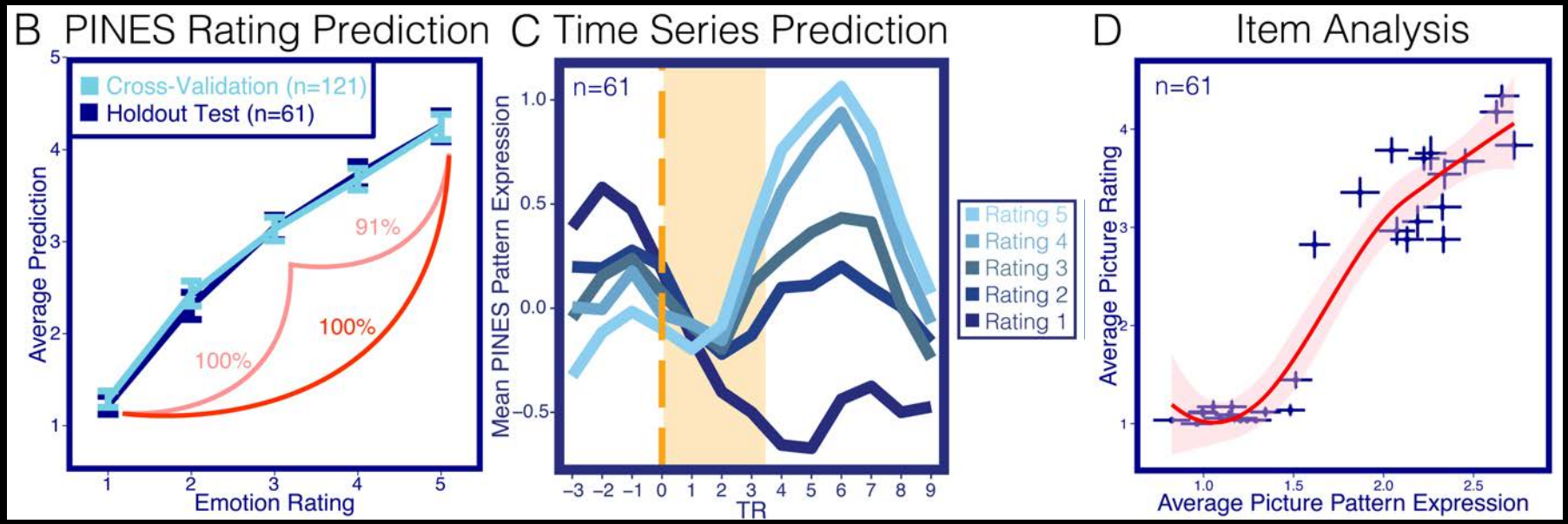


Picture Induced Negative Emotion Signature (PINES)



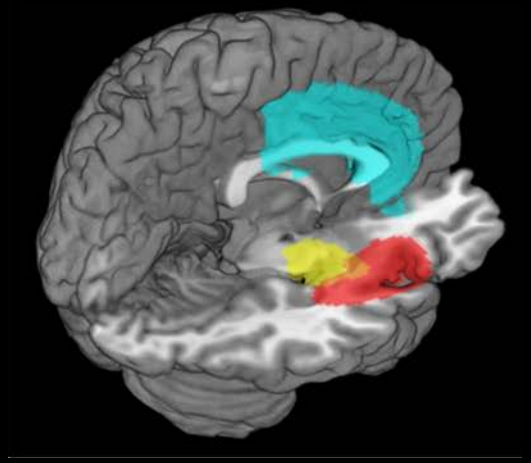
Chang, Gianaros, Manuck, Krishnan, & Wager (2015) PLoS Biology

Validating PINES



Chang, Gianaros, Manuck, Krishnan, & Wager (2015) PLoS Biology

Amount of Emotion Variance Explained by Model



Chang, Gianaros, Manuck, Krishnan, & Wager (2015) PLoS Biology

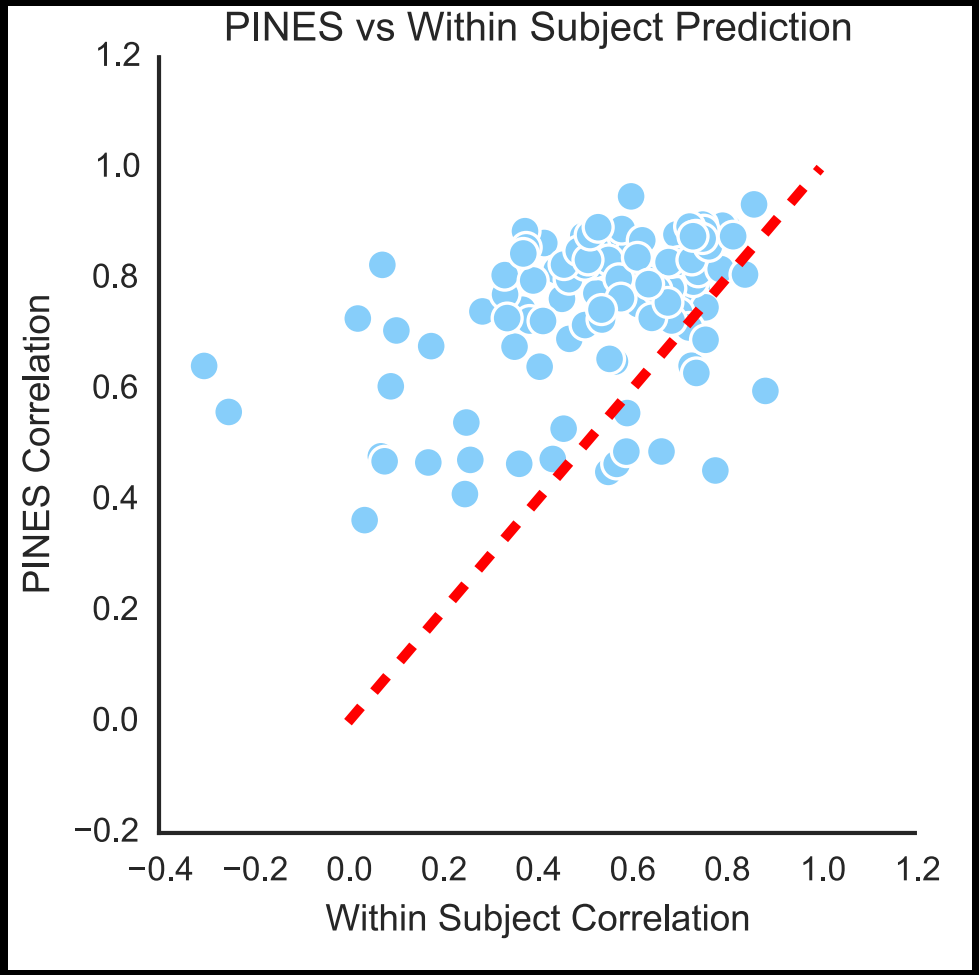
Opinion: Skip the searchlight

- Very computationally expensive
- Need to correct for multiple comparisons
- Only controls for activity in local regions
- Can't actually compare regions (where is information encoded)
- Can't integrate searchlights
- Most people don't even save the model weights
- Use parcellations or ROIs instead

Hackathon Ideas: Other features?

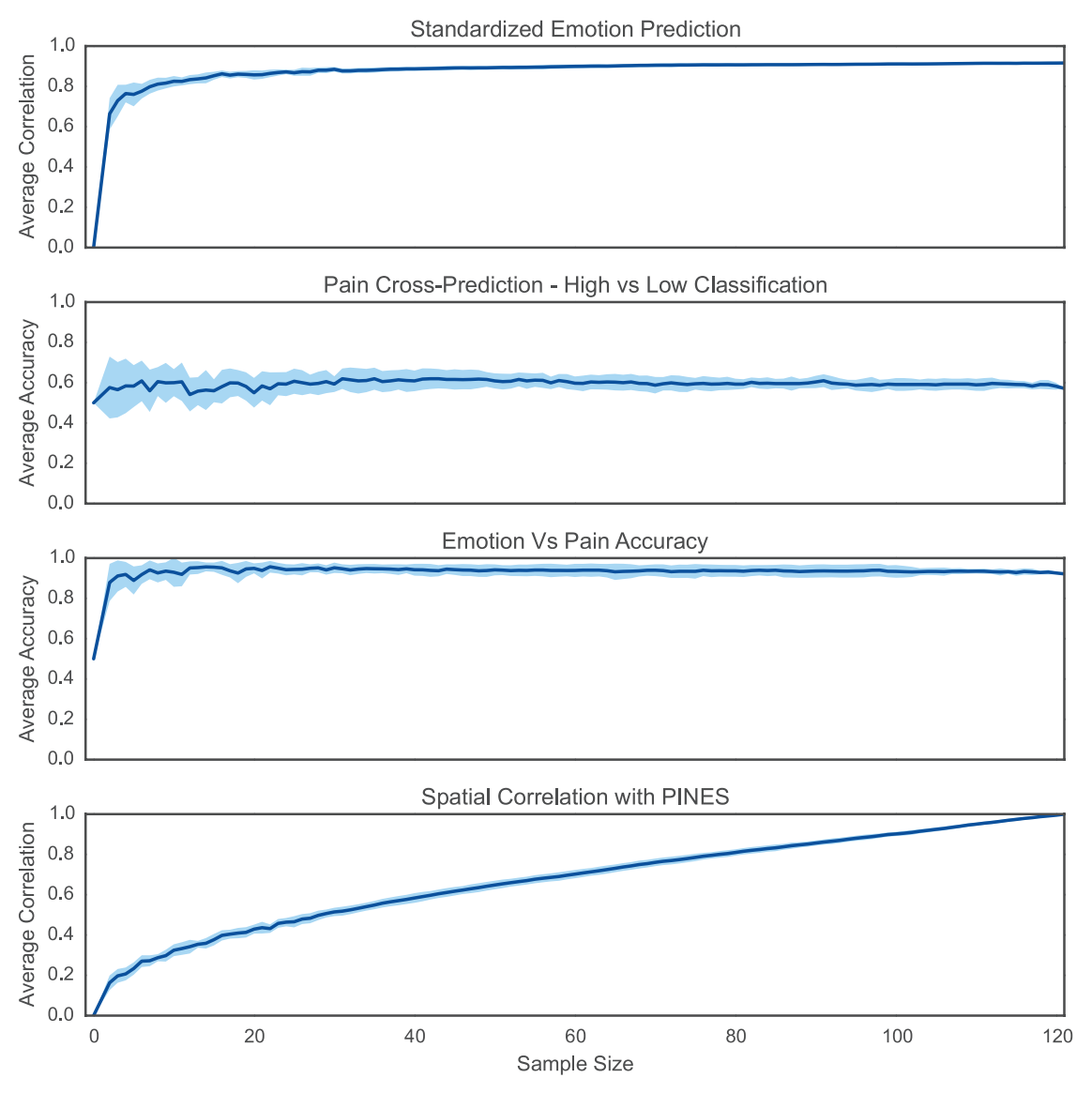
- Pairwise connectivity (Yoni)
- Alternative HRF convolutions (e.g., width instead of height) (Aaron)
- Spatial Frequency (Feilong, Vincent, Steve)

