Preliminary results pre-registration overview

Neural correlates of expectations
of pain, perceived pain, and cognitive effort

Aug 24th, 2021. Heejung Jung

Goal of presentation

- Behavioral Pilot data (updated N: 21 → 48)
- Submitted version of Pre-registration
- Univariate gym results (updated N: 17)
- Future plan: Multilevel mediation analysis

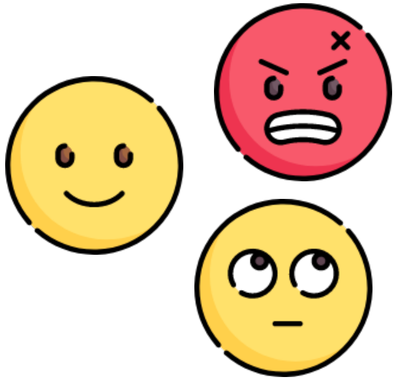
Design

expectations can shape experiences

Social influence

Expectations

Subjective experiences



Icons made by flaticon freepik

Design

Independent variables

- 3 tasks (pain vs. vicarious vs. cognitive)
- 2 Social Cue (high vs. low)
- 3 Stimulus intensity (high vs. med vs. low)

Dependent variables

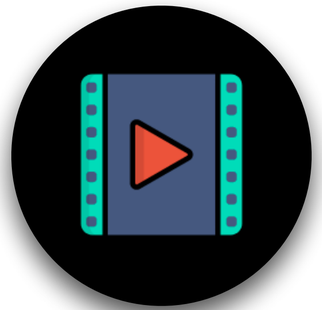
- “expect” ratings
- “actual” ratings

- **3 tasks**
- 2 Social cue
- 3 Stimulus intensity

Pain

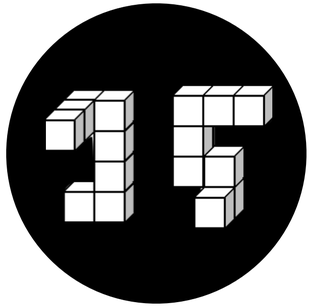
Thermal pain

Vicarious



Vicarious pain videos

Cognitive

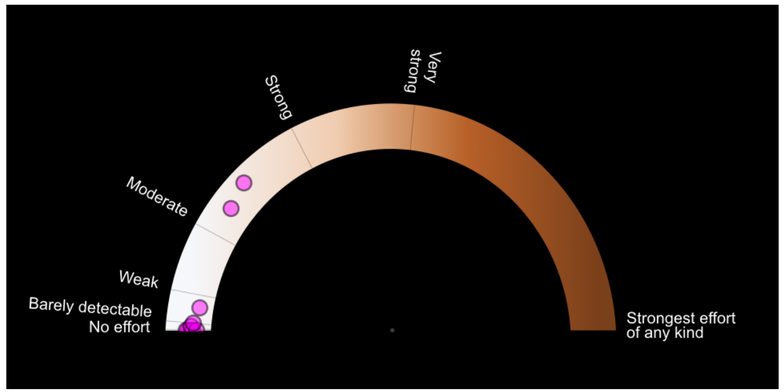


Mental rotation

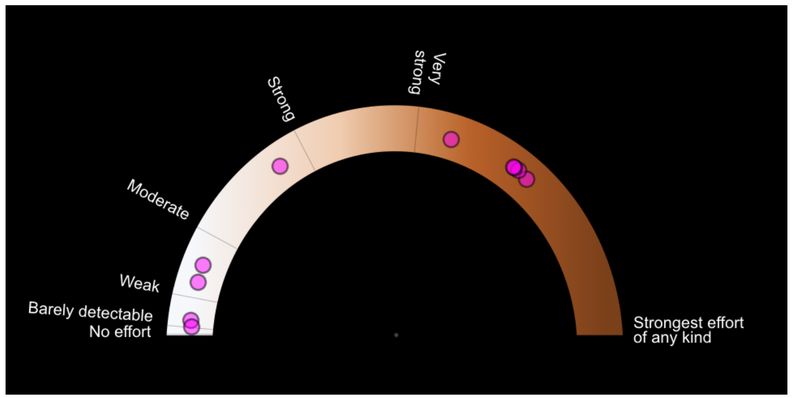
- 3 tasks
- **2 Social cue**
- 3 Stimulus intensity

- Based on pilot data N=5
- Generated cues from beta distribution

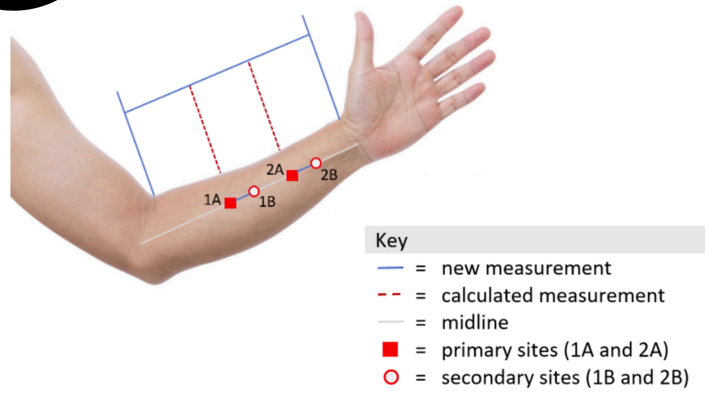
Low cue



High cue



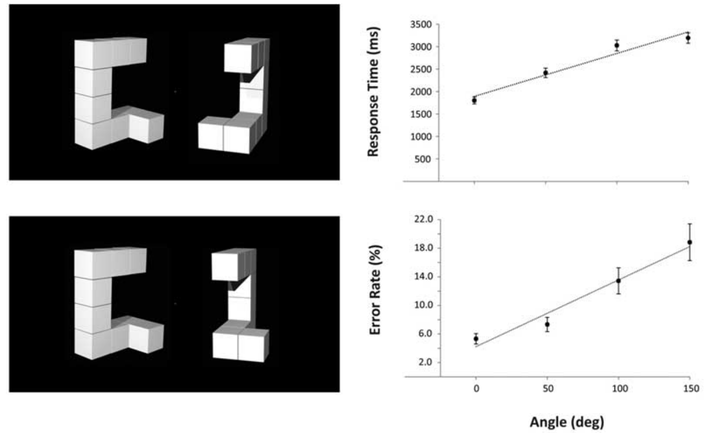
- 3 tasks
- 2 Social cue
- **3 Stimulus intensity**



- Intensity: 48, 49, 50°C

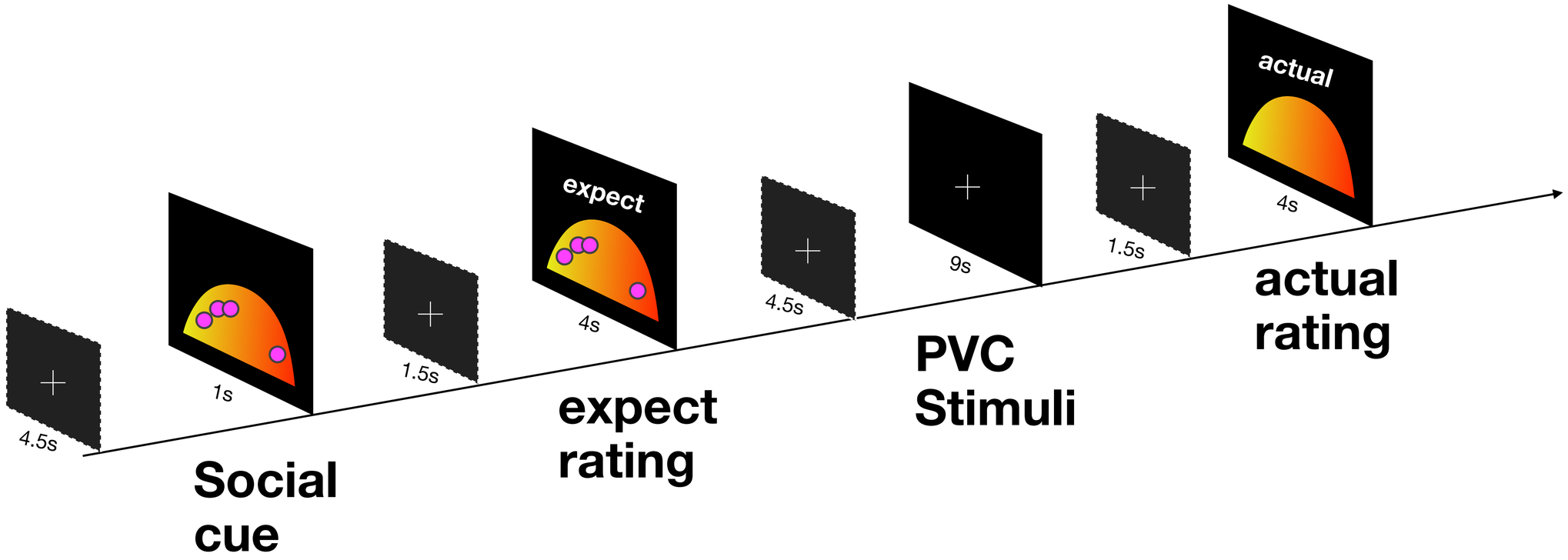
- Intensity: low, med, high

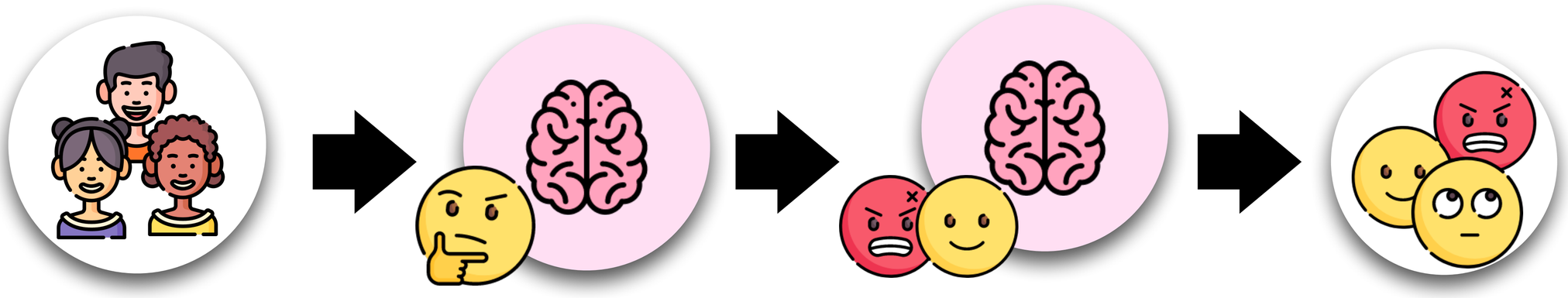
Lucey et al. (2011)



- Intensity: 50, 100, 150°

Ganis & Kievit (2015)
Shepard & Metzler (1971)


4.5s
1s
Social cue
1.5s
expect
4s
expect rating
4.5s
9s
PVC Stimuli
1.5s
actual
4s
actual rating



Cues

brain(expectation)

brain(experience)

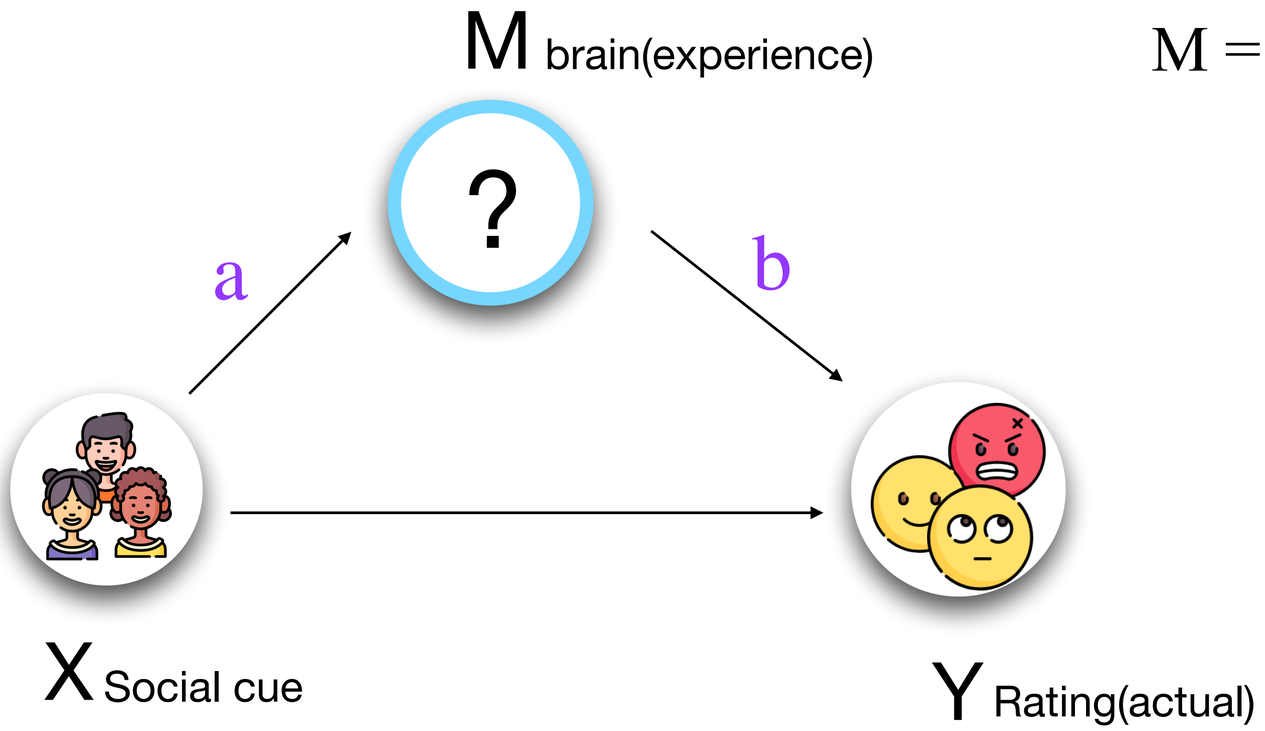
Actual ratings

how do expectations shape actual experiences?

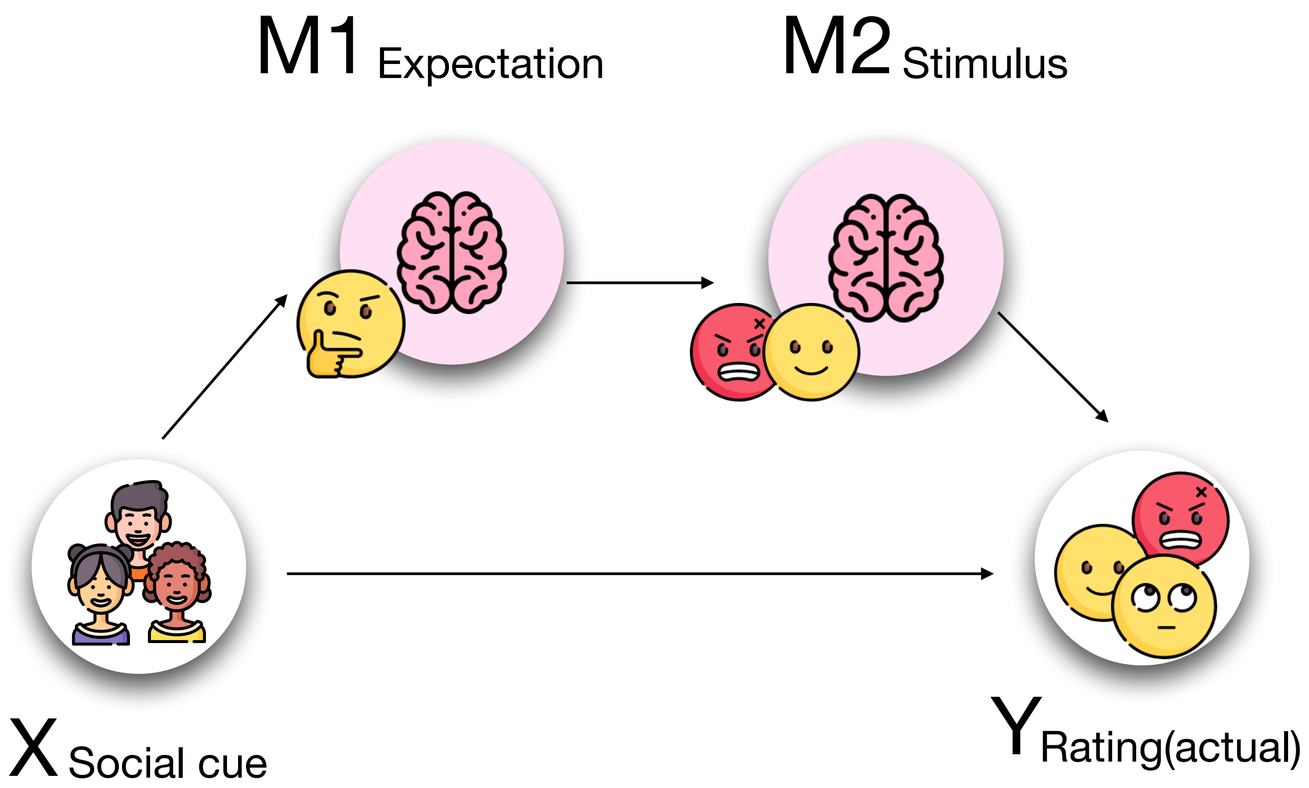
Mediation

Two-path mediation

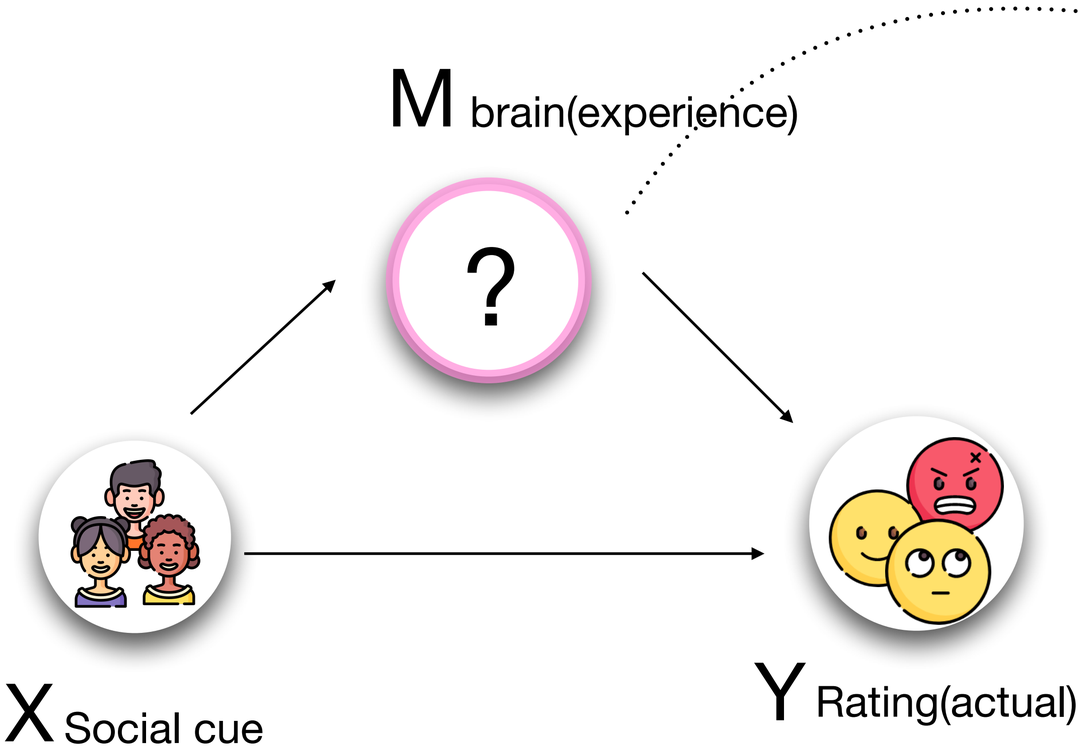
$$Y = \beta_0 + cX$$
$$Y = \beta_0 + c'X + bM$$
$$M = \beta_0 + aX$$