PINES outperforms individual subject models



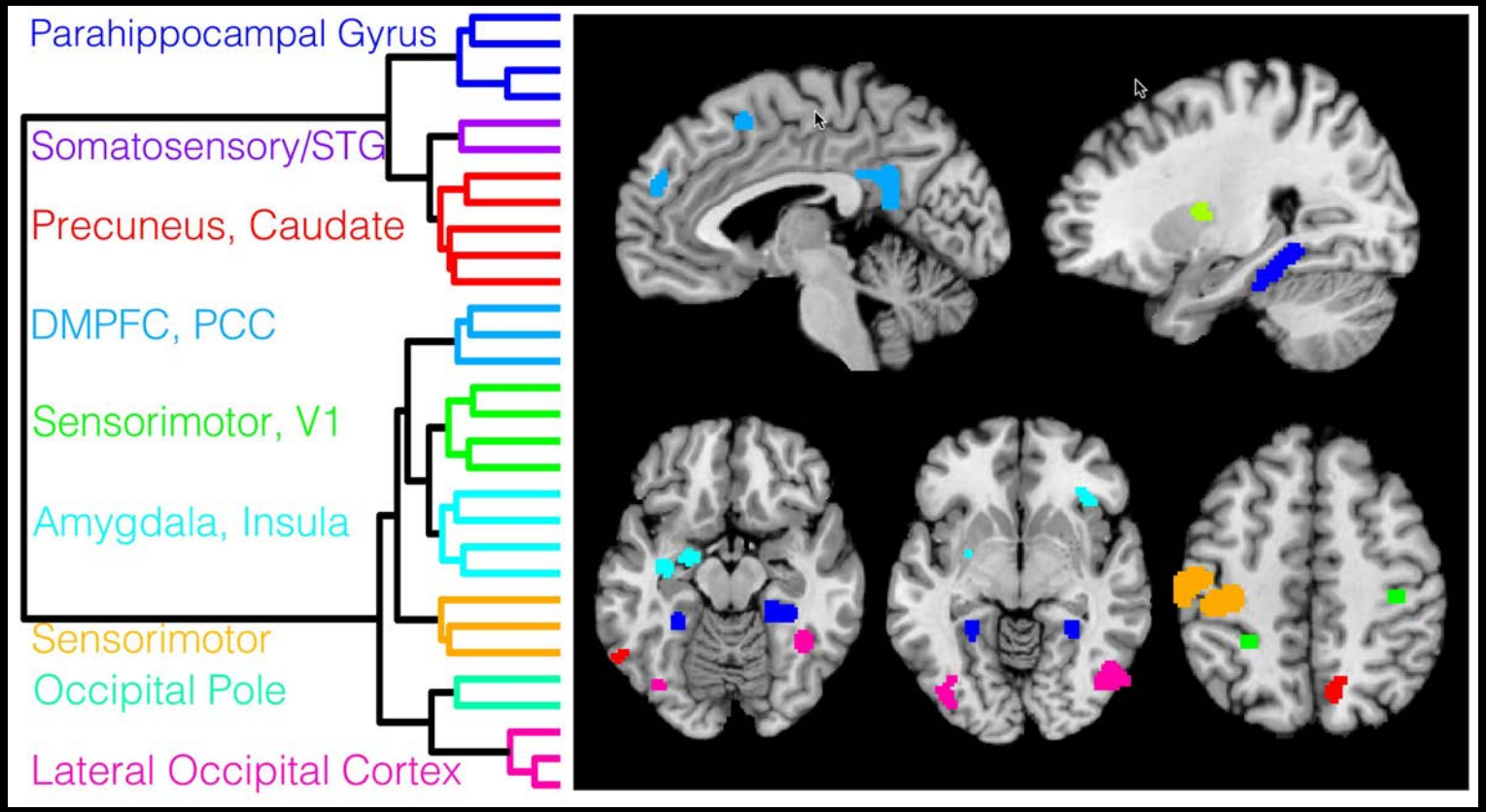
Chang, Gianaros, Manuck, Krishnan, & Wager (2015) PLoS Biology

Training Size



Chang, Gianaros, Manuck, Krishnan, & Wager (2015) PLoS Biology

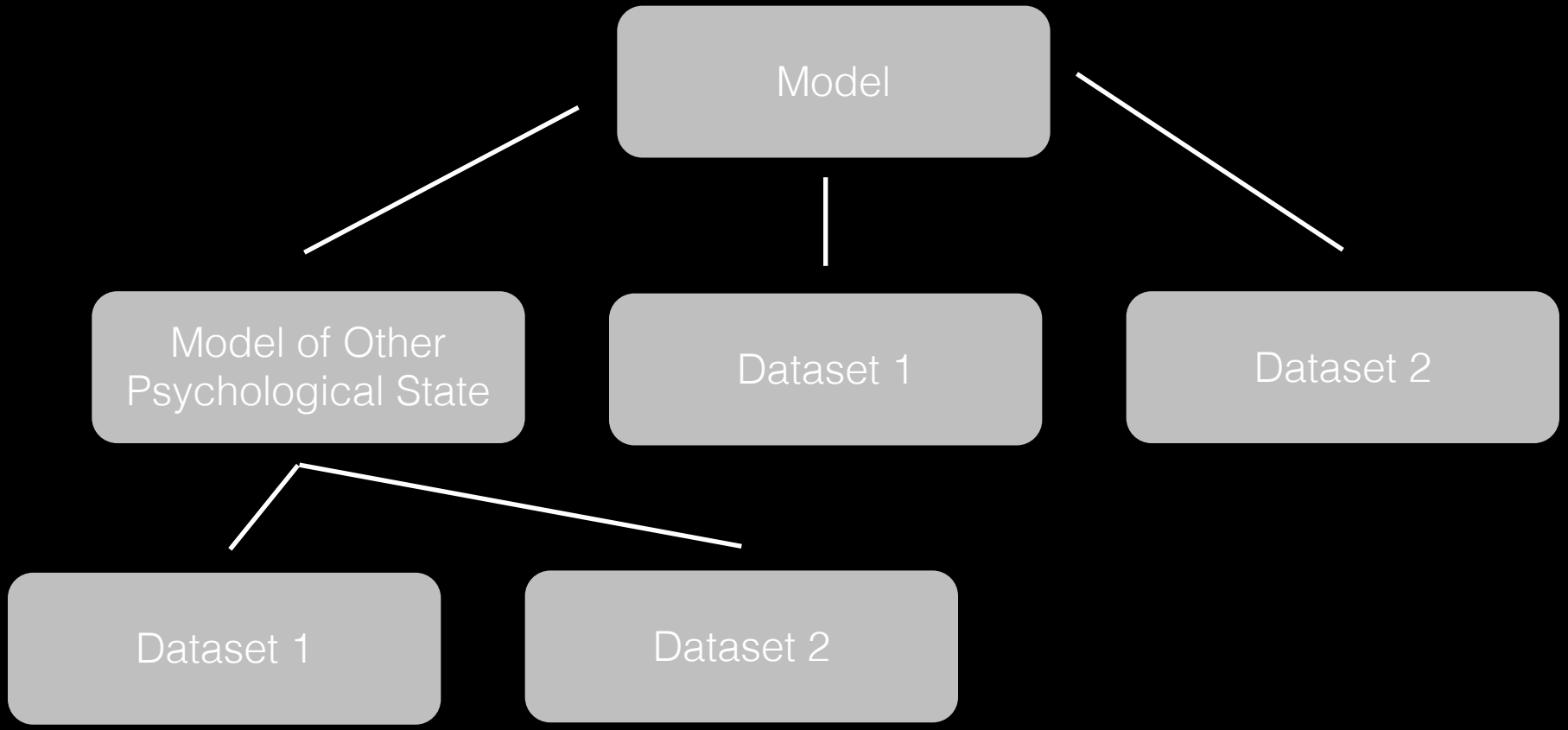
PINES is comprised of multiple functional networks



Chang, Gianaros, Manuck, Krishnan, & Wager (2015) PLoS Biology

Construct Validation

"A construct is defined implicitly by a network of associations or propositions in which it occurs. Constructs employed at different stages of research vary in definiteness."

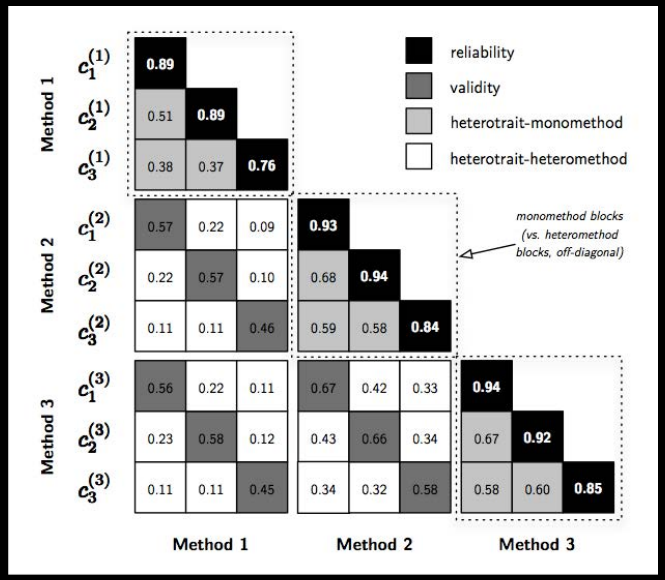


Cronbach & Meehl, 1955

Multitrait Multimethod Matrix

1. Validation requires convergence using independent measurement procedures.
2. Validation must also discriminate non-related constructs
3. There is error in the construct and its measurement

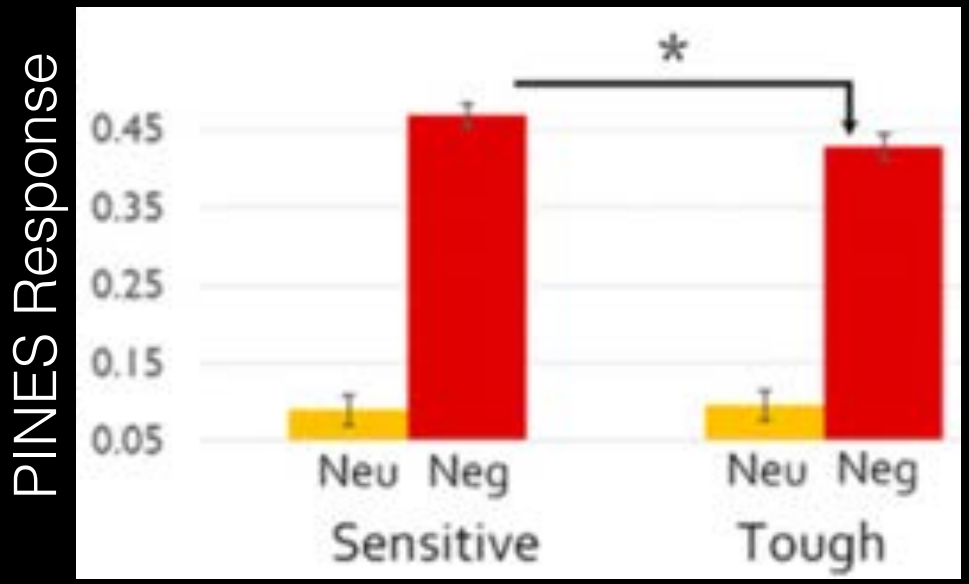
"more than one trait as well as more than one method must be employed in the validation process."



Campbell & Fiske, 1959

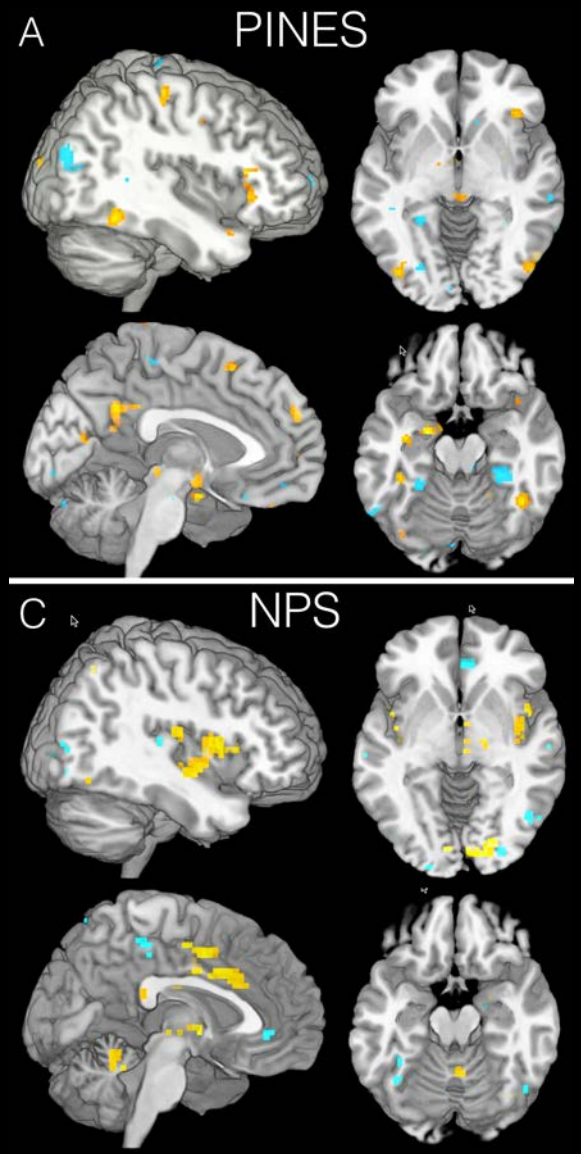
PINES generalizes to new scanner, lab, and task