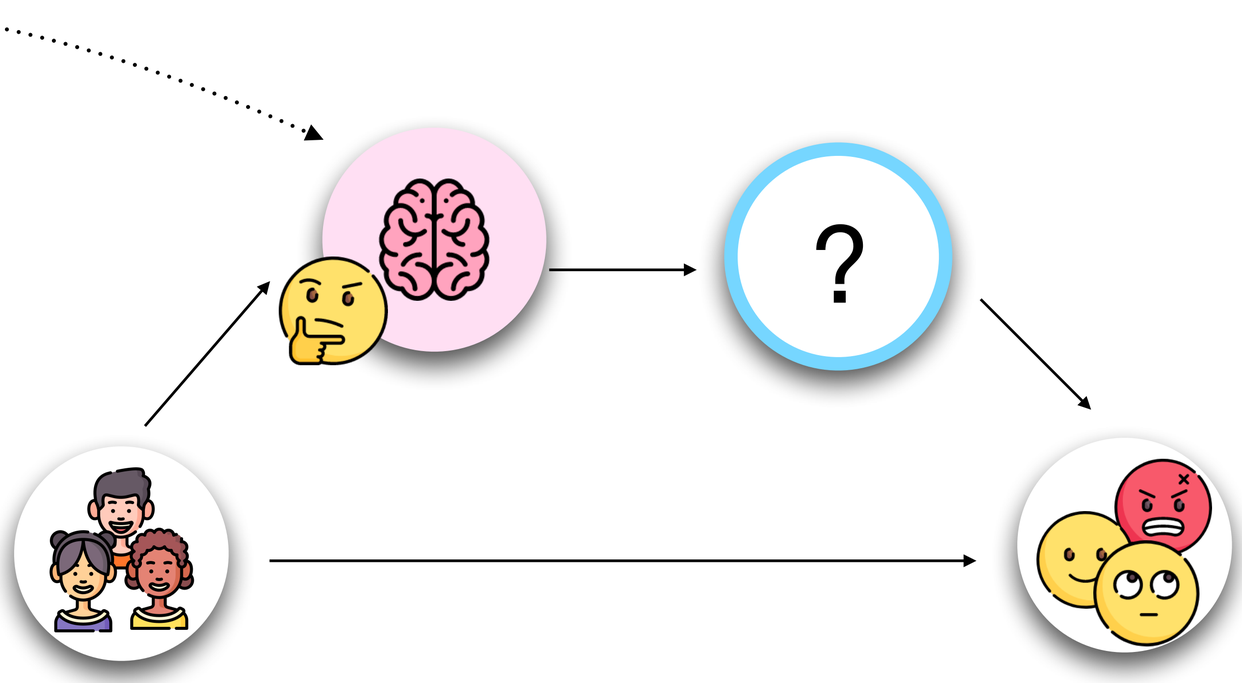
$$\therefore ab = \textit{indirect effect (mediation)}$$

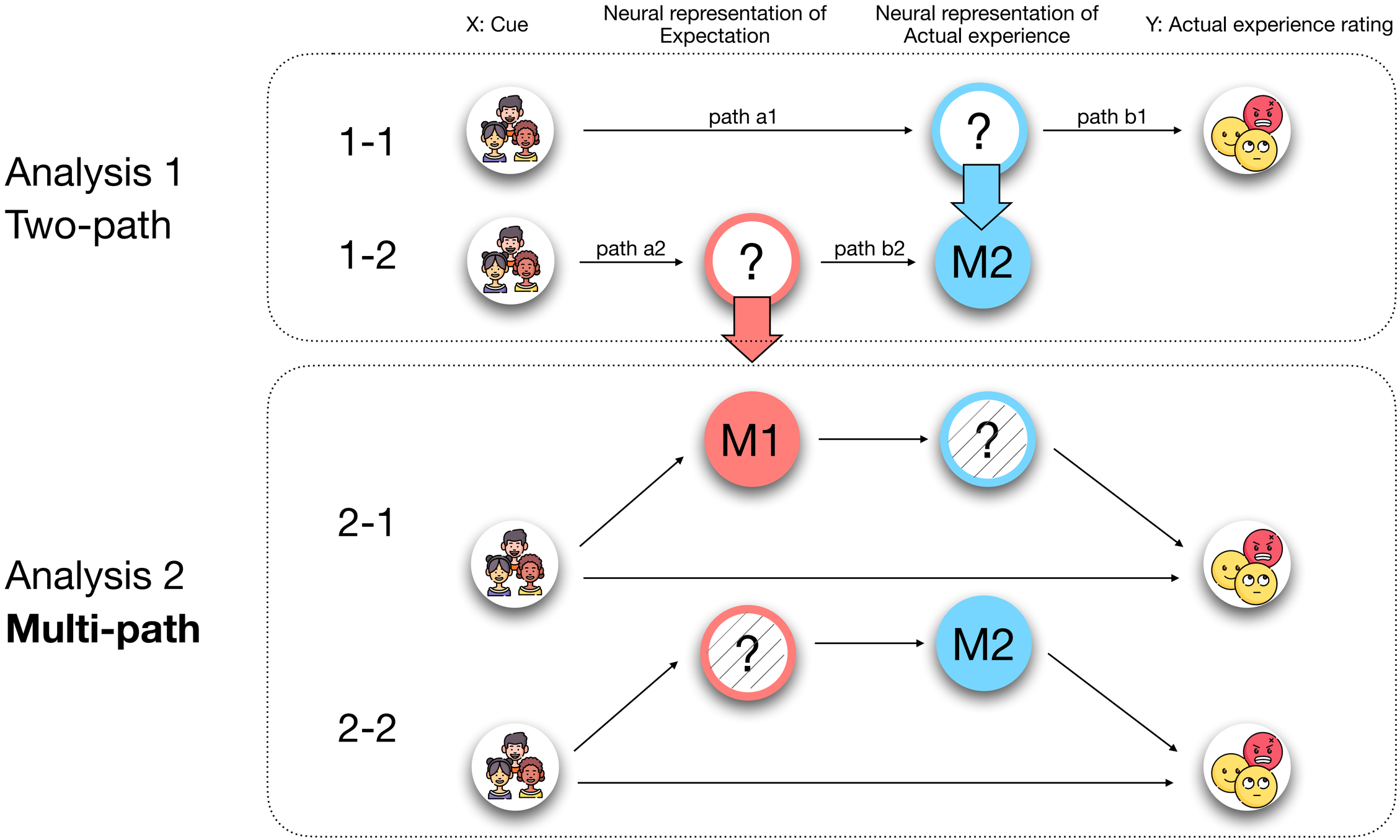

M1 Expectation
M2 Stimulus
X Social cue
Y Rating(actual)

Two-path mediation



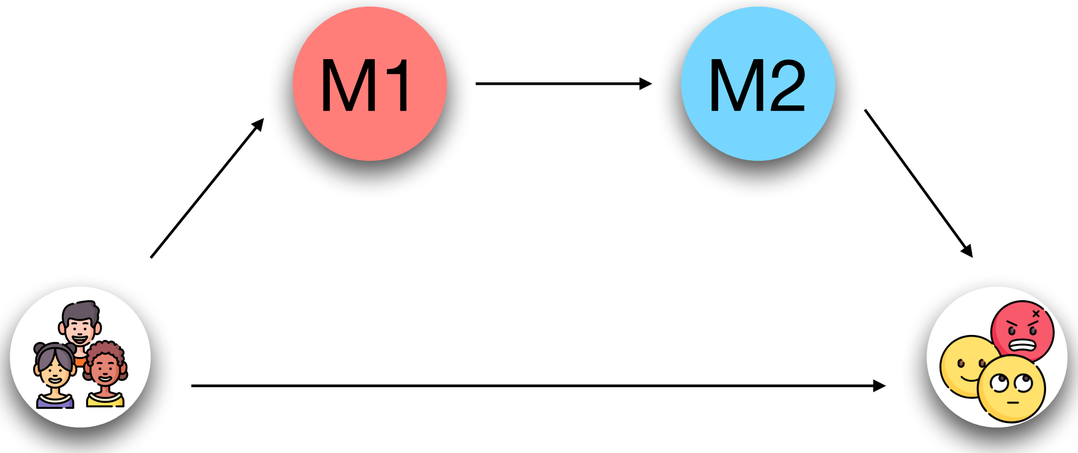
Multi-path mediation




X: Cue
Neural representation of Expectation
Neural representation of Actual experience
Y: Actual experience rating
Analysis 1
Two-path
1-1
path a1
?
path b1
1-2
path a2
?
path b2
M2
Analysis 2
Multi-path
2-1
M1
?
2-2
?
M2