PINES Response to Emotion Distancing



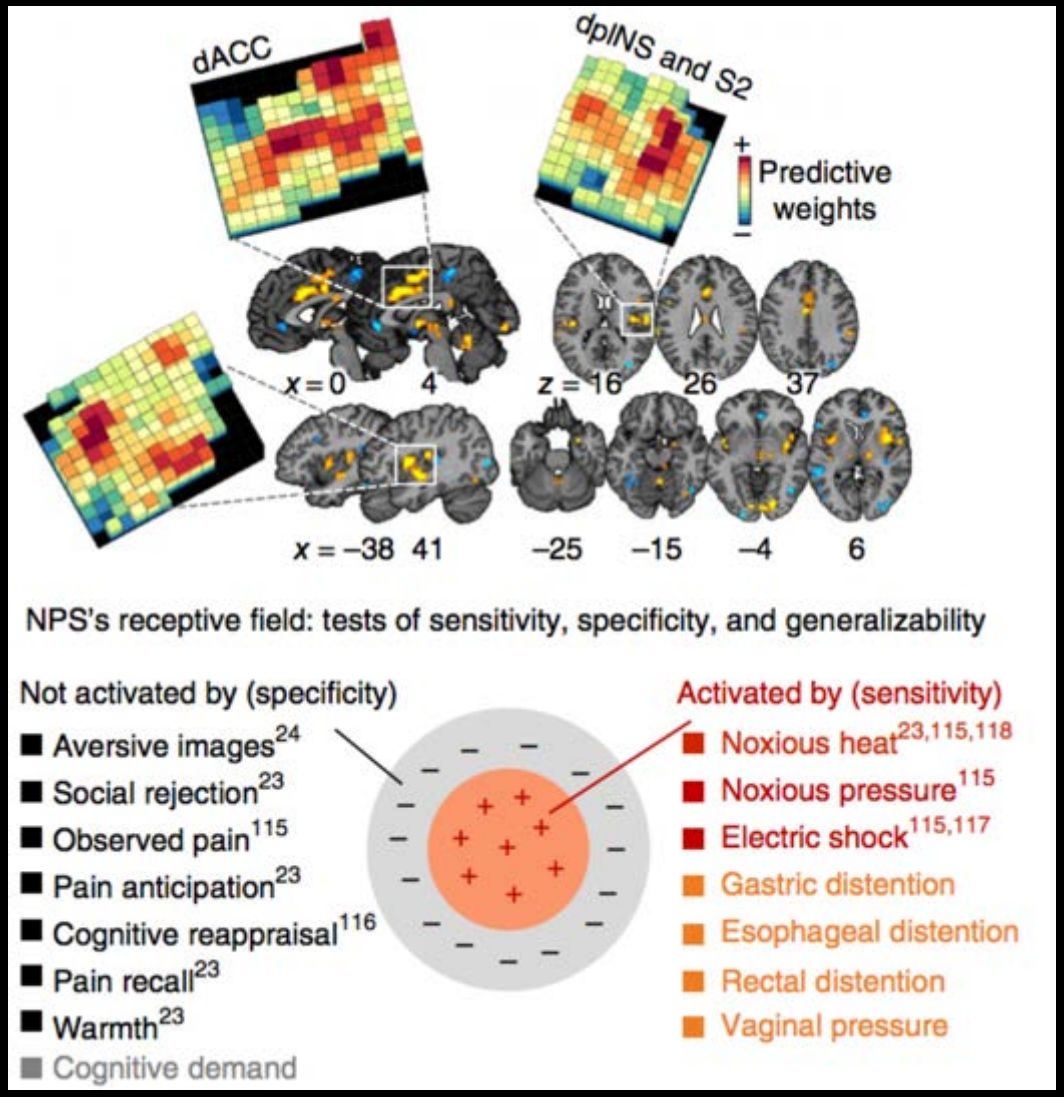
Gilead et al., 2016 PNAS

PINES is Specific to Emotion

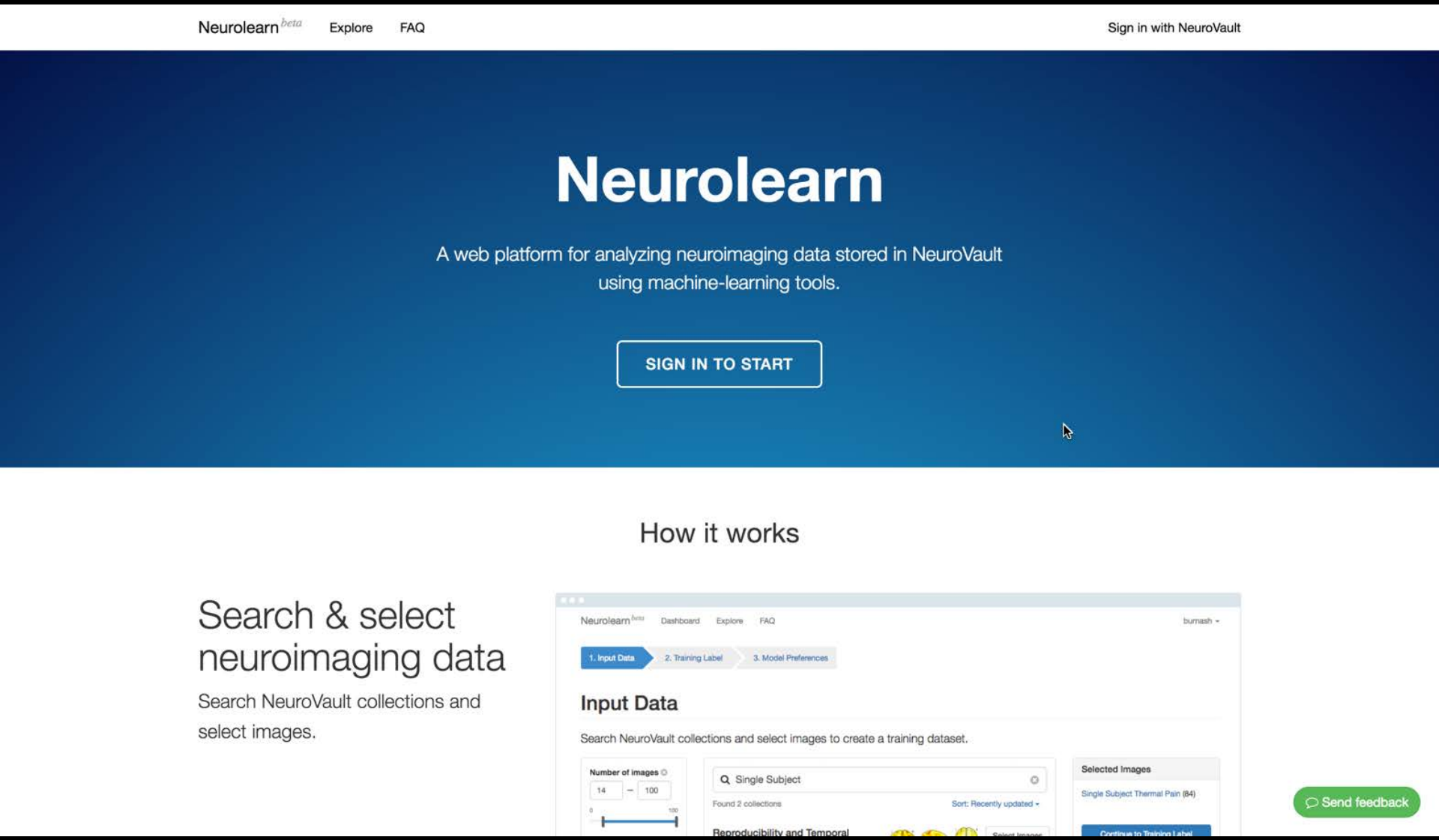


Chang, Gianaros, Manuck, Krishnan, & Wager (2015) PLoS Biology

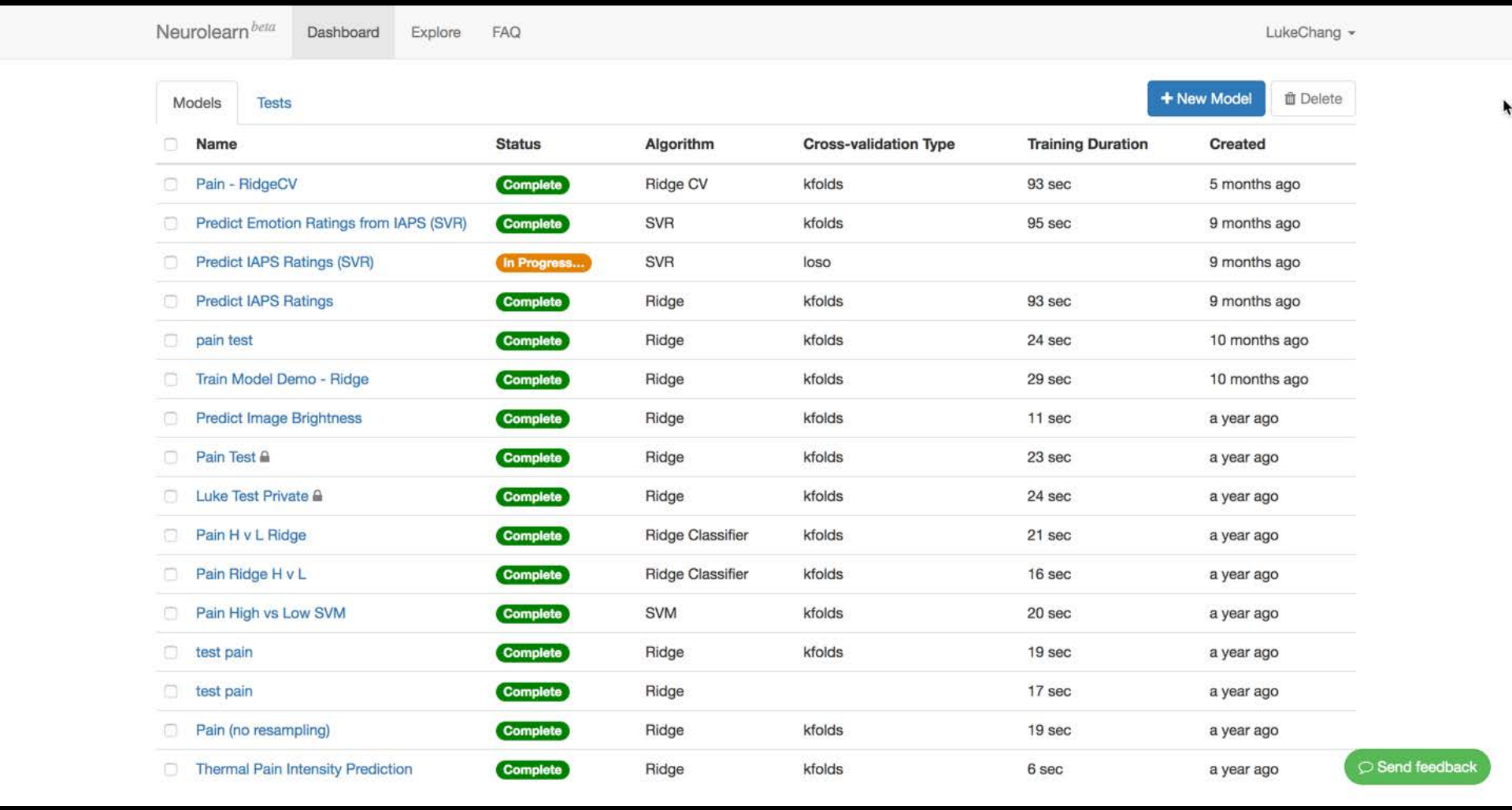
Assessing sensitivity & specificity requires cross-lab collaborations



Woo, Chang, Lindquist, & Wager (2017) Nat Neuro



Chang, Burnashev, & Wager (In Prep)



Chang, Burnashev, & Wager (In Prep)

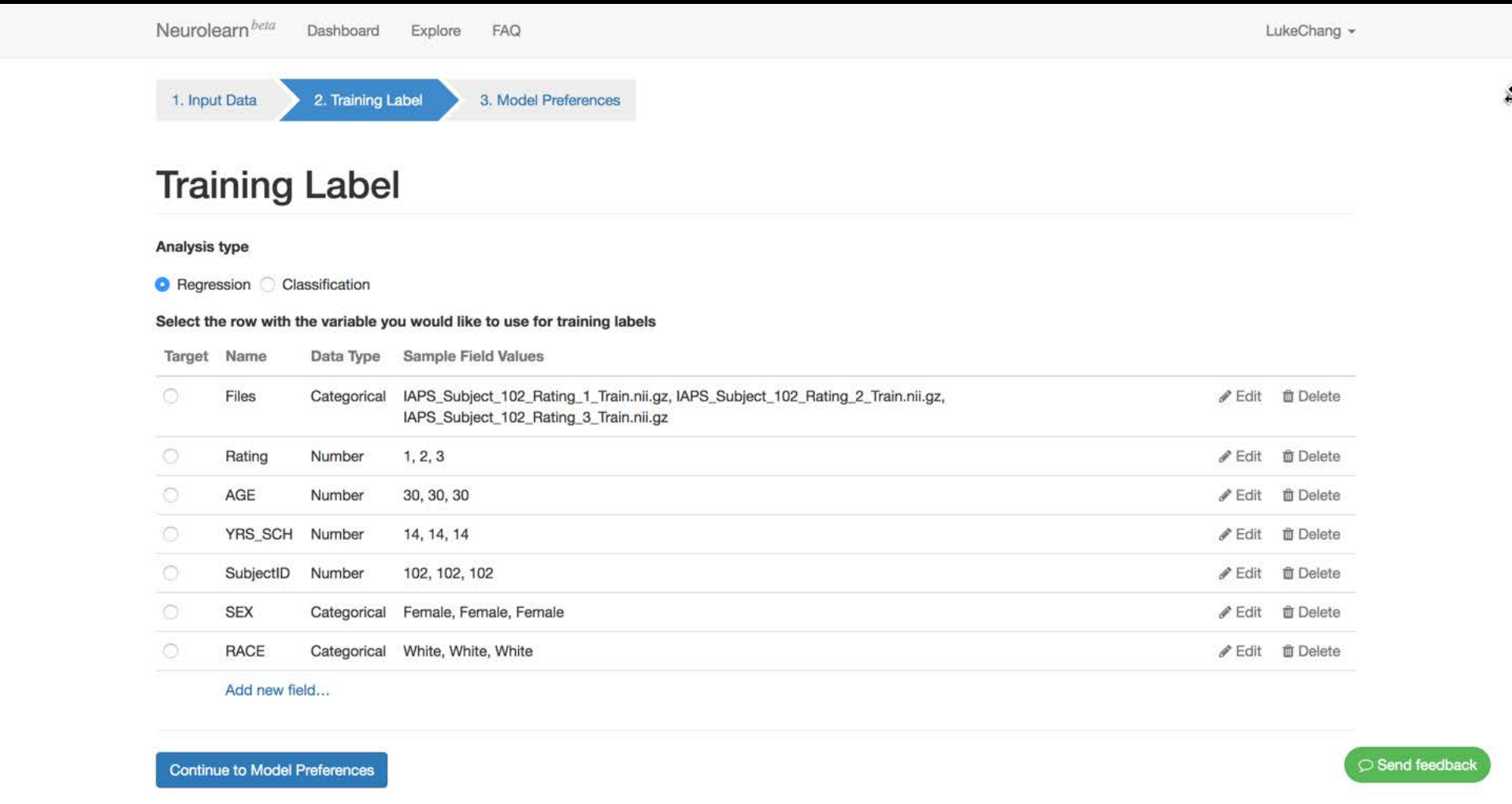
Select Images

Train

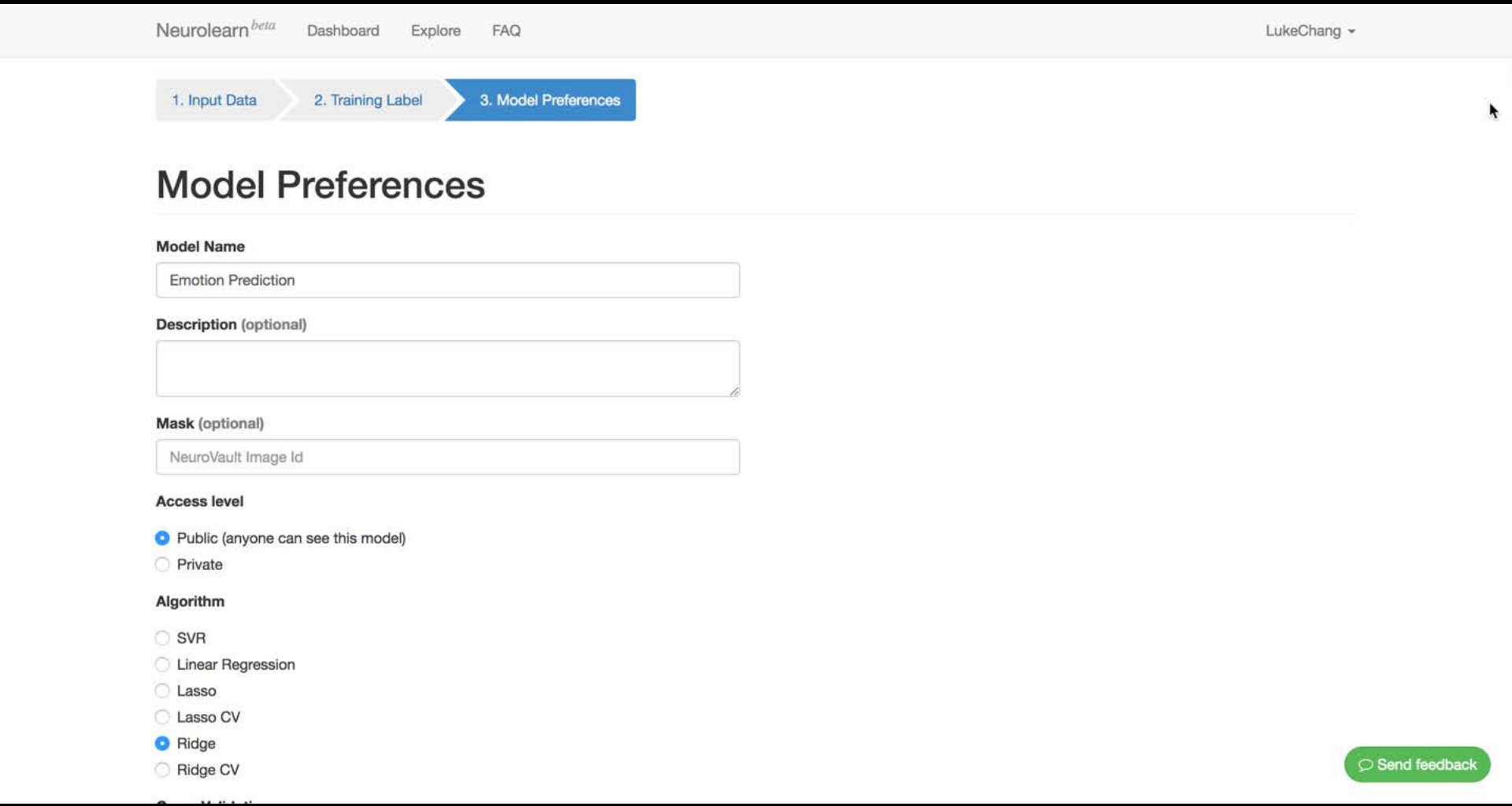
	Name	Image Type	Map Type	
☑	IAPS_Subject_102_Rating_1_Train.nii.gz	statistic_map	univariate-beta map	
☑	IAPS_Subject_102_Rating_2_Train.nii.gz	statistic_map	univariate-beta map	
☑	IAPS_Subject_102_Rating_3_Train.nii.gz	statistic_map	univariate-beta map	
☑	IAPS_Subject_102_Rating_4_Train.nii.gz	statistic_map	univariate-beta map	
☑	IAPS_Subject_102_Rating_5_Train.nii.gz	statistic_map	univariate-beta	

Close | Continue to Training Label

Chang, Burnashev, & Wager (In Prep)



Chang, Burnashev, & Wager (In Prep)



Chang, Burnashev, & Wager (In Prep)

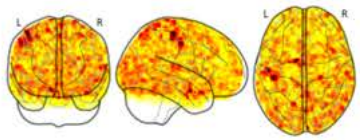
ALGORITHM
Ridge CV Edit

TRAINING LABEL
Rating

TRAINING DATASET
545 images

Model | Training Data

Weightmap



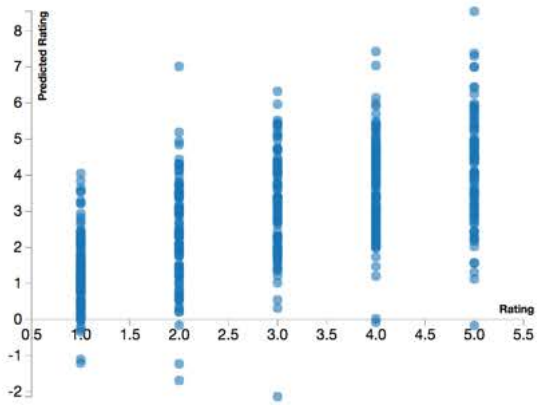
Open Interactive Viewer

Download NIfTI file

Cross Validation

Method	Root Mean Squared Error	Correlation	CV Root Mean Squared Error	CV Correlation
kfolds	0.00	1.00	1.37	0.61