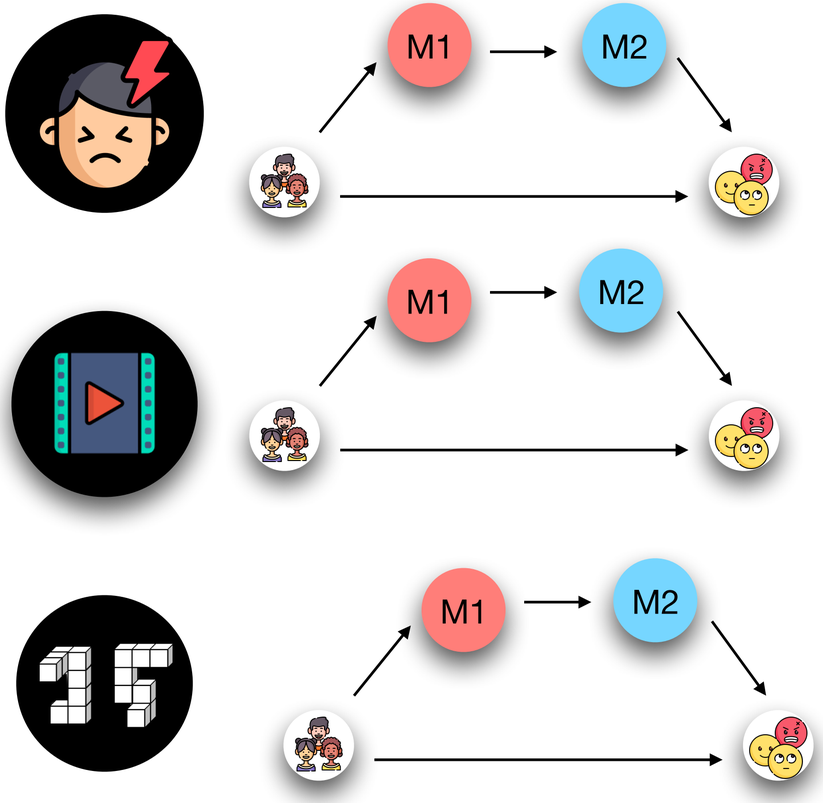
Domain-general

Include all PVC trials

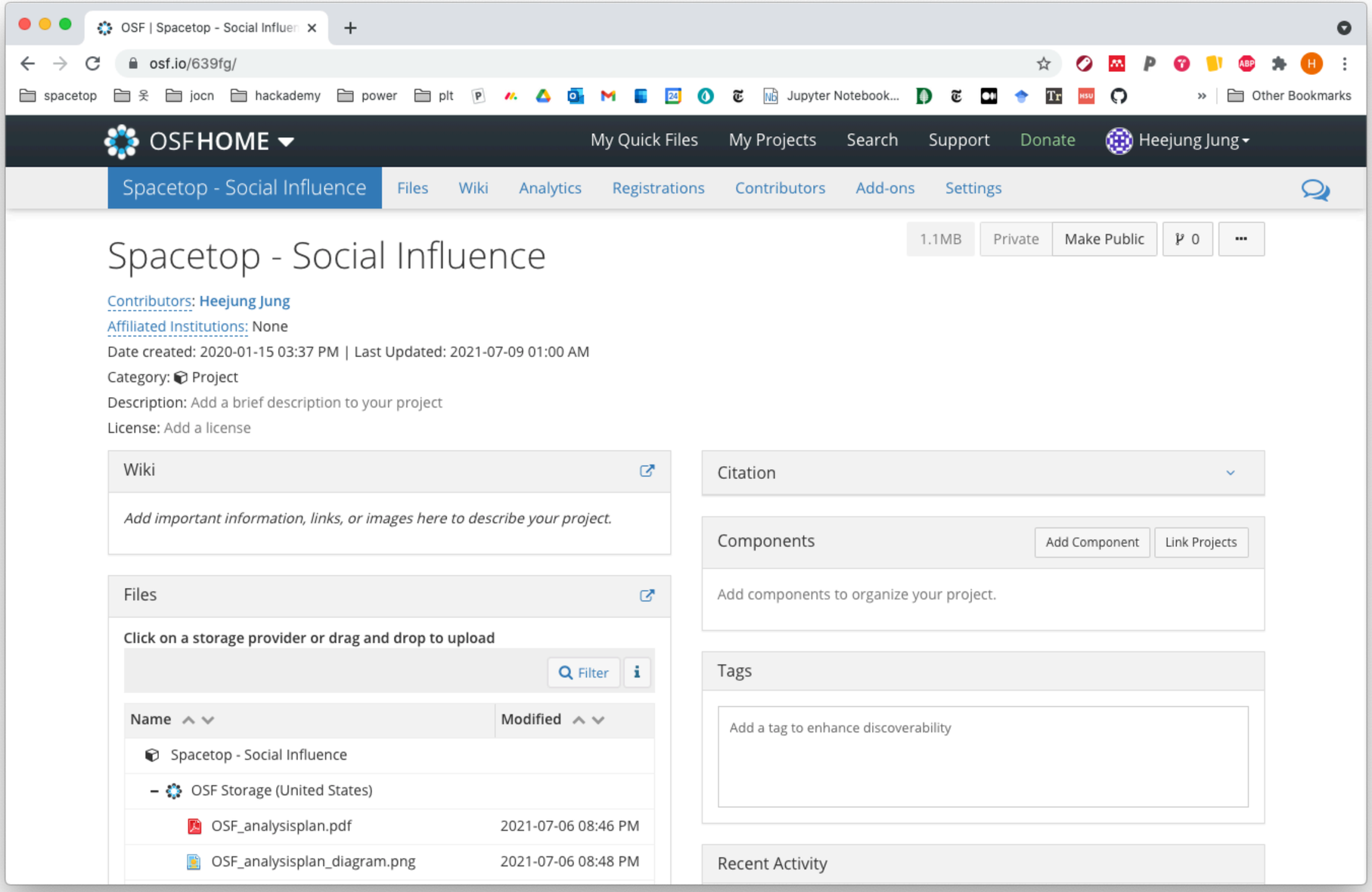


Domain-specific

Include P, V, C trials respectively



Pre-registration


OSF | Spacetop - Social Influen
osf.io/639fg/
spacetop
jocn
hackademy
power
plt
Jupyter Notebook...
Other Bookmarks
OSF HOME
My Quick Files
My Projects
Search
Support
Donate
Heejung Jung
Spacetop - Social Influence
Files
Wiki
Analytics
Registrations
Contributors
Add-ons
Settings
1.1MB
Private
Make Public
0
Spacetop - Social Influence
Contributors: Heejung Jung
Affiliated Institutions: None
Date created: 2020-01-15 03:37 PM | Last Updated: 2021-07-09 01:00 AM
Category: Project
Description: Add a brief description to your project
License: Add a license
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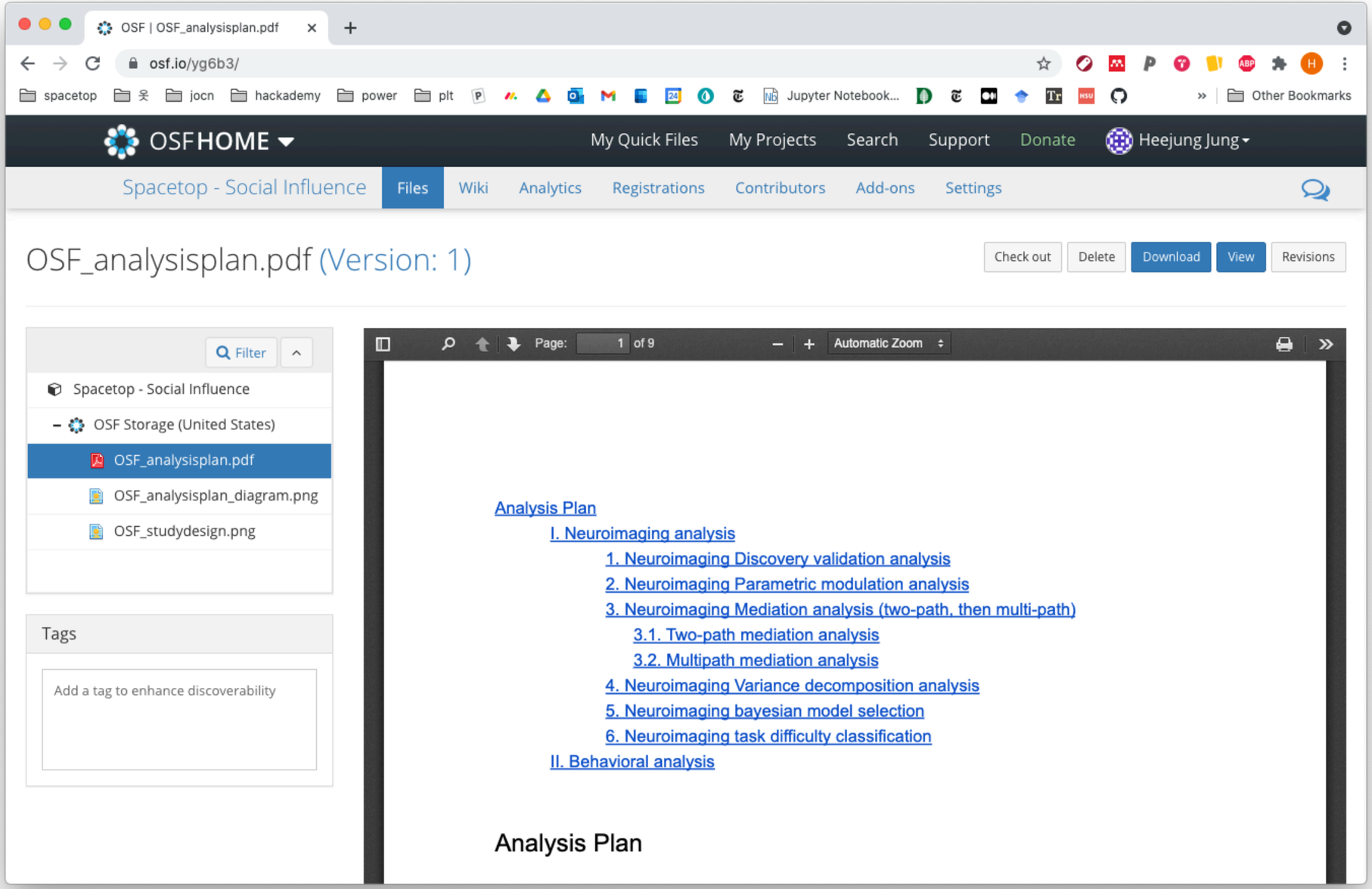
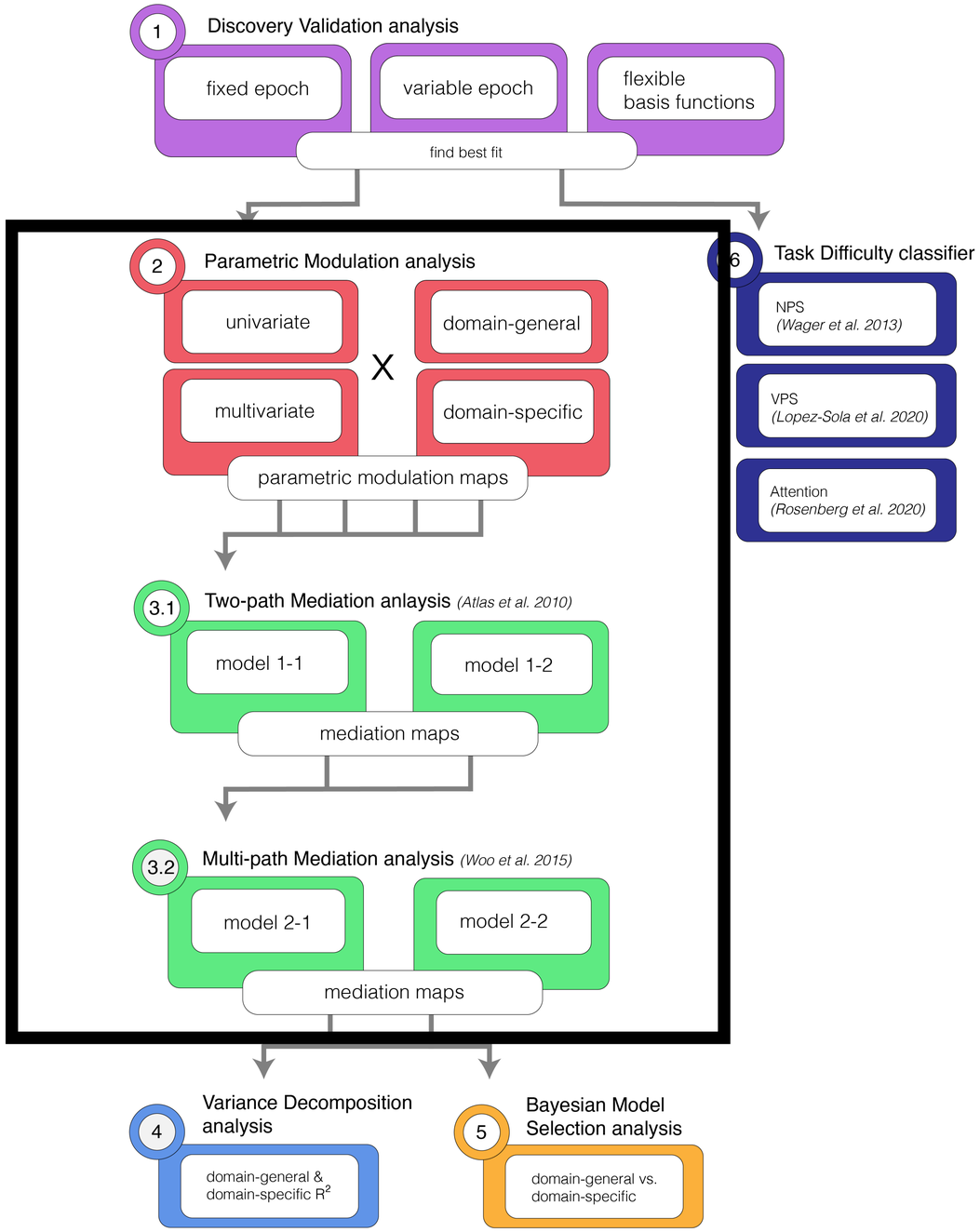
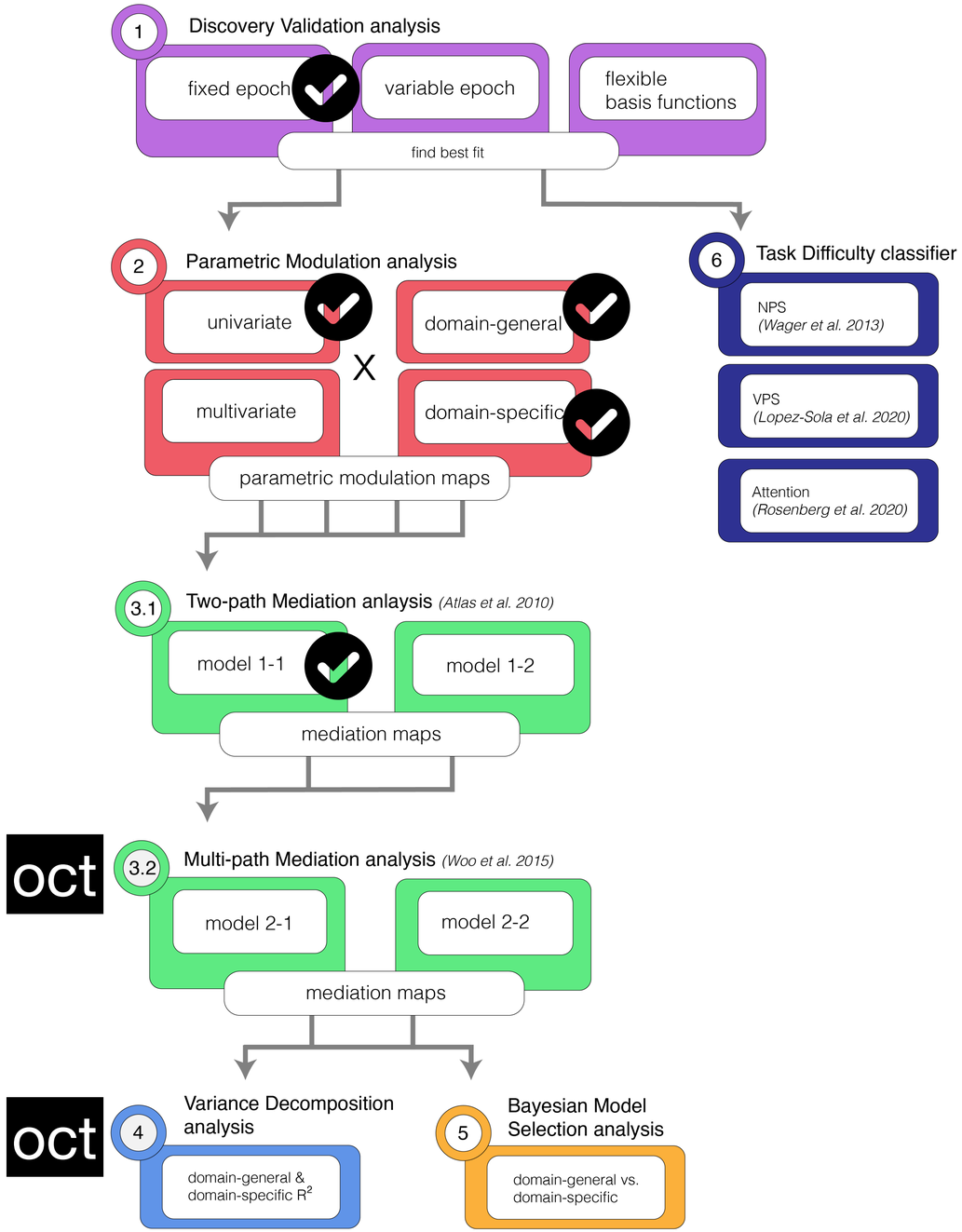
Add important information, links, or images here to describe your project.
Files
Click on a storage provider or drag and drop to upload
Filter
Name
Modified
Spacetop - Social Influence
OSF Storage (United States)
OSF_analysisplan.pdf
2021-07-06 08:46 PM
OSF_analysisplan_diagram.png
2021-07-06 08:48 PM
Citation
Components
Add Component
Link Projects
Add components to organize your project.
Tags
Add a tag to enhance discoverability
Recent Activity


OSF | OSF_analysisplan.pdf
osf.io/yg6b3/
OSFHOME
My Quick Files
My Projects
Search
Support
Donate
Heejung Jung
Spacetop - Social Influence
Files
Wiki
Analytics
Registrations
Contributors
Add-ons
Settings
OSF_analysisplan.pdf (Version: 1)
Check out
Delete
Download
View
Revisions
Filter
Spacetop - Social Influence
OSF Storage (United States)
OSF_analysisplan.pdf
OSF_analysisplan_diagram.png
OSF_studydesign.png
Tags
Add a tag to enhance discoverability
Page: 1 of 9
Automatic Zoom
Analysis Plan
I. Neuroimaging analysis
1. Neuroimaging Discovery validation analysis
2. Neuroimaging Parametric modulation analysis
3. Neuroimaging Mediation analysis (two-path, then multi-path)
3.1. Two-path mediation analysis
3.2. Multipath mediation analysis
4. Neuroimaging Variance decomposition analysis
5. Neuroimaging bayesian model selection
6. Neuroimaging task difficulty classification
II. Behavioral analysis
Analysis Plan


1
Discovery Validation analysis
fixed epoch
variable epoch
flexible basis functions
find best fit
2
Parametric Modulation analysis
univariate
multivariate
X
domain-general
domain-specific
parametric modulation maps
3.1
Two-path Mediation anlaysis (Atlas et al. 2010)
model 1-1
model 1-2
mediation maps
3.2
Multi-path Mediation analysis (Woo et al. 2015)
model 2-1
model 2-2
mediation maps
4
Variance Decomposition analysis
domain-general & domain-specific R^2
5
Bayesian Model Selection analysis
domain-general vs. domain-specific
6
Task Difficulty classifier
NPS
(Wager et al. 2013)
VPS
(Lopez-Sola et al. 2020)
Attention
(Rosenberg et al. 2020)


1
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variable epoch
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univariate
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multivariate
domain-specific
parametric modulation maps
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mediation maps
oct
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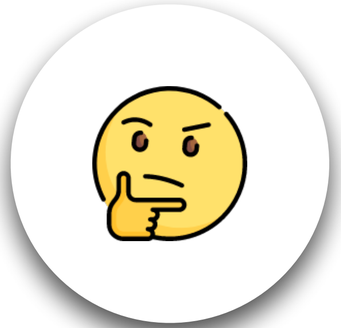
Multi-path Mediation analysis (Woo et al. 2015)
model 2-1
model 2-2
mediation maps
oct
4
Variance Decomposition analysis
domain-general & domain-specific R^2
5
Bayesian Model Selection analysis
domain-general vs. domain-specific

Behavioral analysis

2 Social cues

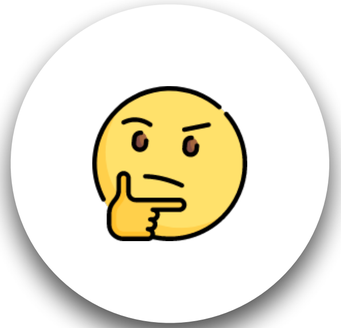


expectations

3 stimulus intensity

Actual experience

2 Social cues



expect rating

3 stimulus intensity

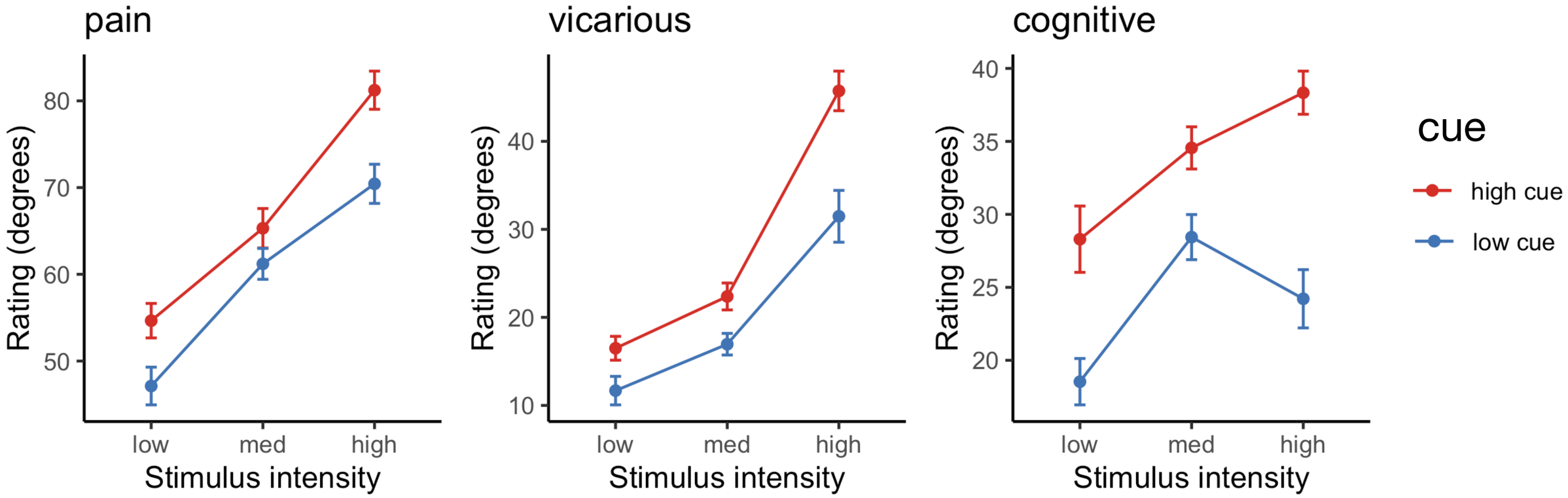
Actual experience

Can social cues modulate actual experiences?

Subjective ratings on stimulus intensity experie

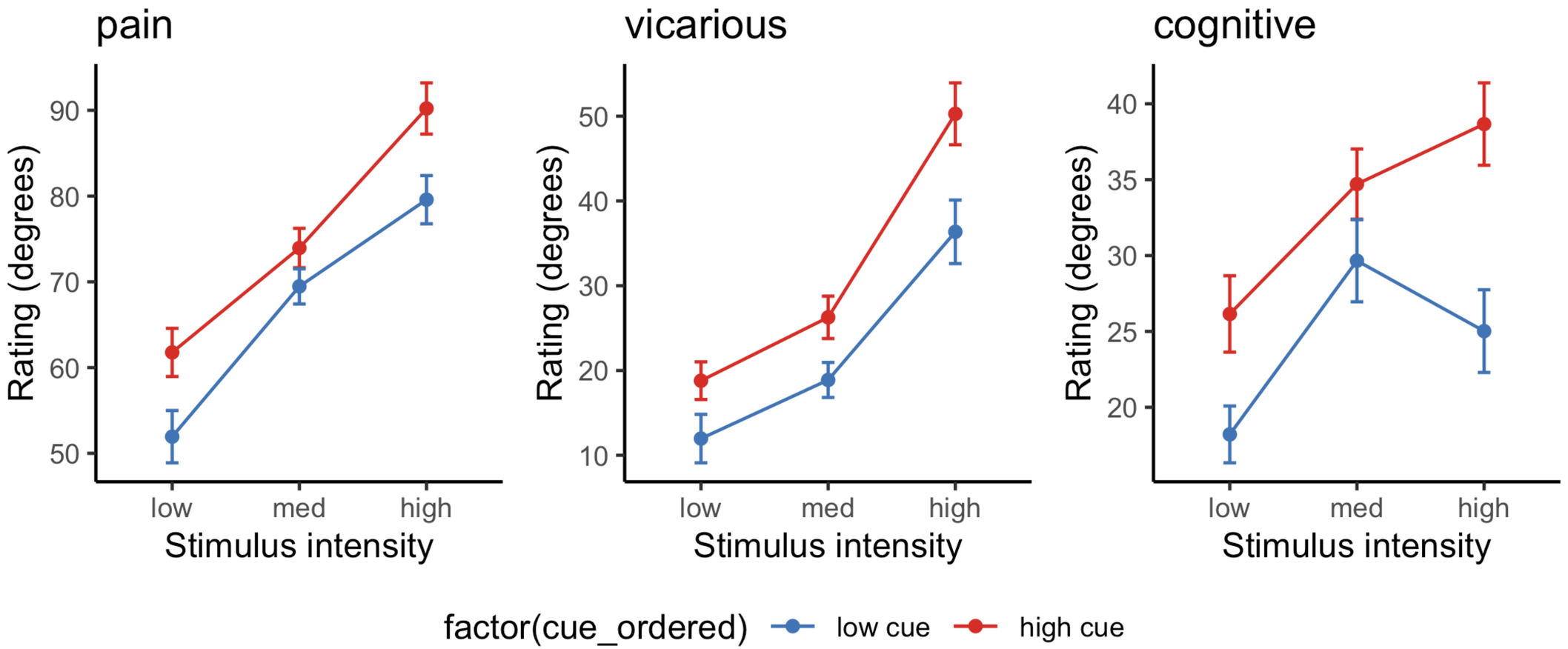
Can social cues modulate actual experiences?