Actual vs. Predicted



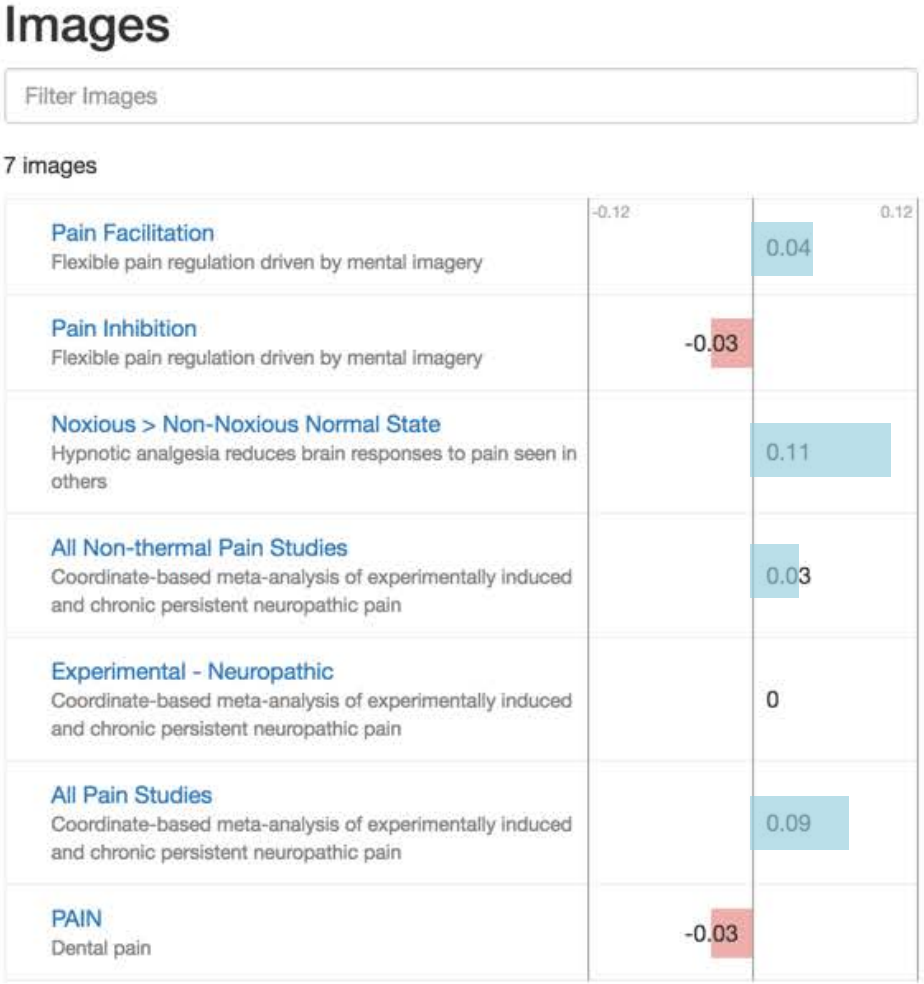
Recent Model Tests

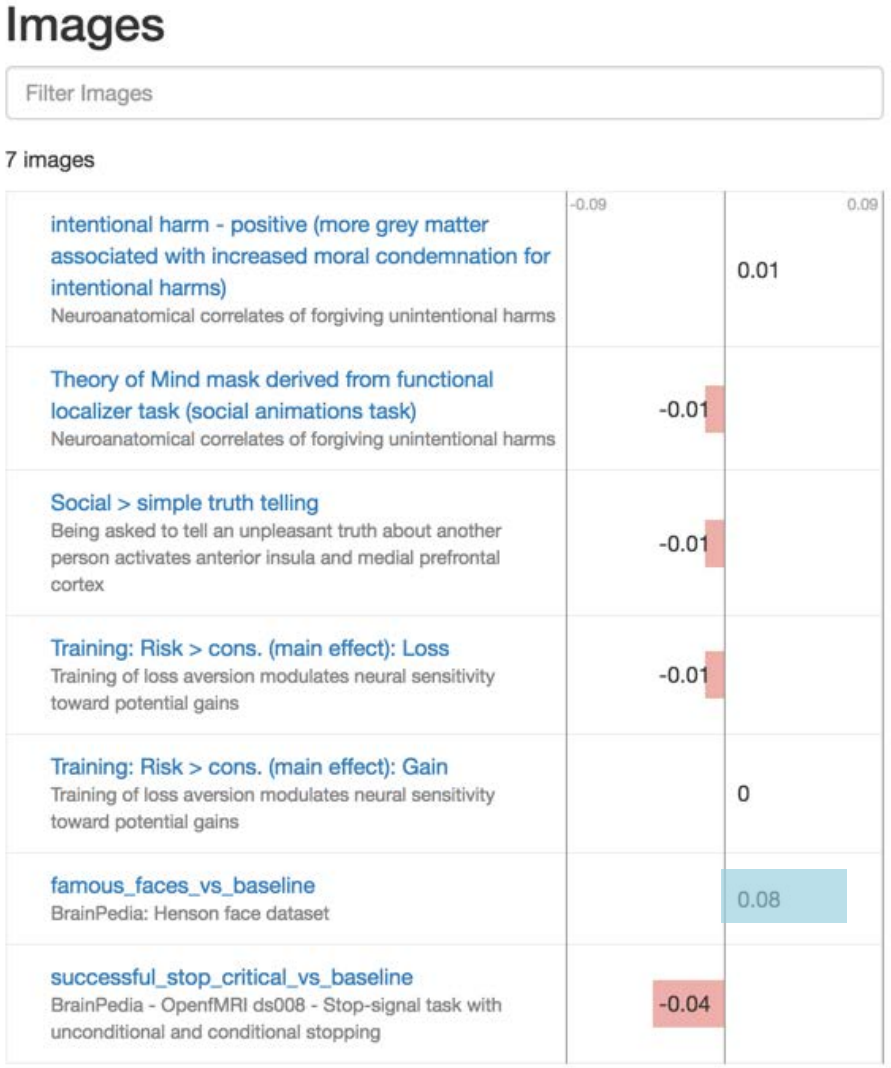
A large-scale gradient describing the topographical organisation of multi-dimensional memory representations in the human cortex
12 images • 0 mean r

Send feedback

Chang, Burnashev, & Wager (In Prep)

Test Models





Chang, Burnashev, & Wager (In Prep)

How do we represent other's experiences?

Opposing views on mental representations

Simulation Theory (mirror neuron, embodied emotions, shared affect)

"The discovery of mirror neurons in the frontal lobes of monkeys, and their potential relevance to human brain evolution … is the single most important "unreported" … story of the decade. I predict that mirror neurons will do for psychology what DNA did for biology: they will provide a unifying framework and help explain a host of mental abilities that have hitherto remained mysterious and inaccessible to experiments."

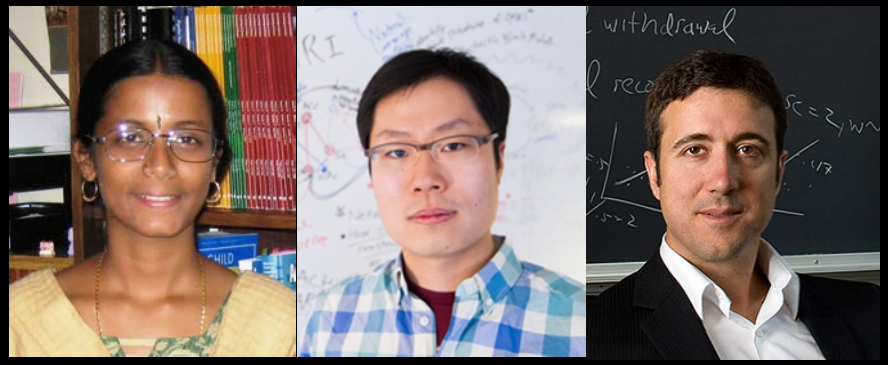
V.S. Ramachandran (2000)

Theory-Theory (mentalizing, perspective-taking, cognitive)

"Though our brother is upon the rack, as long as we ourselves are at our ease, our senses will never inform us of what he suffers. … it is by the imagination only that we can form any conception of what are his sensations."

Adam Smith (1759)

Somatic Pain



CUE

2s

+

~8s

STIM

11s

+

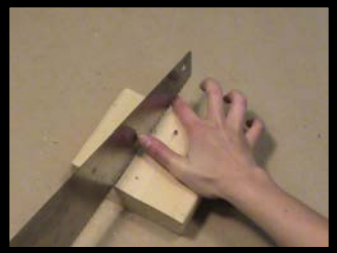
~8s

RATE

4s

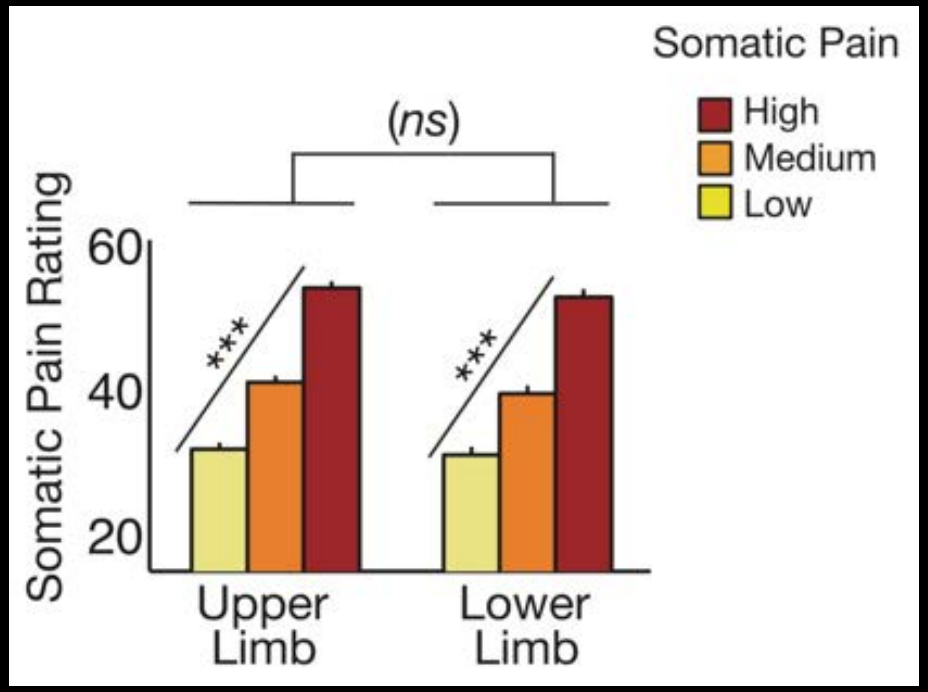
+

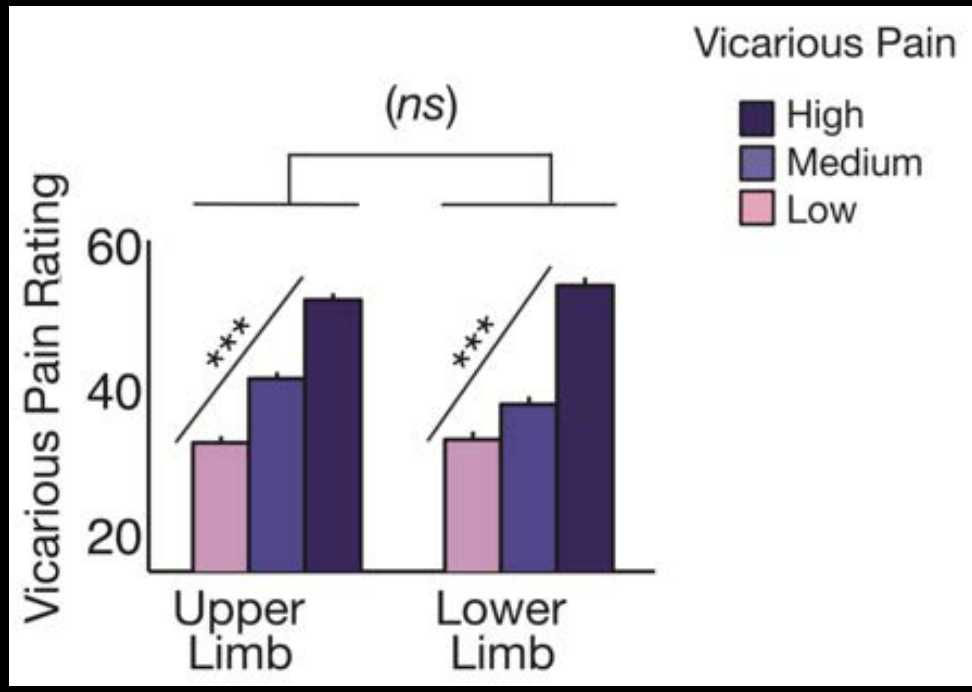
~6s



Vicarious Pain

Krishnan, Woo, Chang, et al. (2016) eLife





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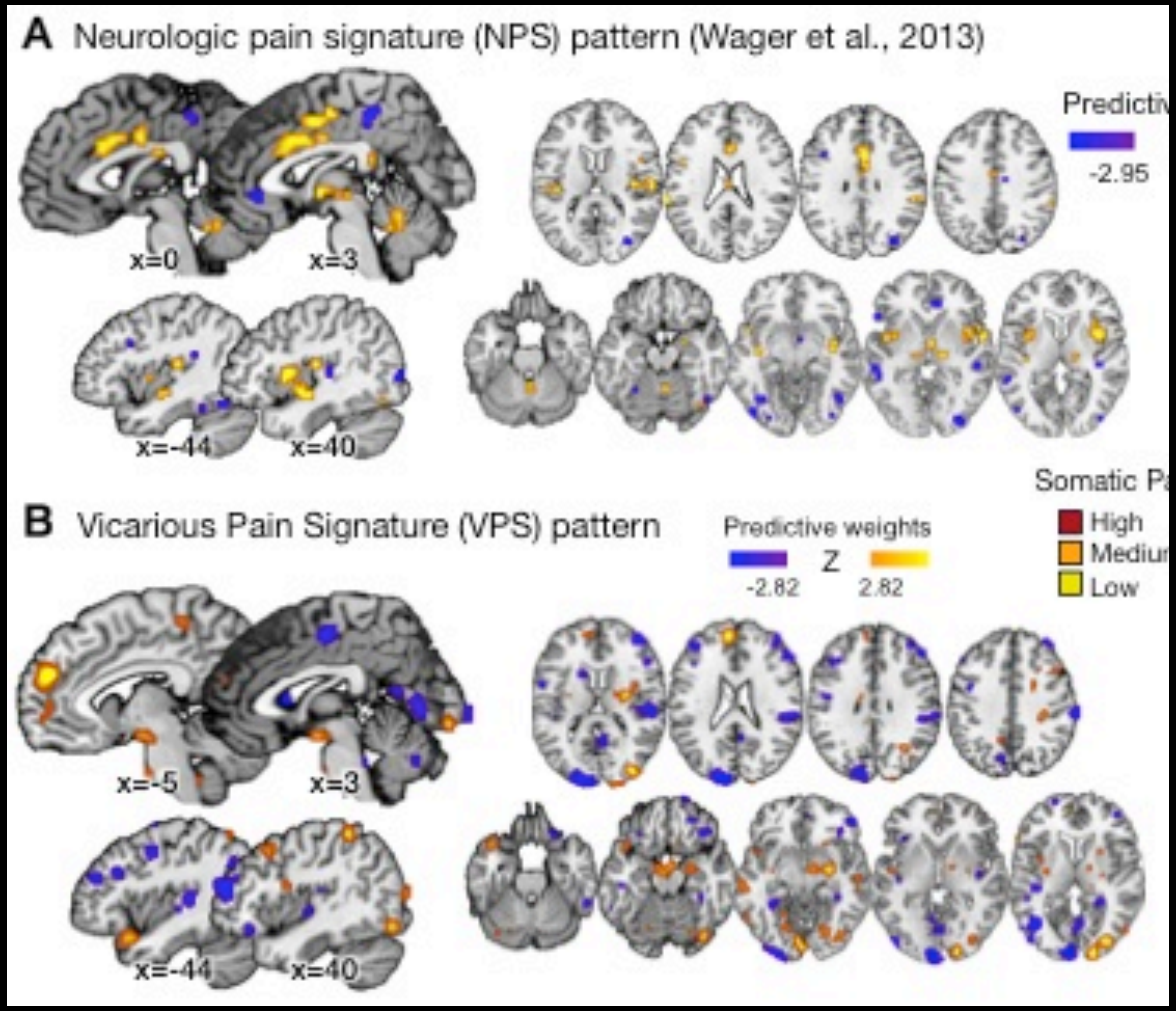
Somatic & vicarious pain are encoded in dissociable systems



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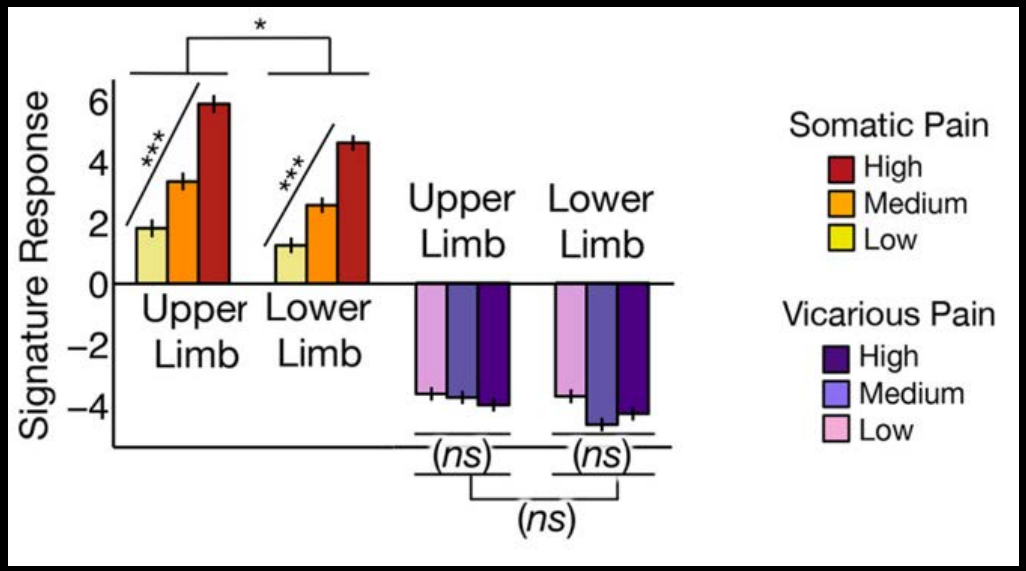
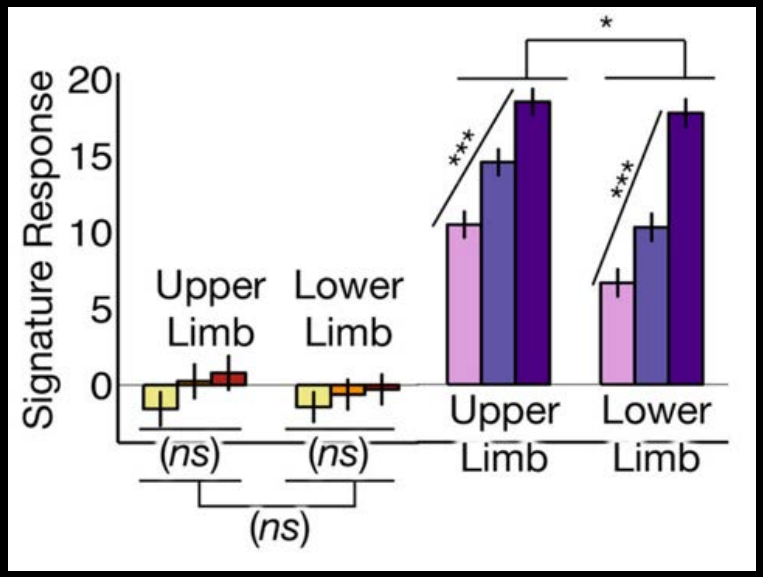
Separate Modifiability





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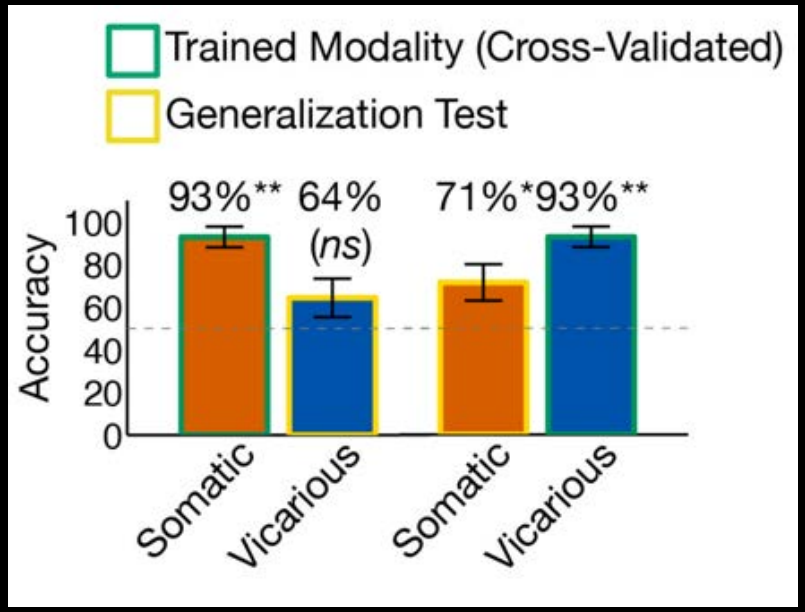
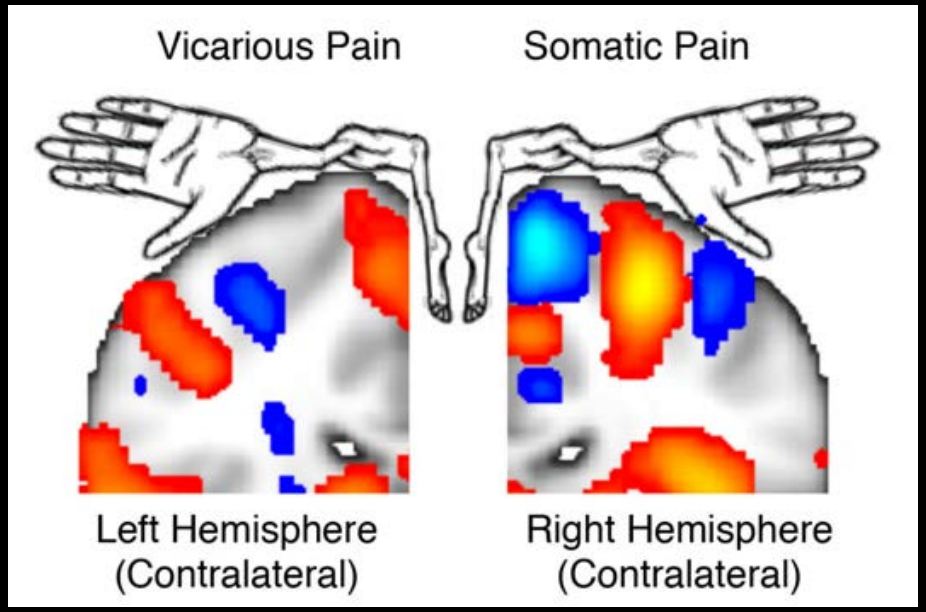
No sensorimotor somatopy for vicarious pain