N = 21



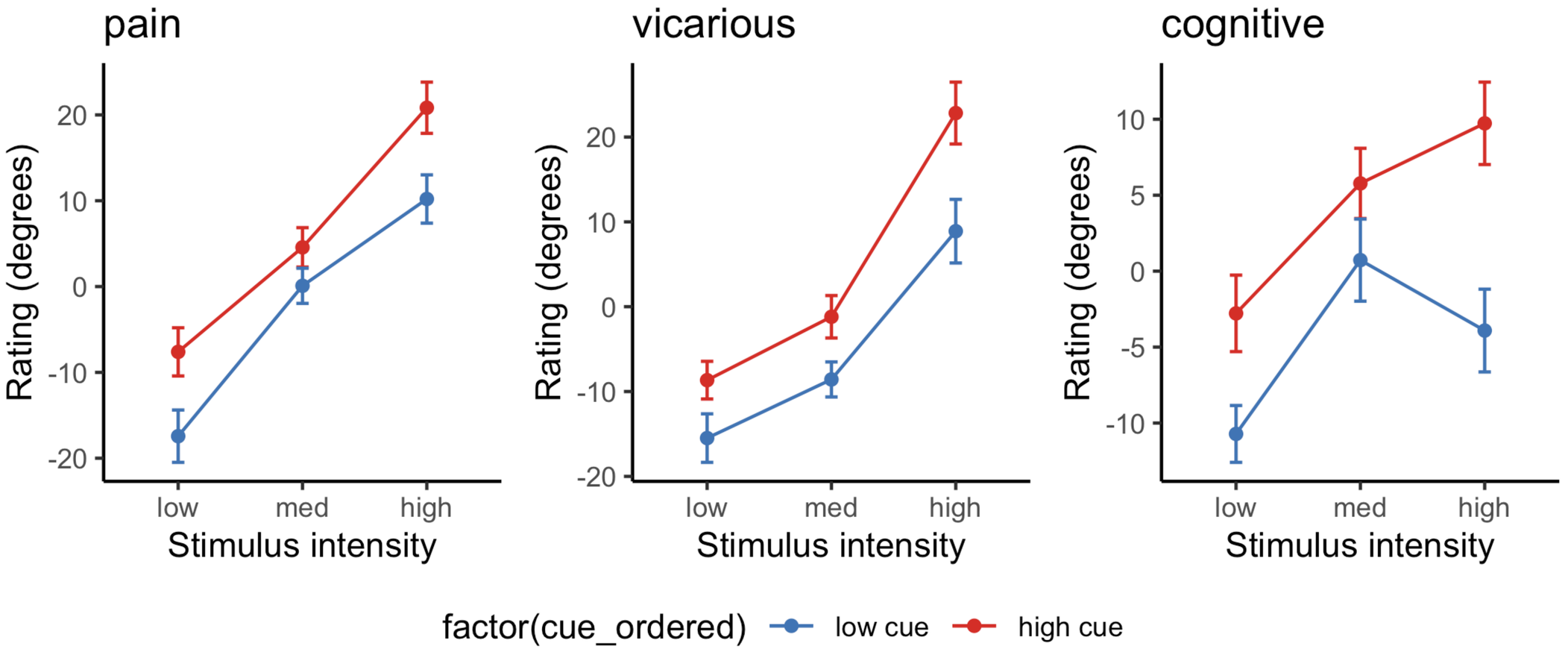
Can social cues modulate actual experiences?

N = 48



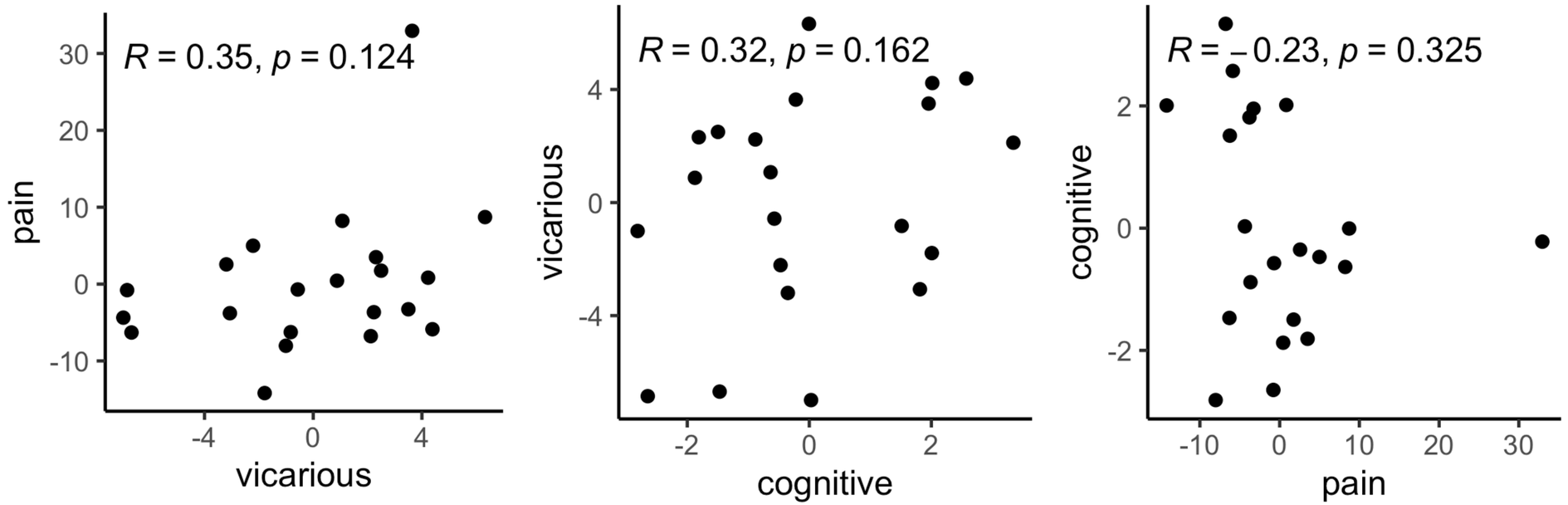
Can social cues modulate actual experiences?

N = 48 demean



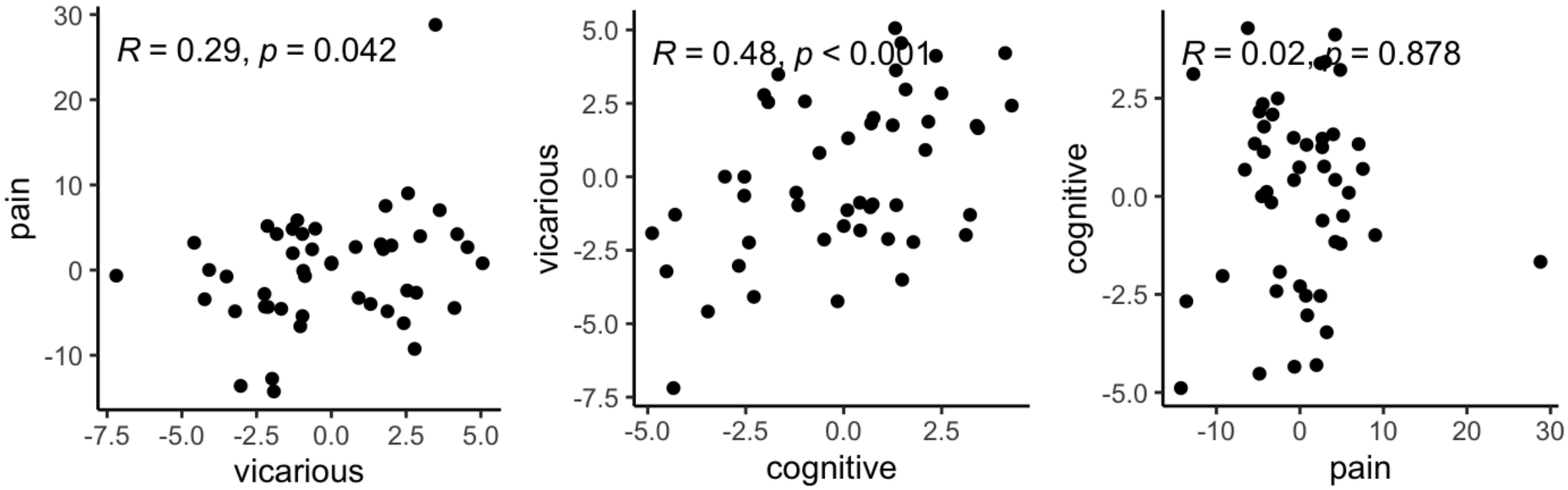
Are individual differences in cue effects domain-general?

N = 21 Plot random slopes of “cue effect on actual ratings” N = 21



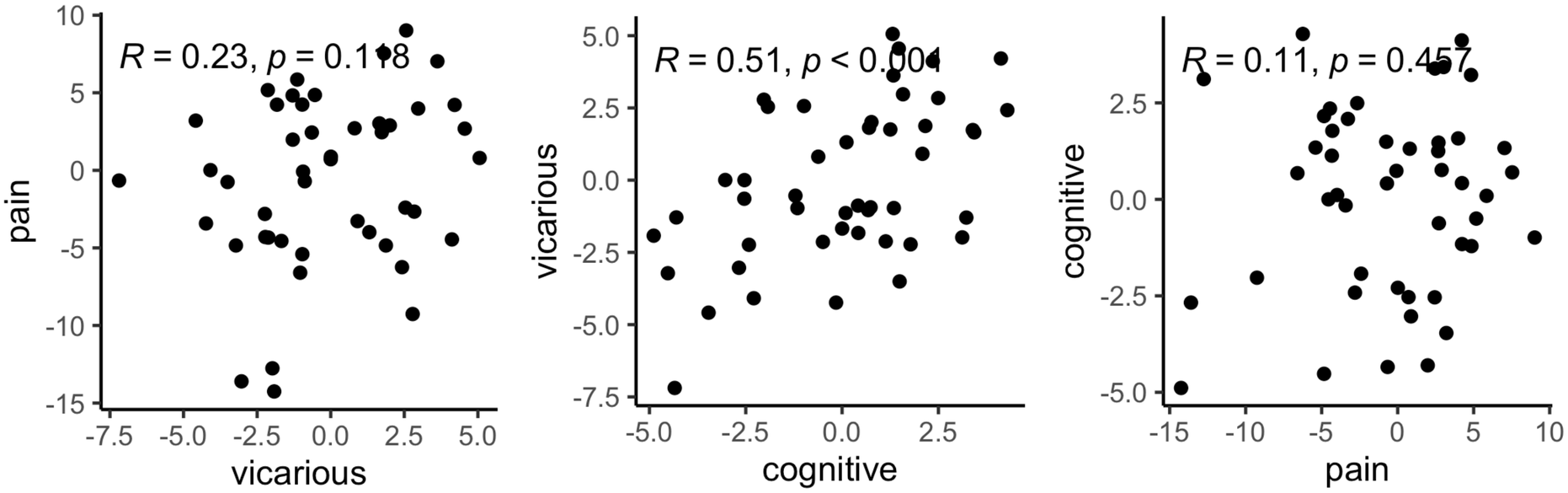
Are individual differences in cue effects domain-general?

N = 48 Plot random slopes of “cue effect on actual ratings” N = 48



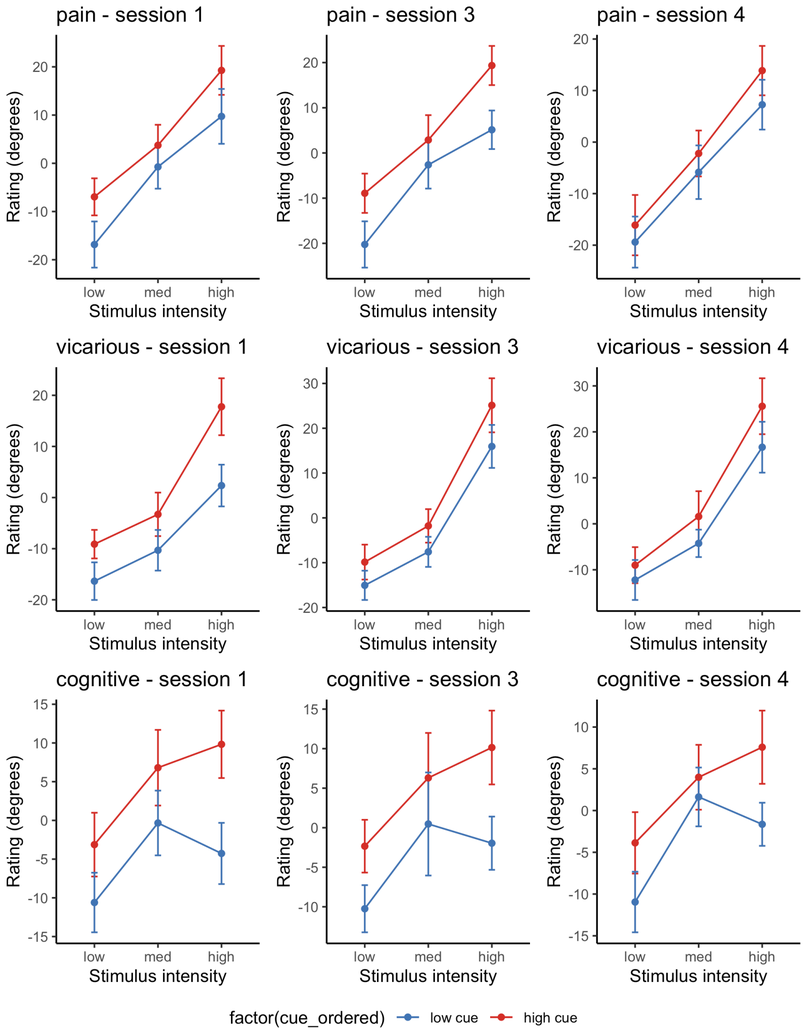
Are individual differences in cue effects domain-general?

N = 47 (Outlier removed) Plot random slopes of “cue effect on actual ratings”



Formula: Actual Rating ~ CUE * Stim_lin * SES+ CUE * Stim_quad *SES + (CUE * SES | subj) ~ DATA[, IV] * DATA[, STIMC1] * DATA[, SES] + DATA[, IV] * DATA[, STIMC2] * DATA[, SES] + (DATA[, IV] * DATA[, SES] | DATA[, SUBJECT])

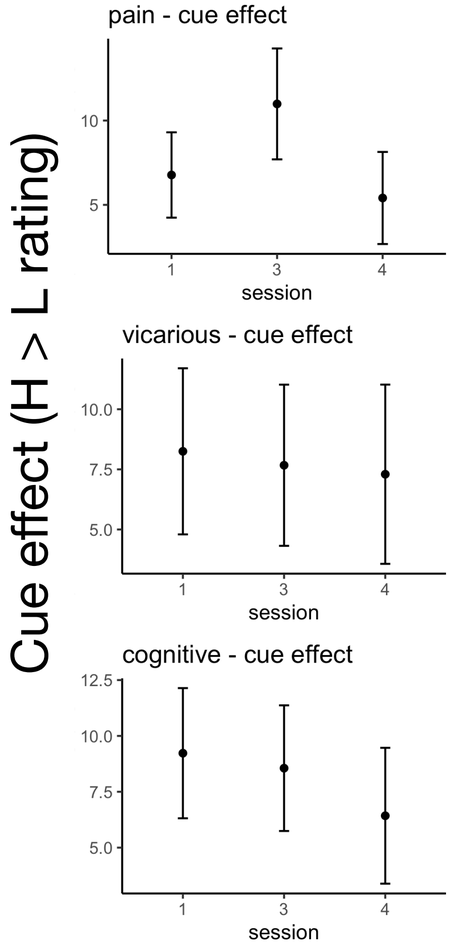
Is the cue effect different across sessions?



Main effect of SESSION: Marginal
Interaction CUE x SESSION: N.S.

Main effect of SESSION: Marginal
Interaction CUE x SESSION: N.S.

Main effect of SESSION: N.S.
Interaction CUE x SESSION: N.S.

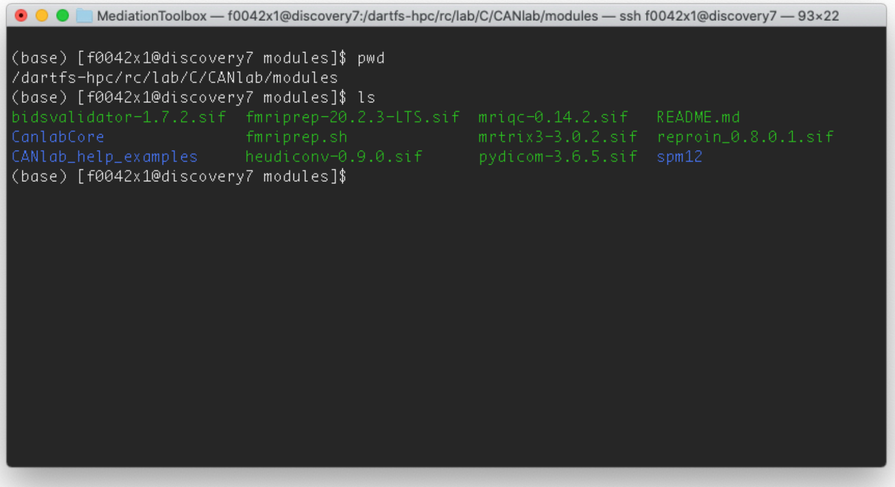


Discovery modules

/dartfs-hpc/rc/lab/C/CANlab/modules

Lab common modules

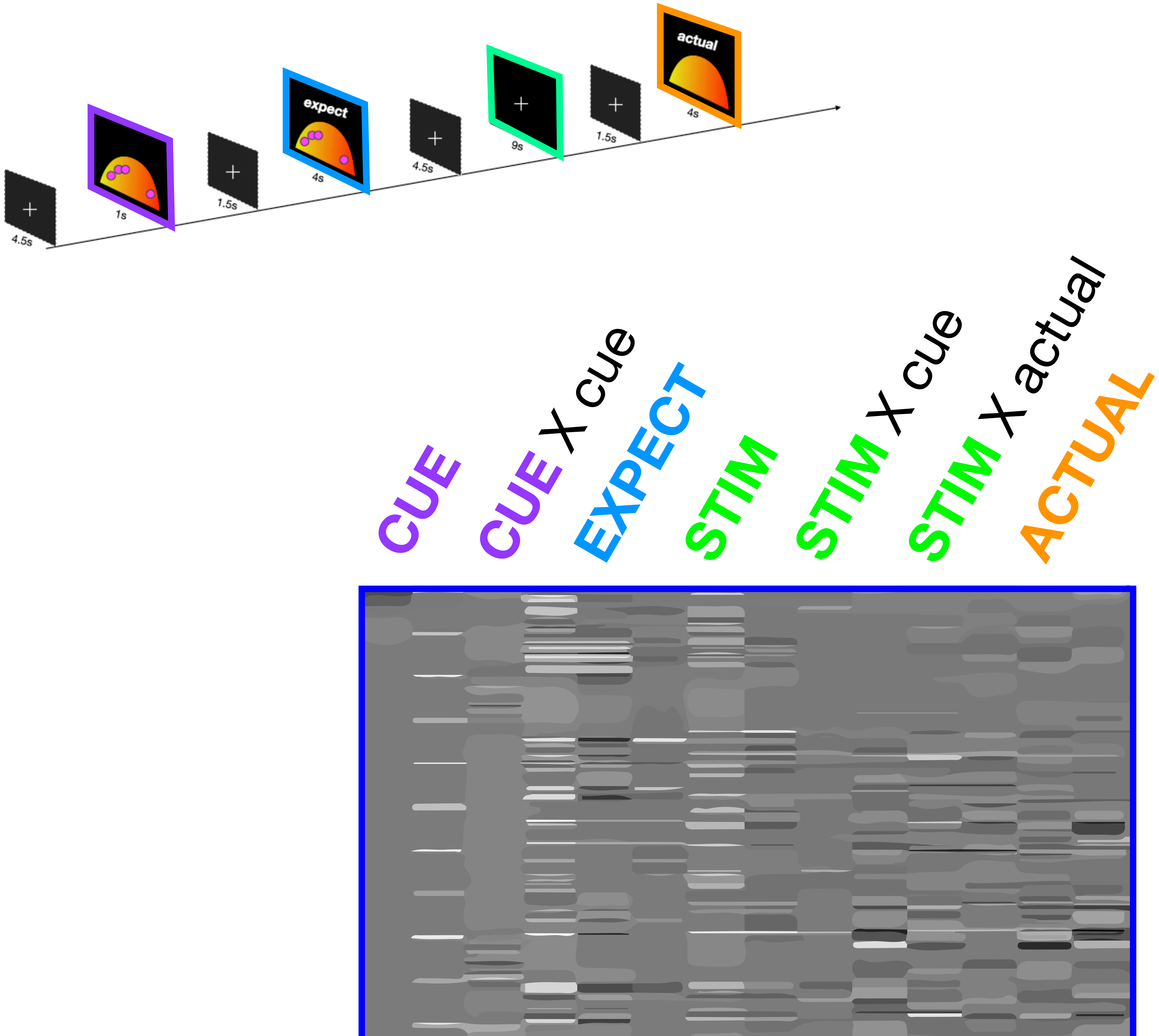
- bidsvalidator-1.7.2.sif
- mriqc-0.14.2.sif
- pydicom-3.6.5.sif
- reproin_0.8.0.1.sif
- fmriprep-20.2.3-LTS.sif
- heudiconv-0.9.0.sif
- mrtrix3-3.0.2.sif
- README.md
- CANlab_help_examples
- spm12
- CanlabCore



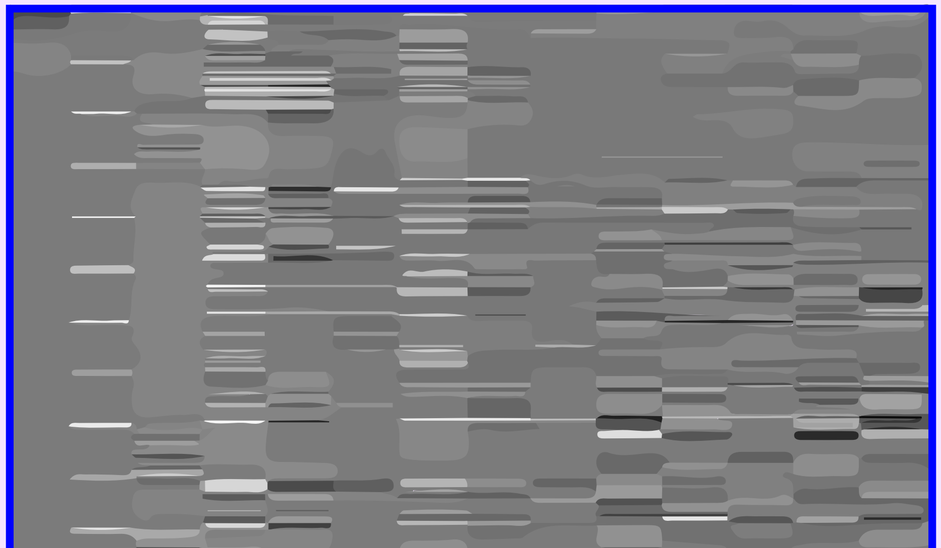
Group permissions

- Scenario 1: you started a new study
- Scenario 2: you have a new member on your project

Univariate glm


4.5s
1s
1.5s
expect
4s
4.5s
9s
1.5s
actual
4s
CUE
CUE X cue
EXPECT
STIM
STIM X cue
STIM X actual
ACTUAL

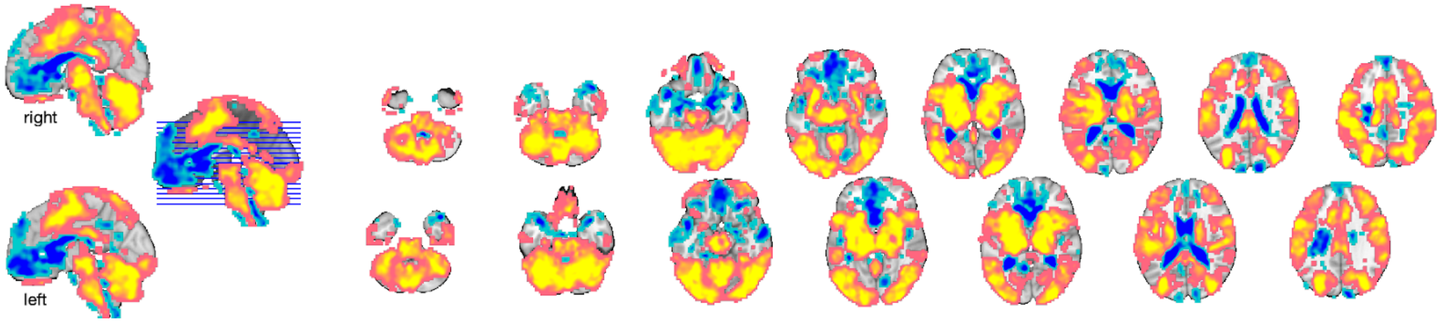
CUE
CUE X cue
EXPECT
STIM
STIM X cue
STIM X actual
ACTUAL



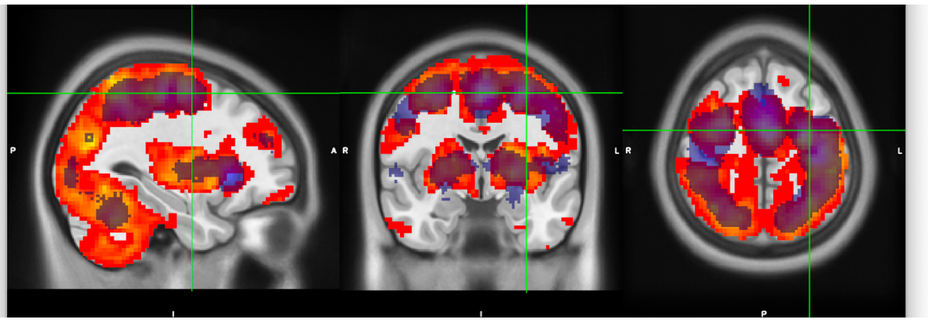
Q1. Sanity Check:
Do we see motor responses during button presses?

Sanity Check: Do we see motor responses during button presses

Motor (q < .05, FDR adjusted)



Overlay with neurosynth



Social influence button press

Neurosynth “motor” Z > 3

CUE

CUE X cue

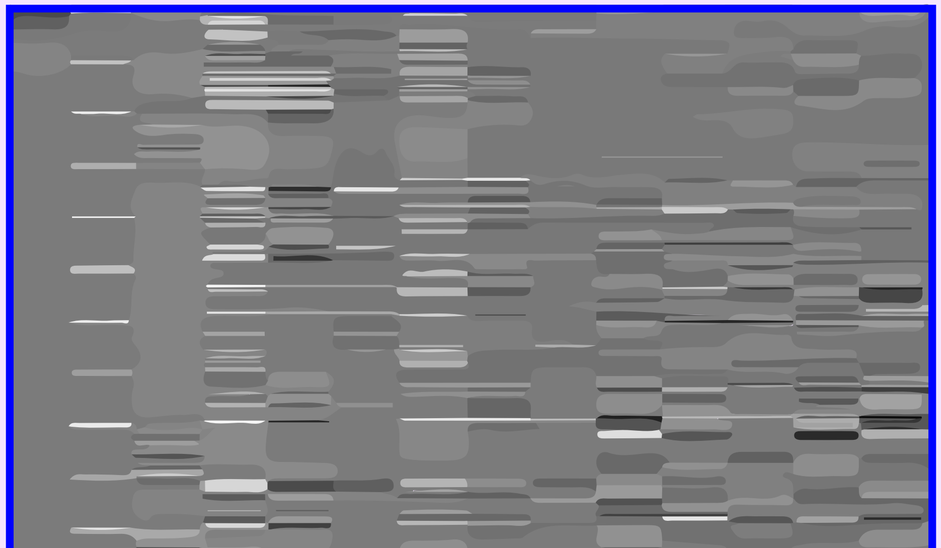
EXPECT

STIM

STIM X cue

STIM X actual

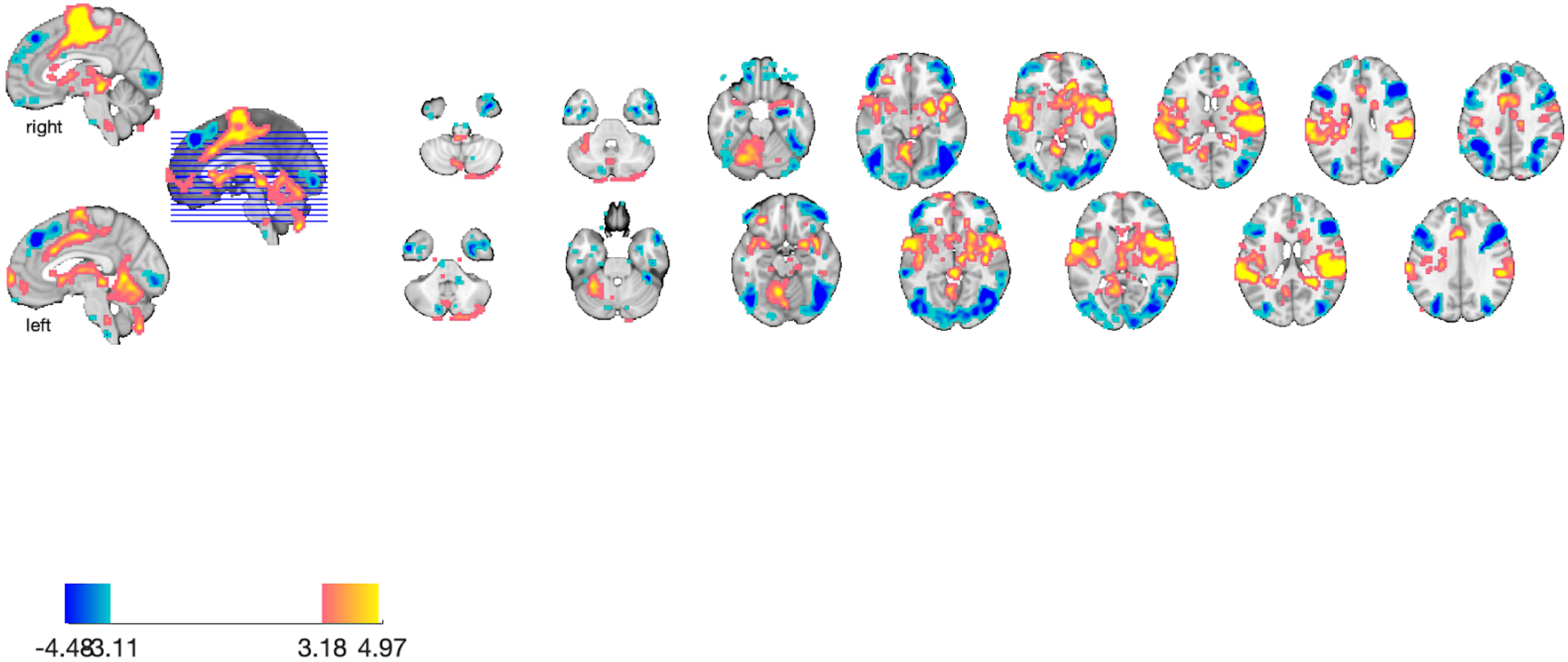
ACTUAL



Q2. Stimulus effects: **What are the neural correlates of stimulus intensity?**

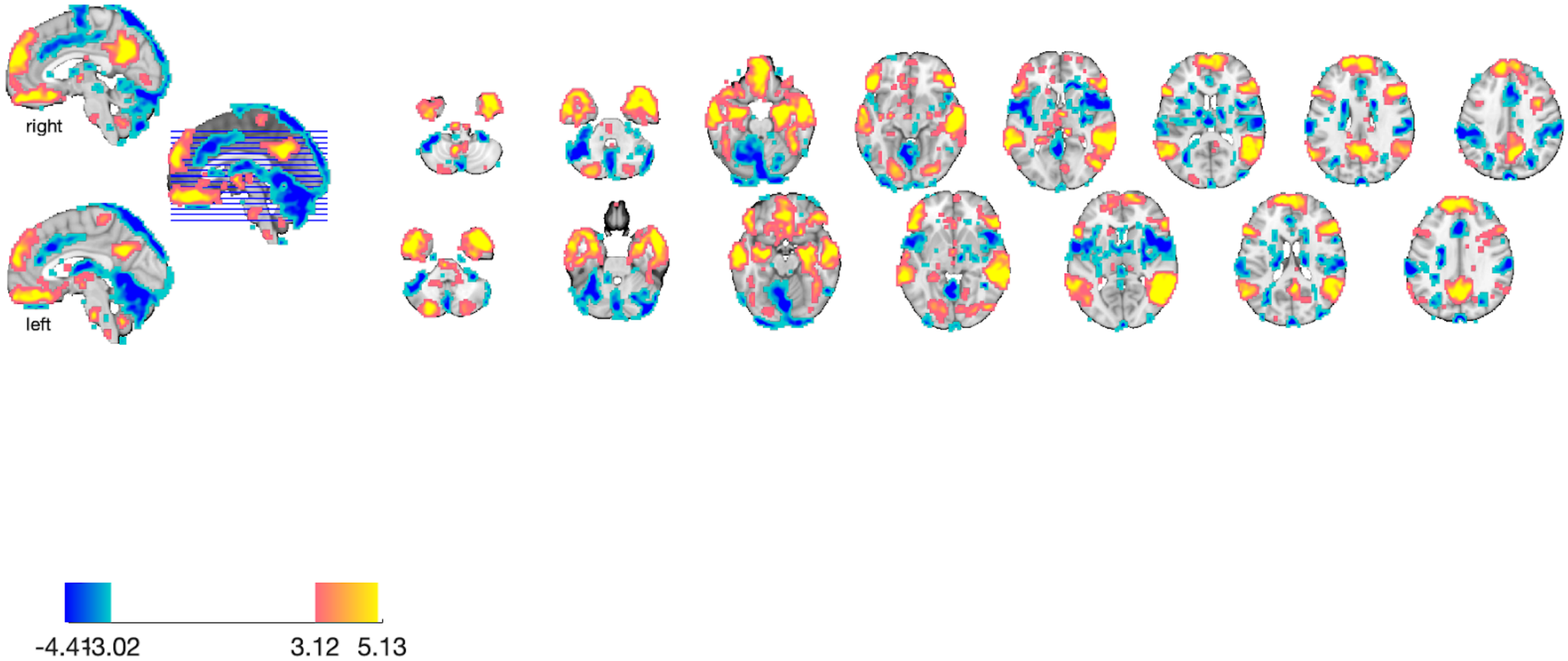
What are the neural correlates of stimulus intensity?

Pain > VC (q < .05, FDR adjusted)



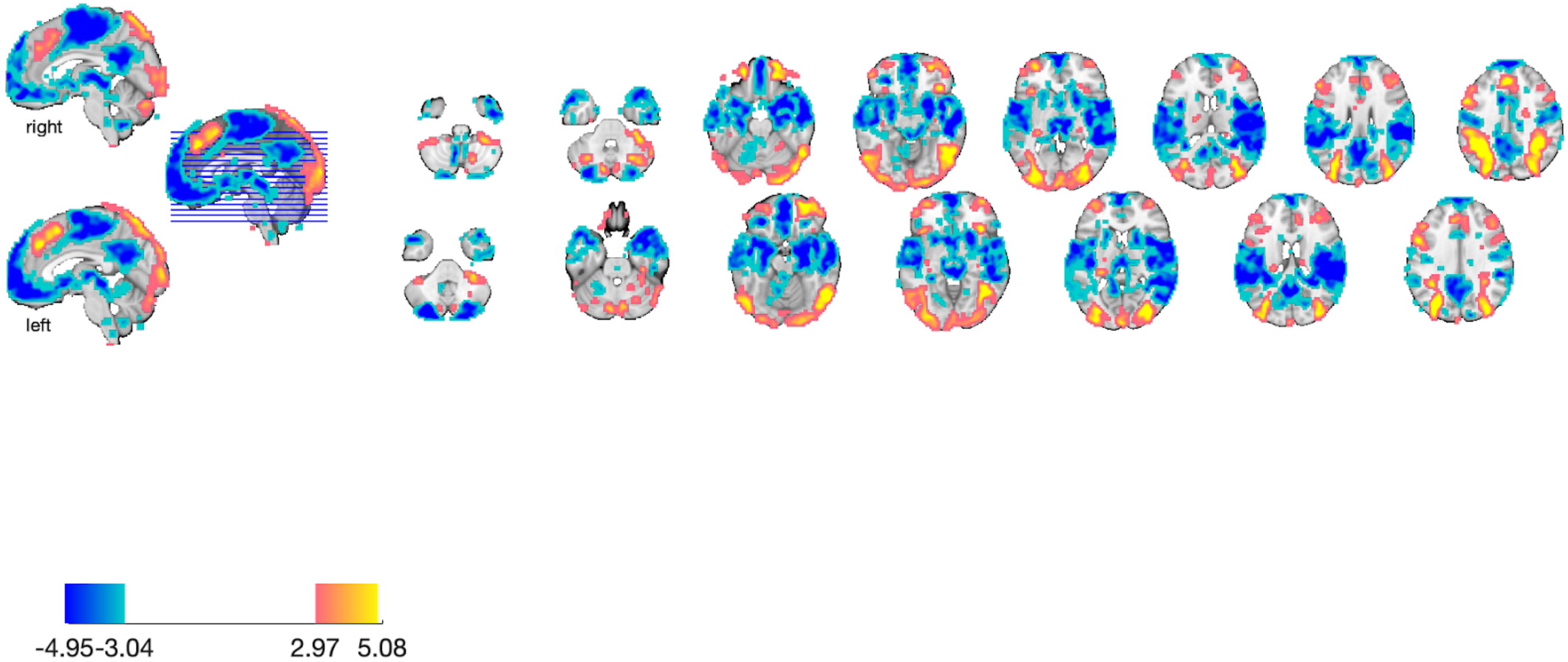
What are the neural correlates of stimulus intensity?