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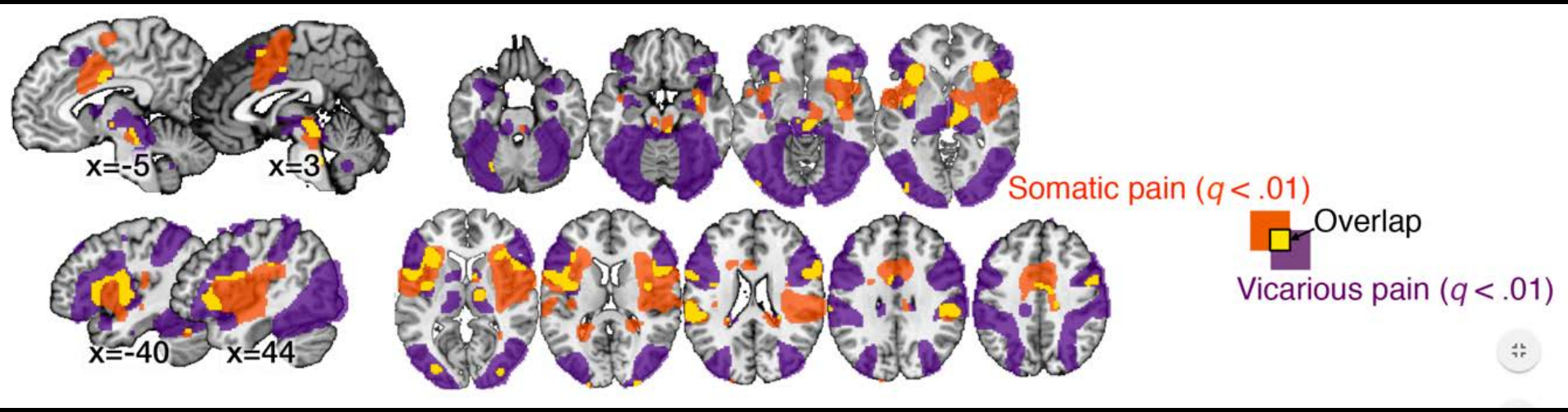
Overlap in univariate analyses



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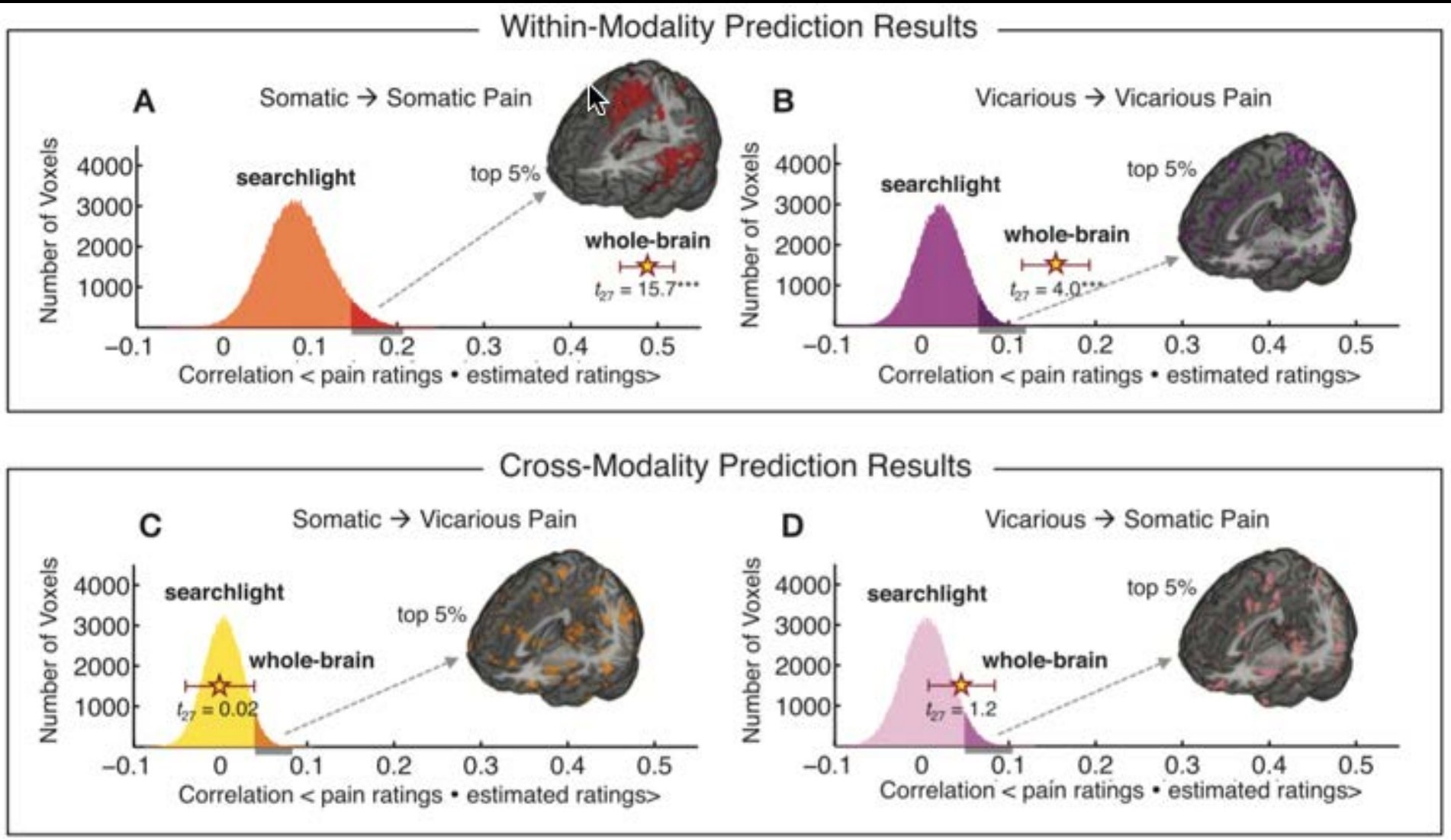
Vicarious Pain Searchlight Analysis



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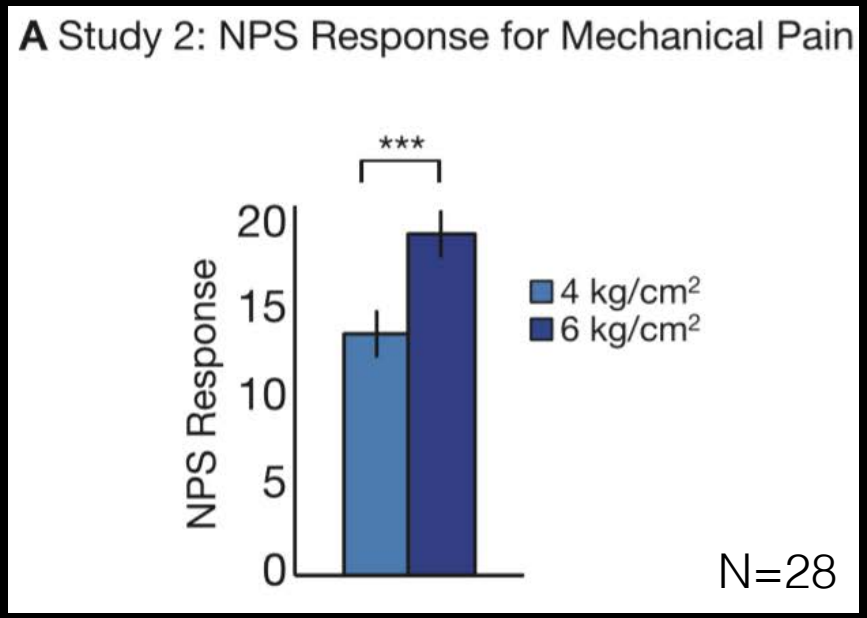
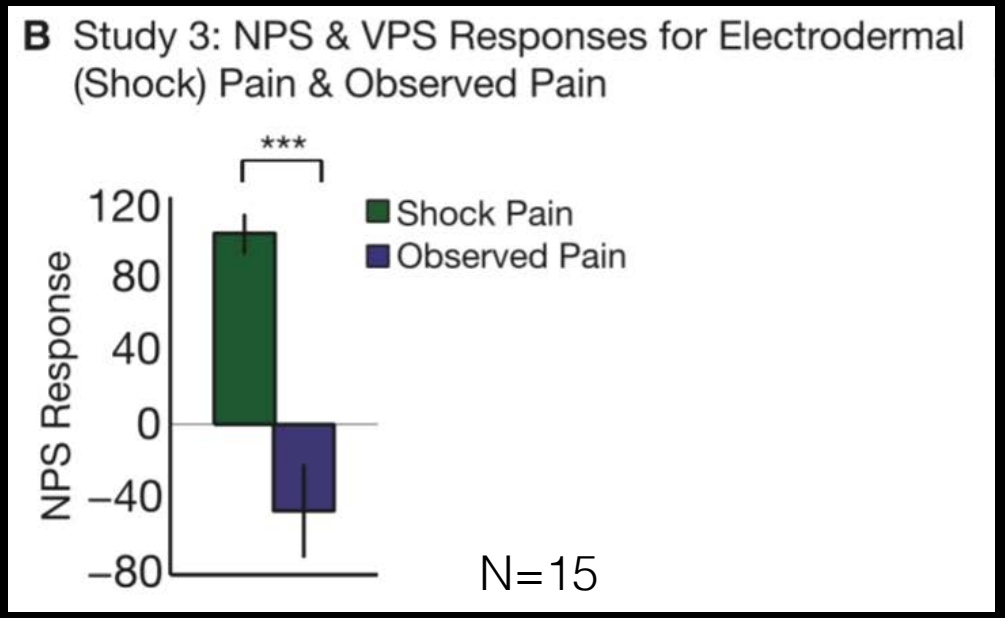
Generalizability to Other Labs & Paradigms





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https://github.com/ljchang/nltools