Vicarious > PC (q < .05, FDR adjusted)



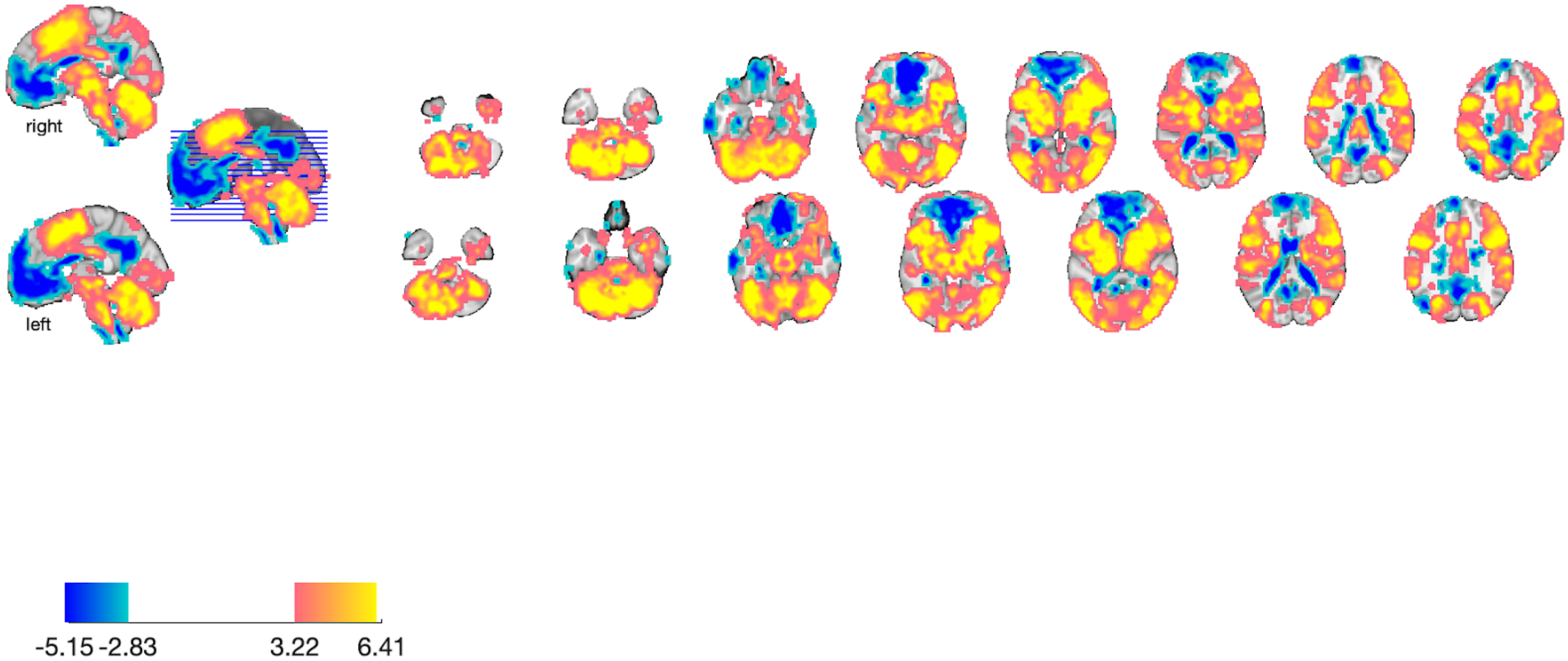
What are the neural correlates of stimulus intensity?

Cognitive > PV (q < .05, FDR adjusted)

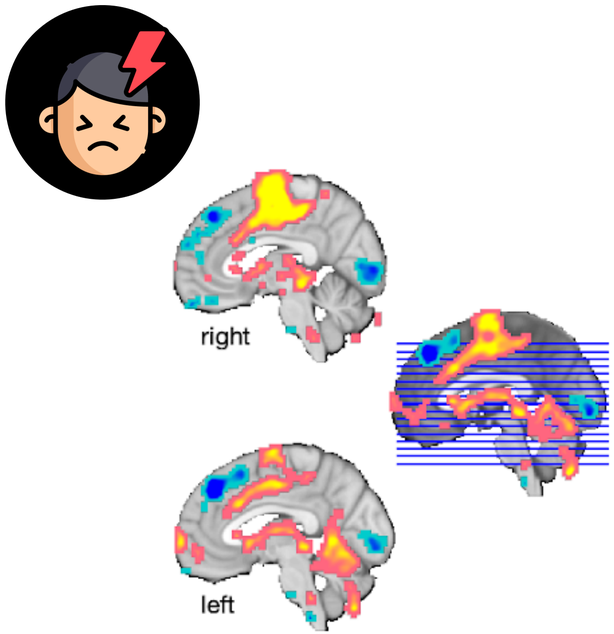


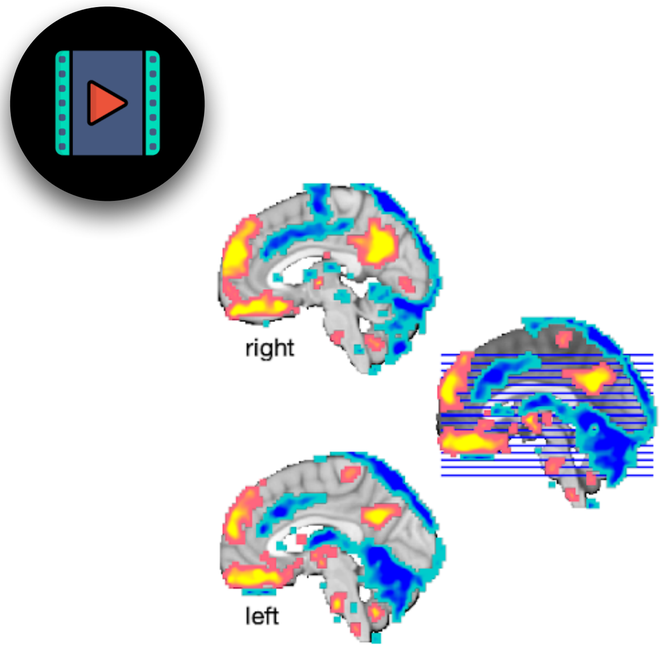
What are the neural correlates of stimulus intensity?

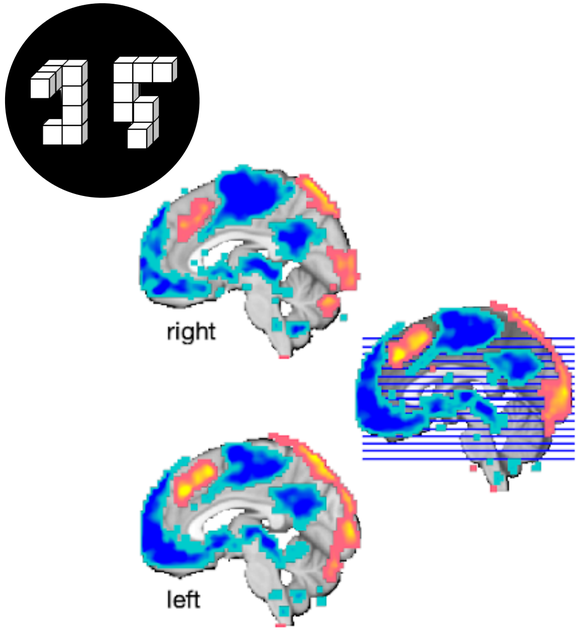
Domain general (q < .05, FDR adjusted)



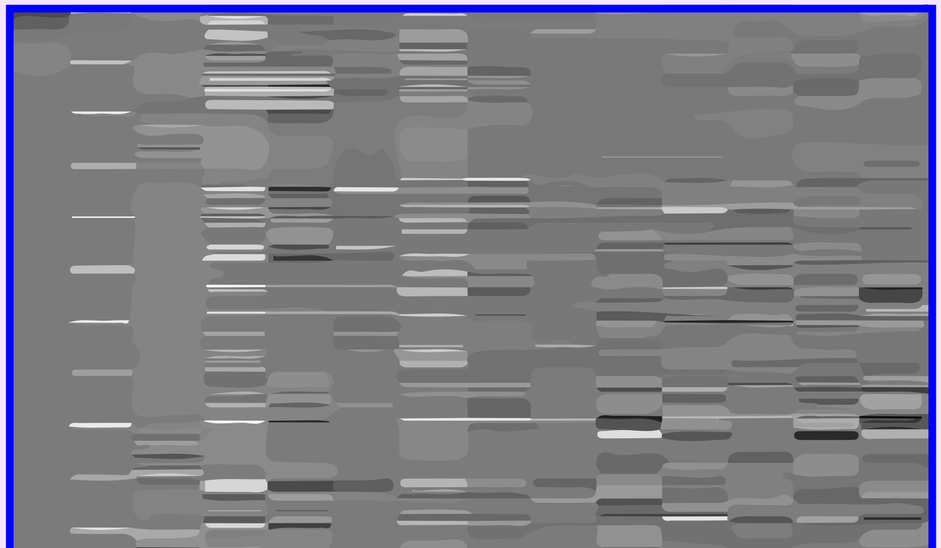
What are the neural correlates of stimulus intensity?







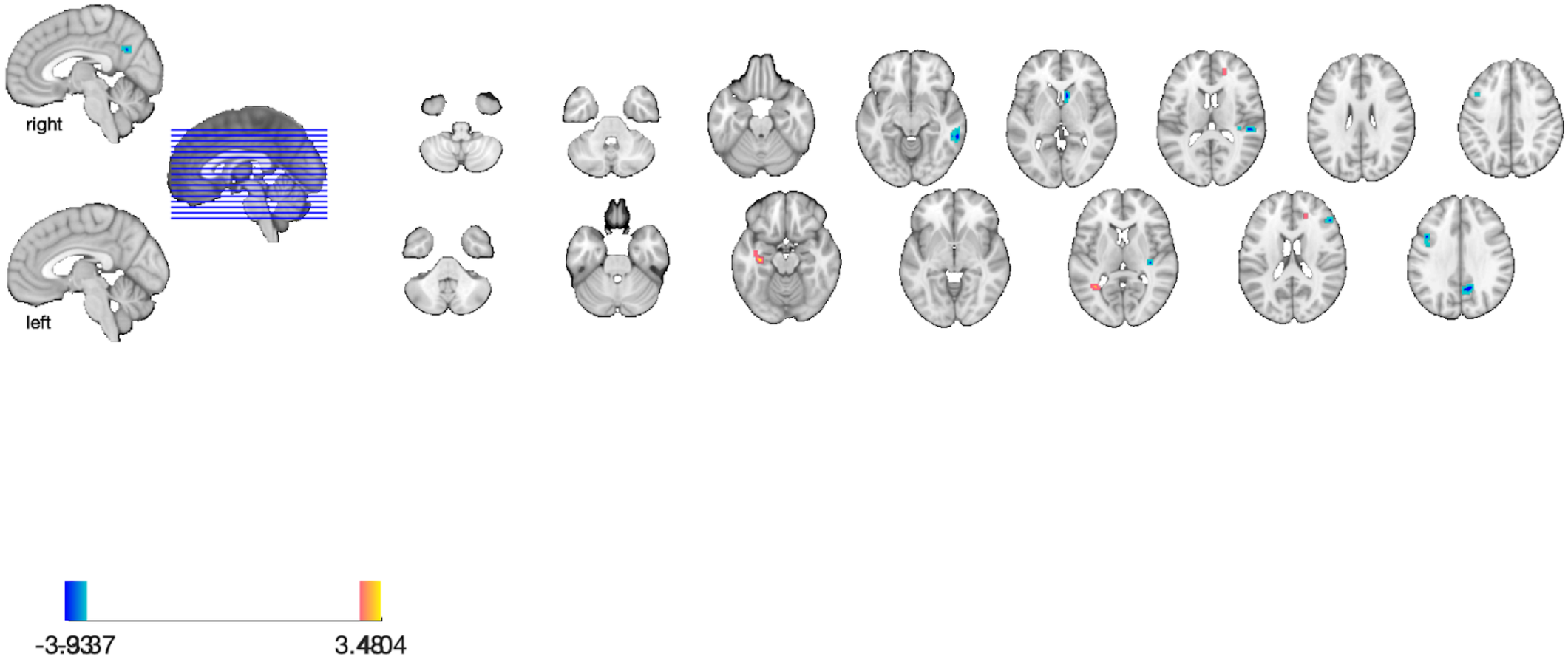
CUE
CUE X cue
EXPECT
STIM
STIM X cue
STIM X actual
ACTUAL



Q2. Cue effects:
What are the neural correlates of cue modulated stimulus effects?

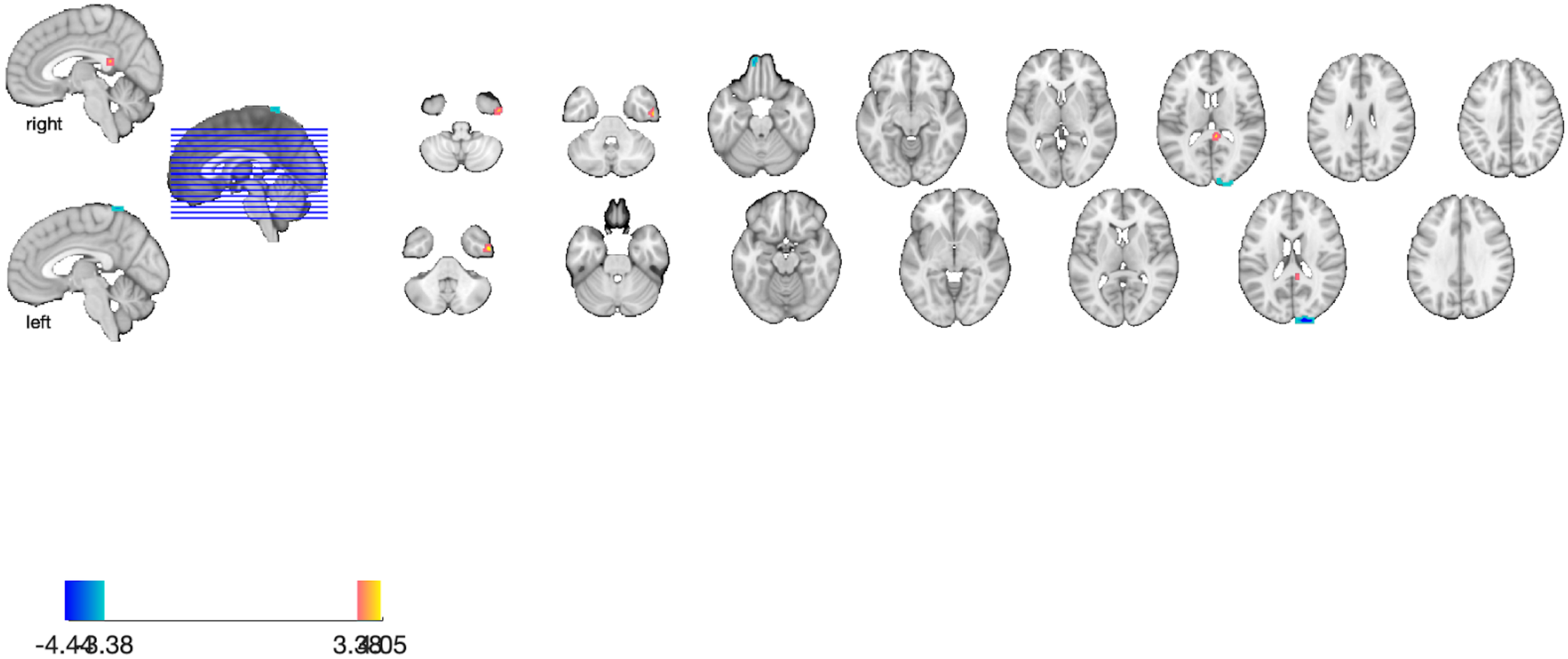
Cue-modulated stimulus intensity effects

Pain > VC (p < .001, uncorrected)



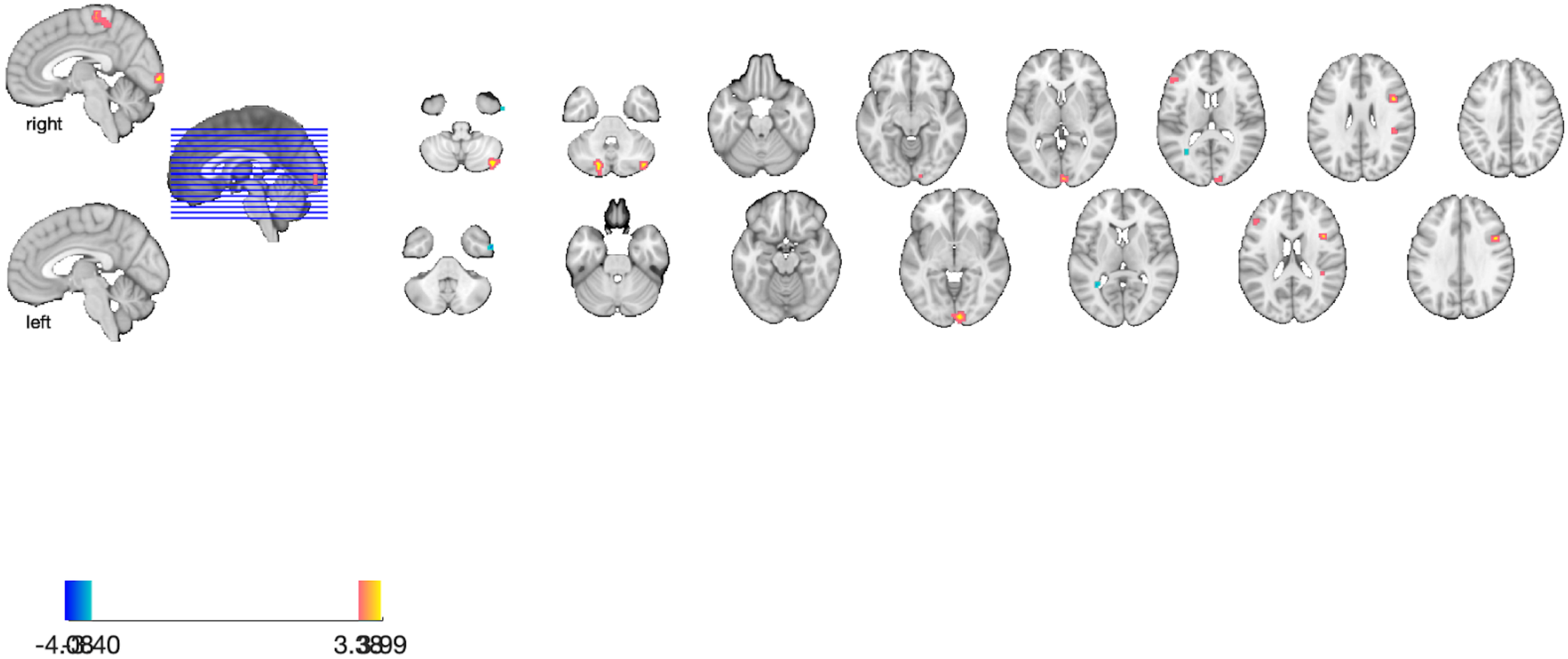
Cue-modulated stimulus intensity effects

Vicarious > PC (p < .001, uncorrected)



Cue-modulated stimulus intensity effects

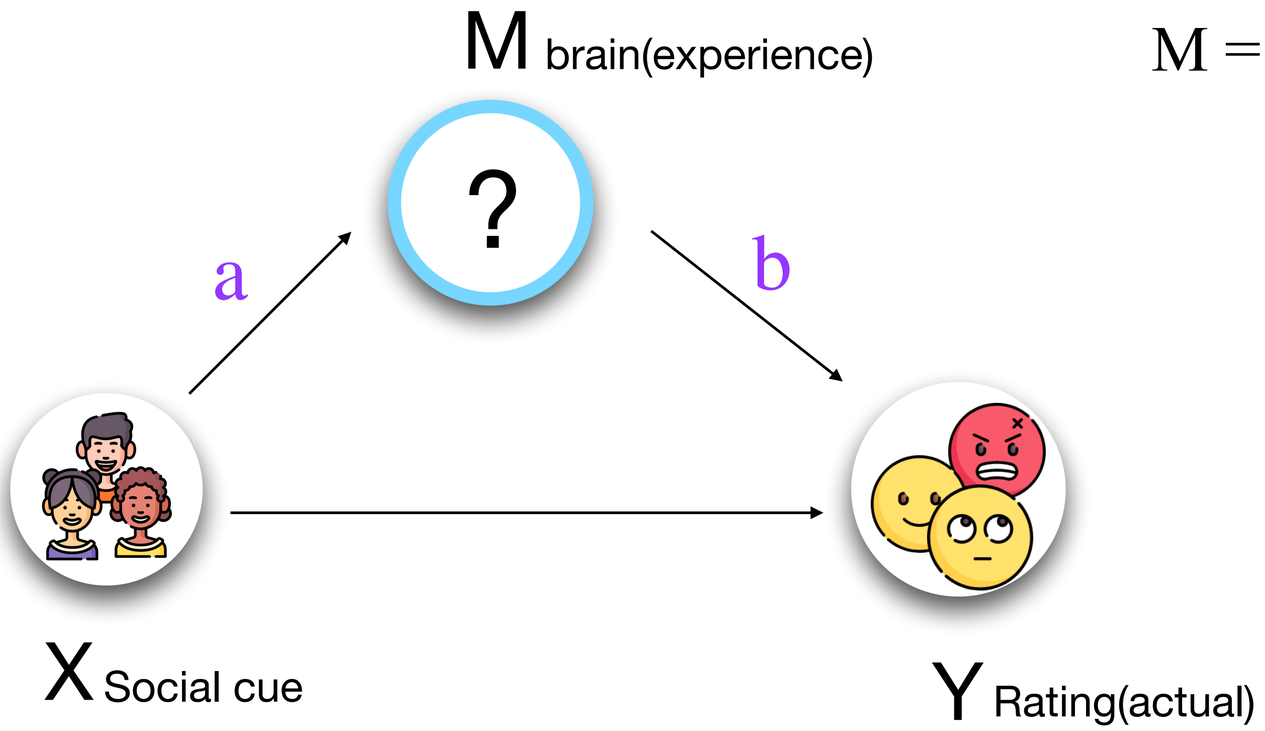
Cognitive > PV (p < .001, uncorrected)

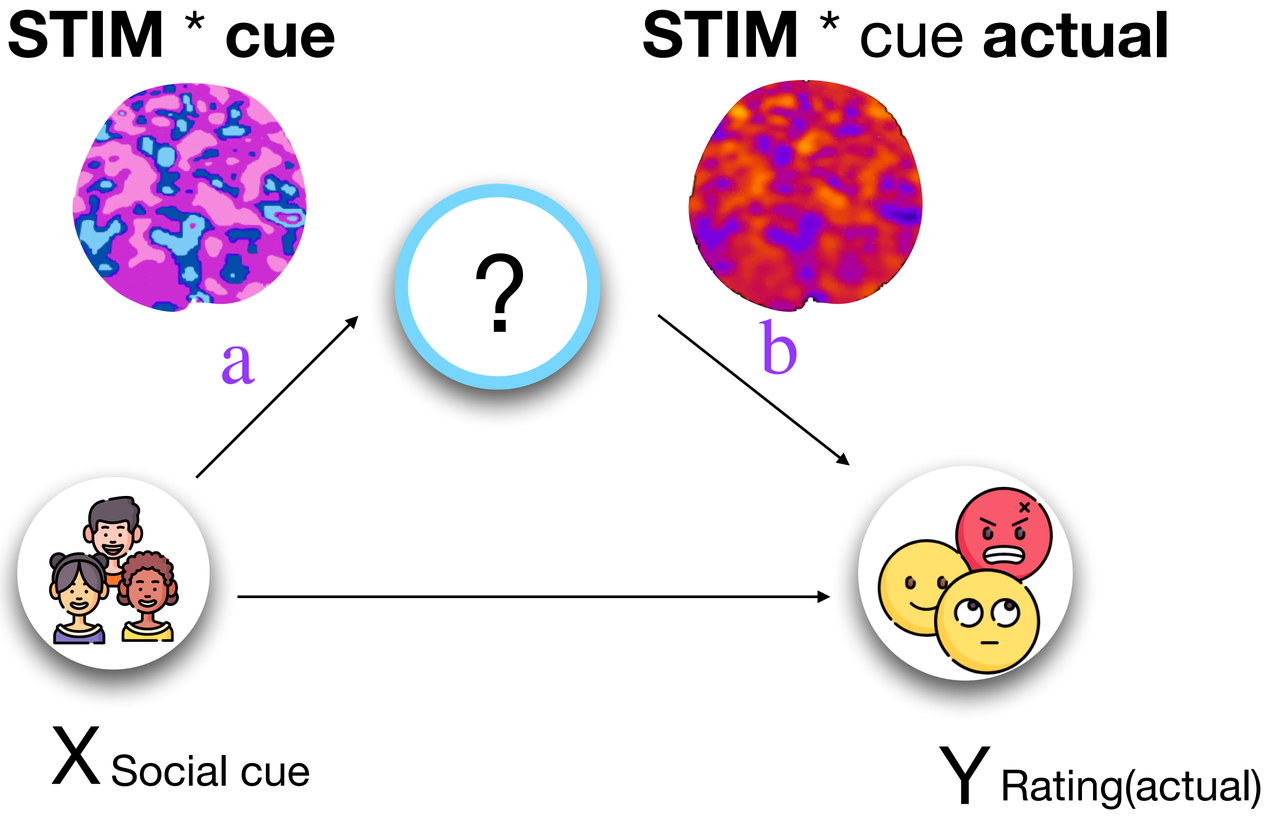


Mediation

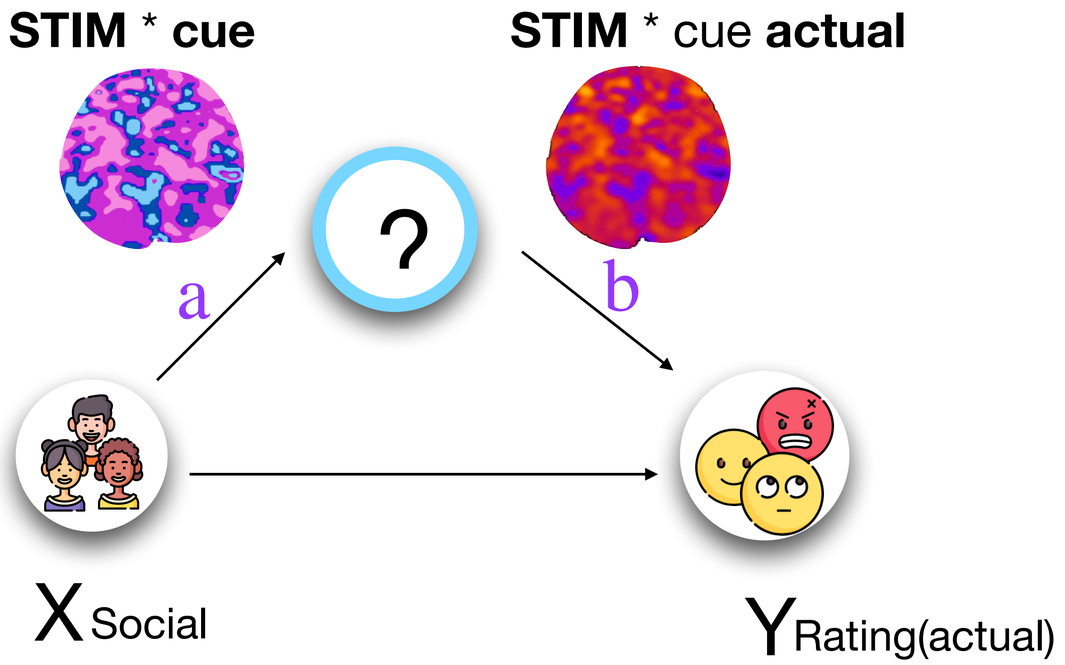
Two-path mediation

$$Y = \beta_0 + cX$$
$$Y = \beta_0 + c'X + bM$$
$$M = \beta_0 + aX$$





$\therefore ab = indirect\ effect\ (mediation)$



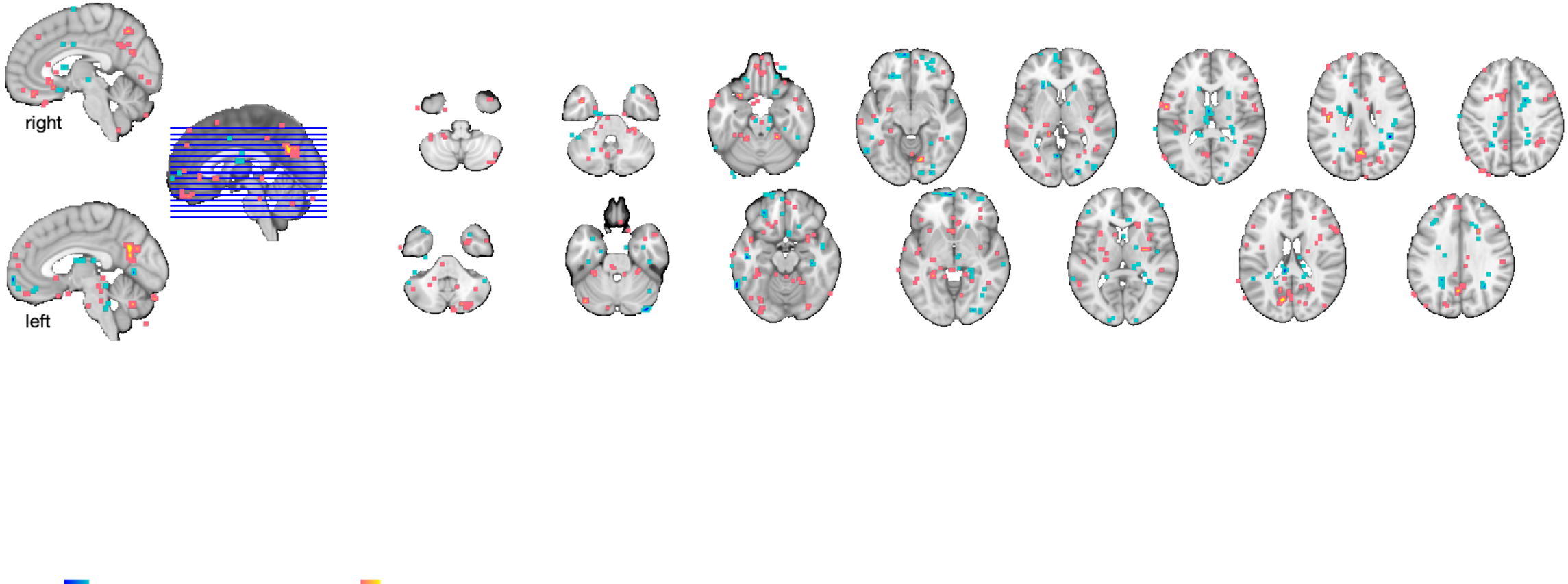
$$Y_{(Rating)} = \beta_0 + c'CUE + bBRAIN$$
$$M_{(brain)} = \beta_0 + aCUE$$

$$\therefore ab = \textit{indirect effect}$$

$$M_{(brain)} = \beta_0 + c'CUE + bACTUAL$$
$$M_{(brain)} = \beta_0 + aCUE$$

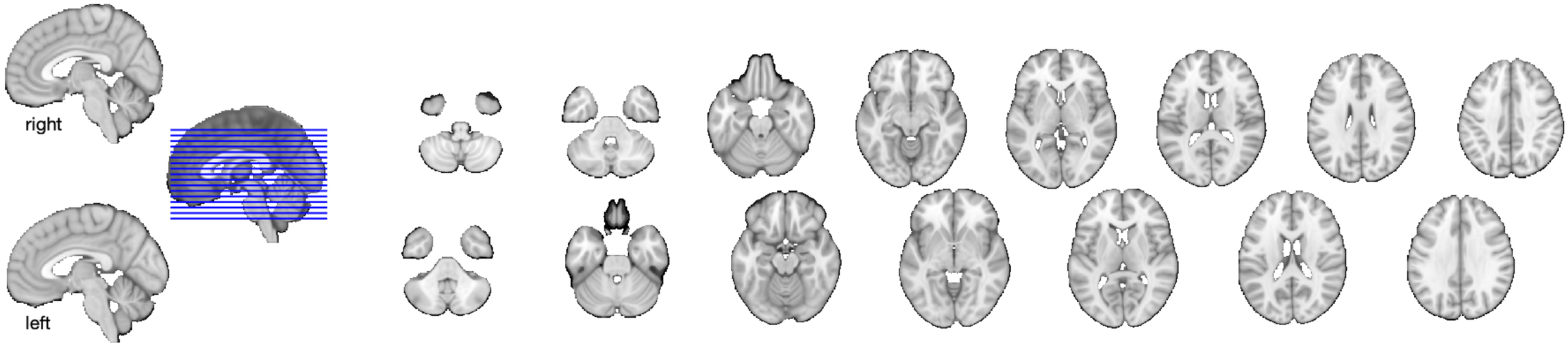
Mediation ab map

Pain stimXcue * stimXactual (p < .001, uncorrected)



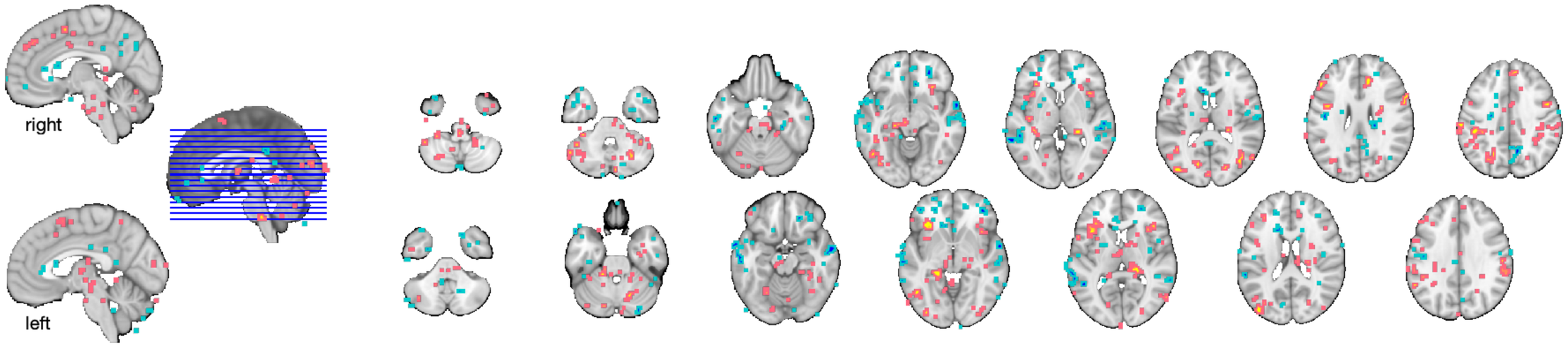
Mediation ab map

Vicarious stimXcue * stimXactual (p < .001, uncorrected)



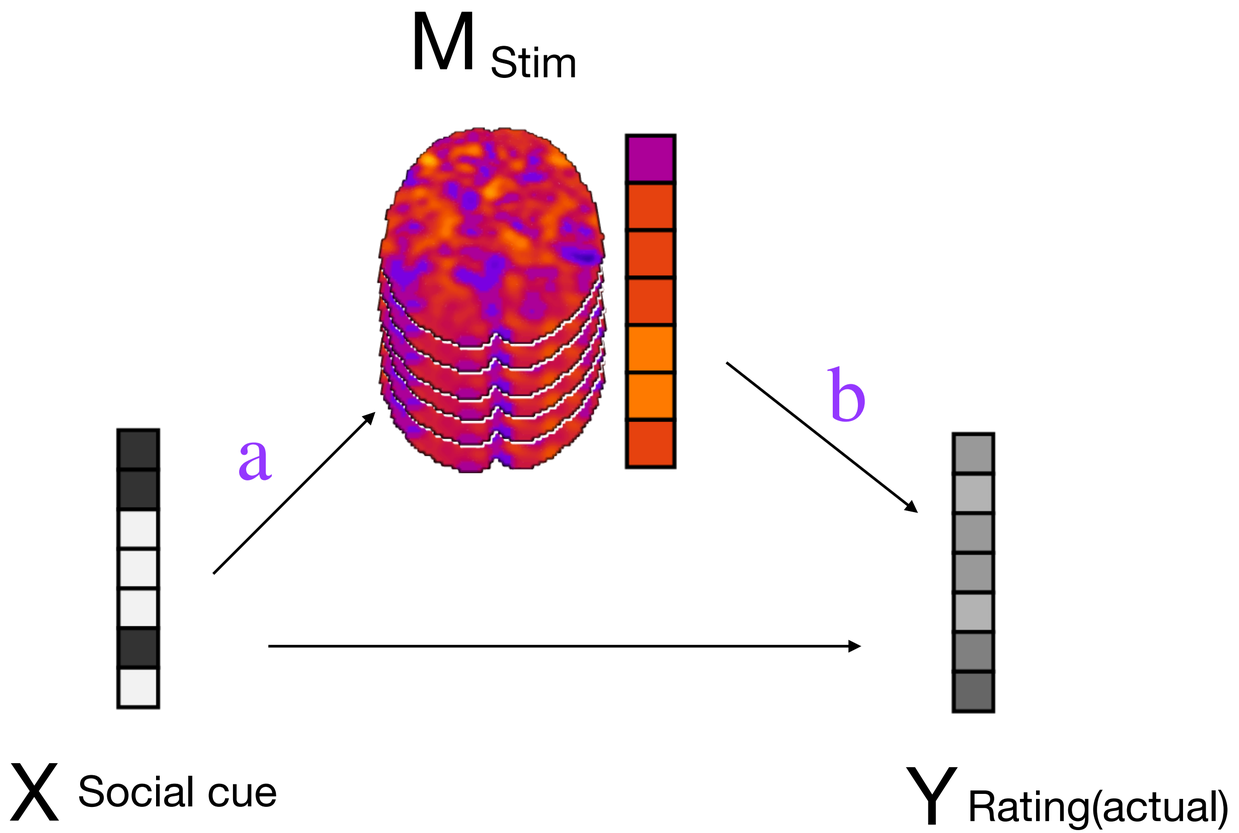
Mediation ab map

Cognitive stimXcue * stimXactual (p < .001, uncorrected)



What's next?

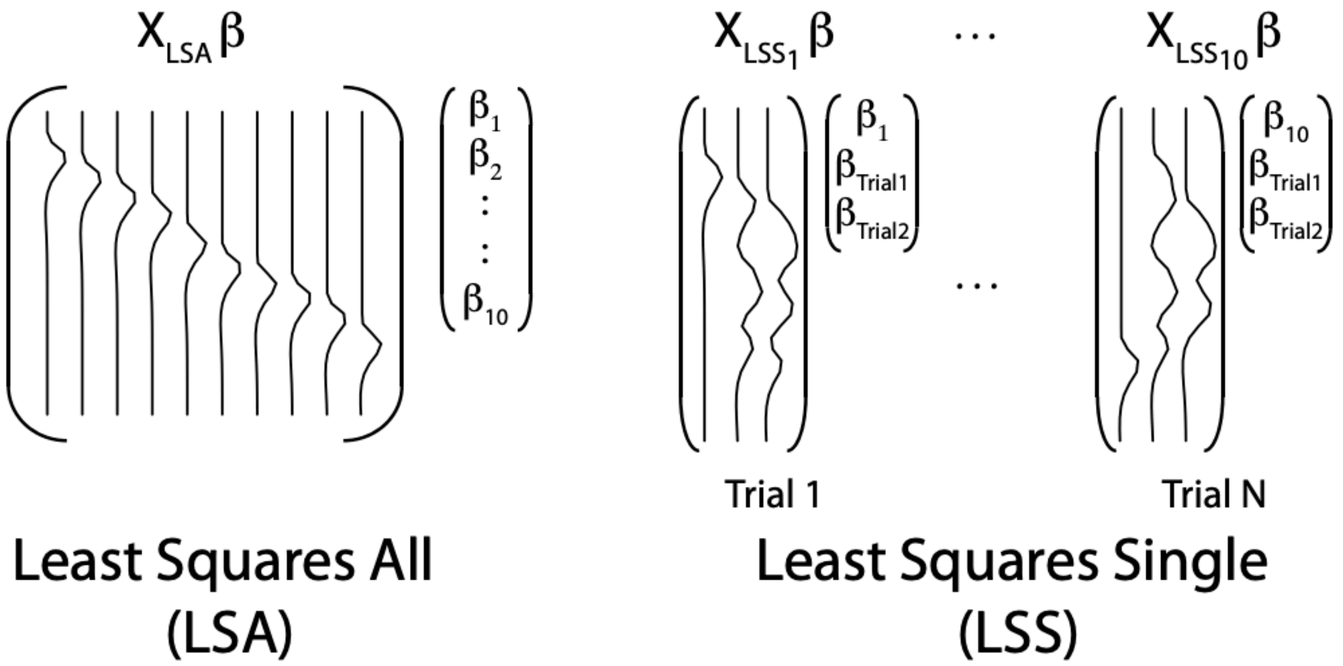
Single trial analyses and multi-level mediation

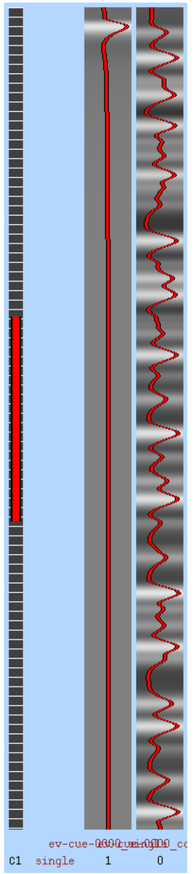


Single trial analysis

Least Squares Single

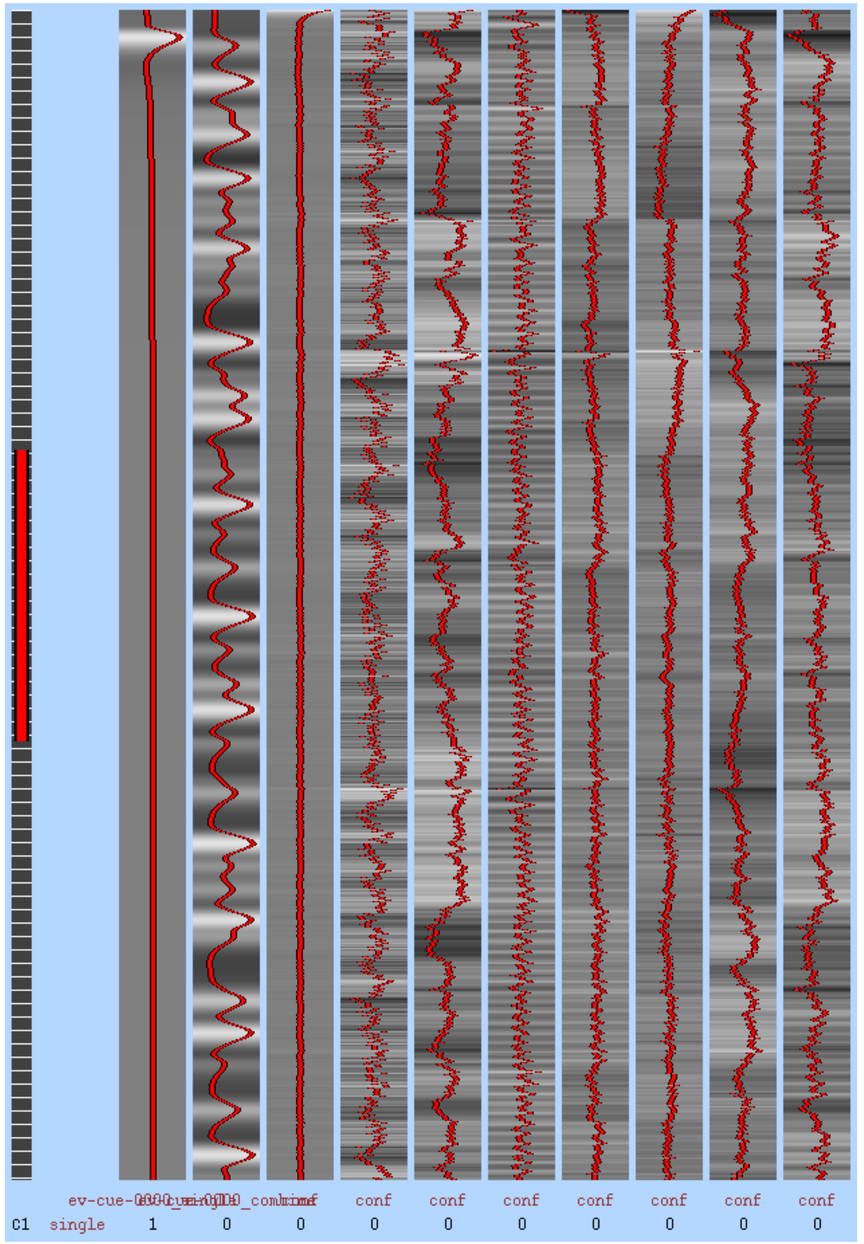
When you have short inter-stimulus interval (ISI)





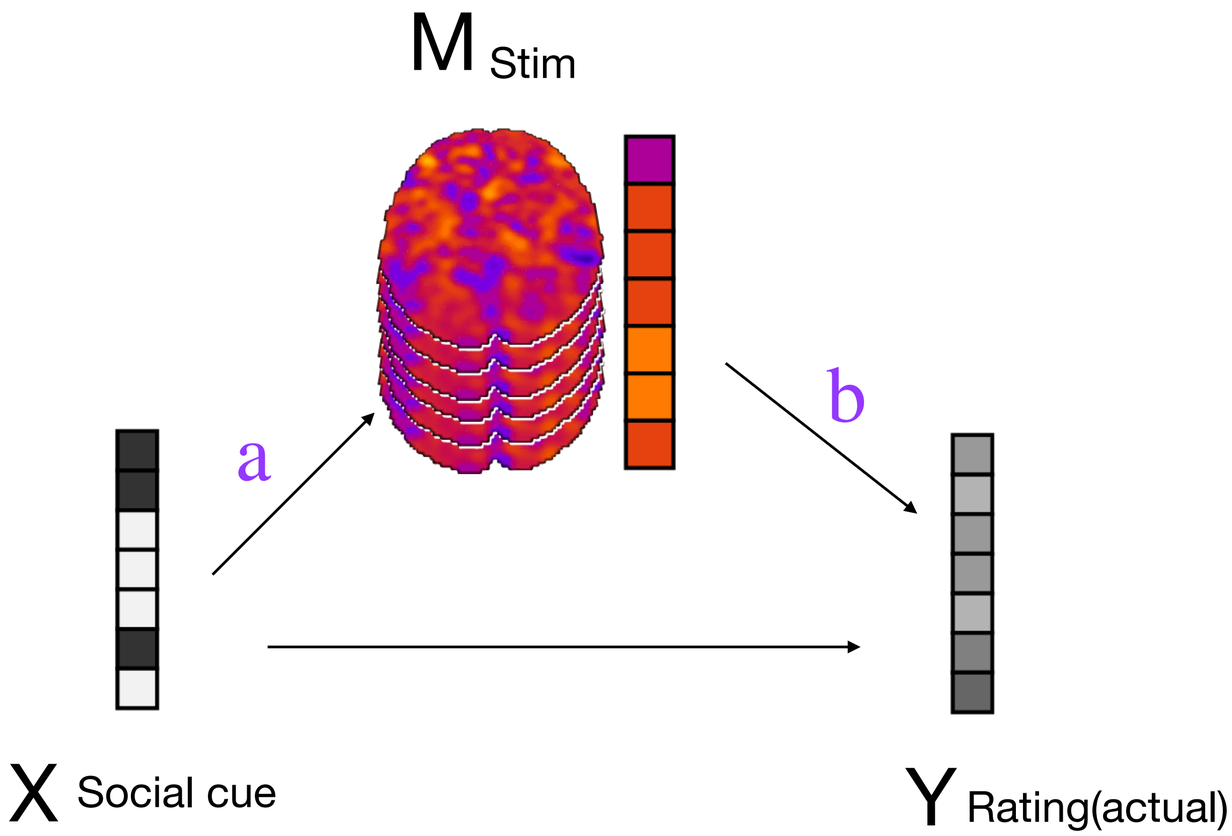
Example trial of my pipeline

Mumford et al., 2012; 2014

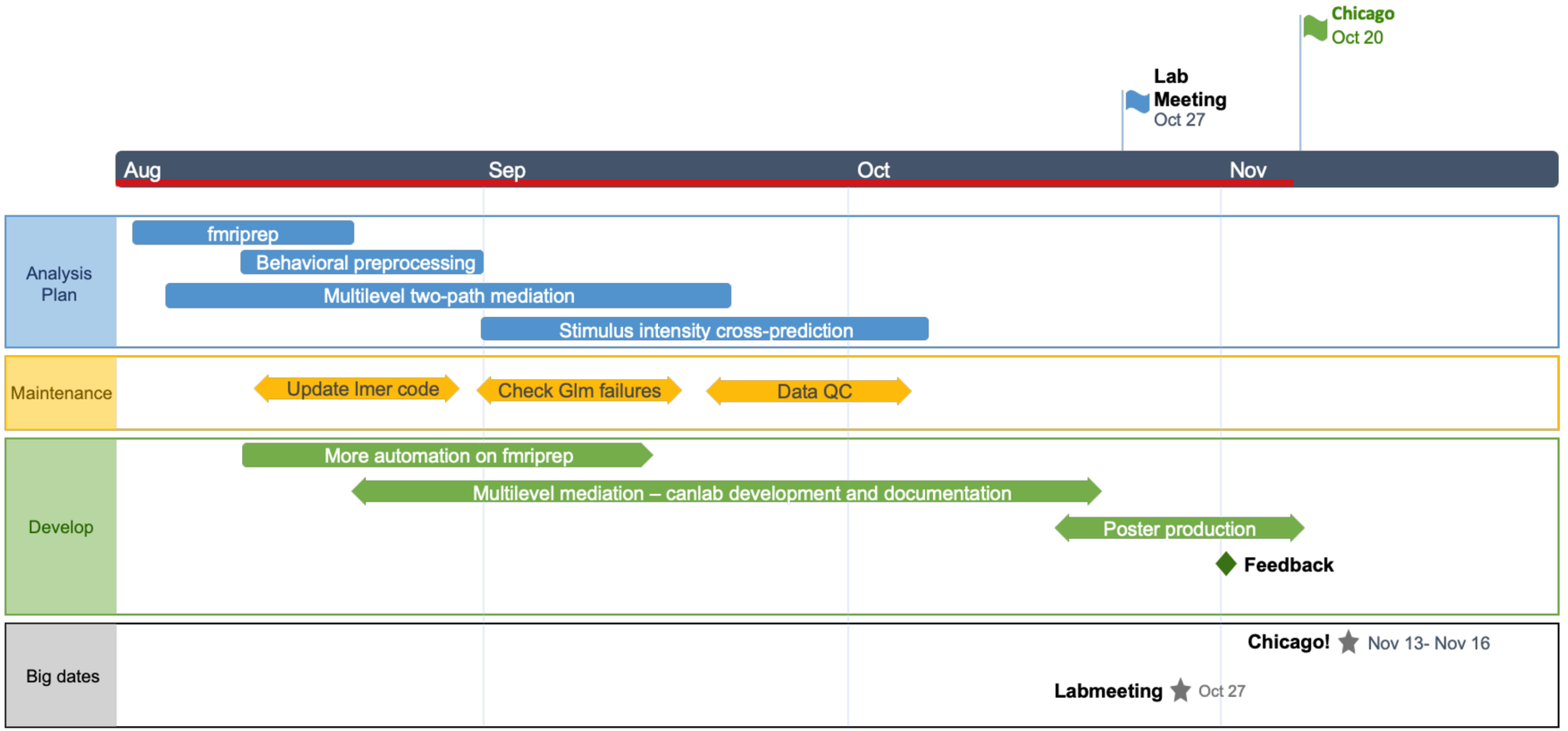

ev-cue-
conf conf conf conf conf conf conf conf
C1 single 1 0 0 0 0 0 0 0 0 0

What's next?

Single trial analyses and multi-level mediation

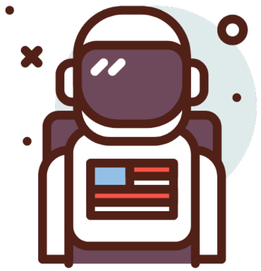


Social influence analysis roadmap



Feedback & Questions

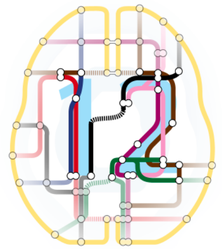
Thank you!



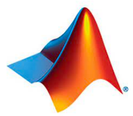
- Maryam
- Bethany
- Eilis
- Luke

- Courtney Rodgers
- Terry Sackett

- Rotem



- Michael
- Ke

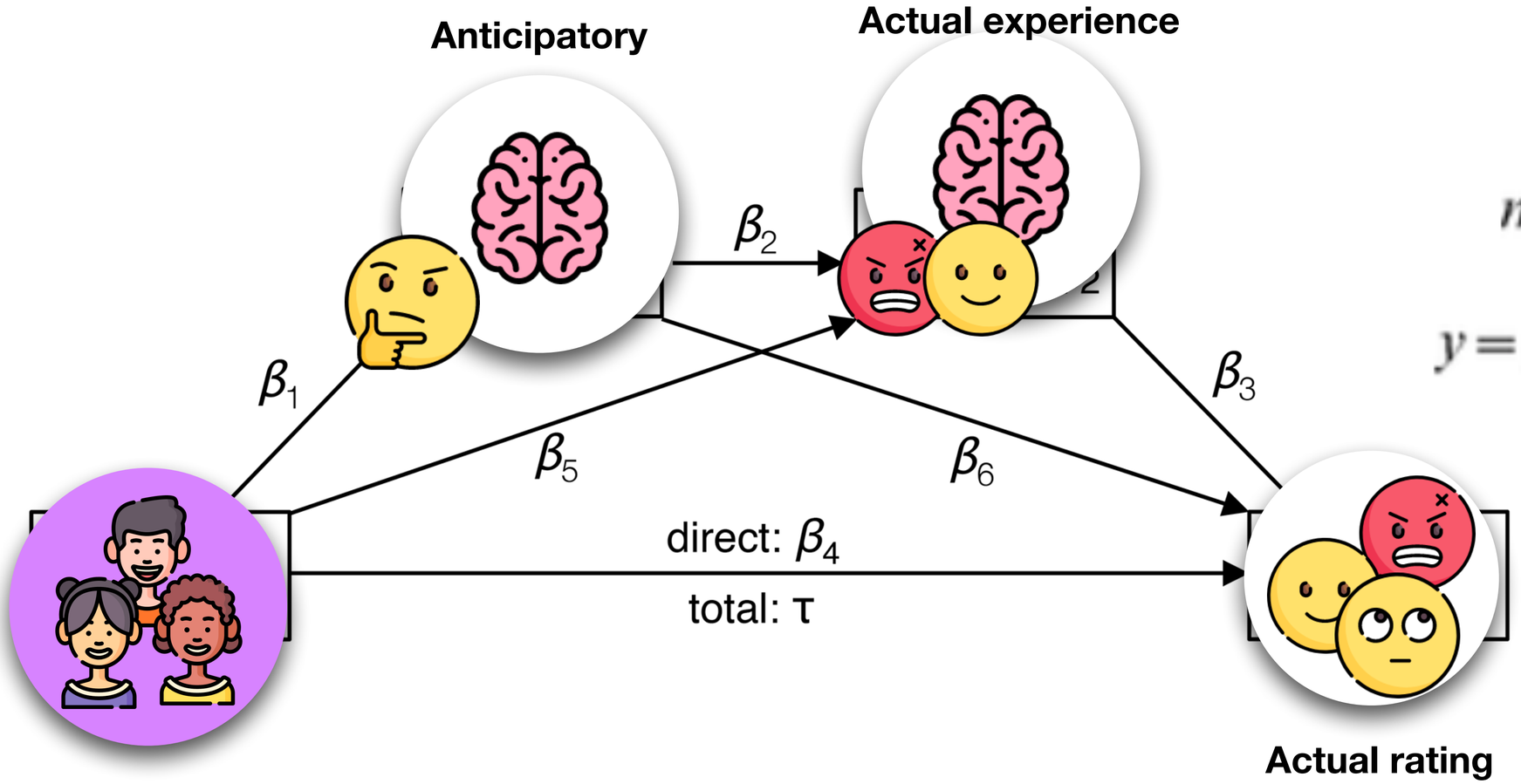




Tor!

Appendix

What is the relationship (in the brain) between expectation & actual experiences?

“multilevel mediation analysis”



$$y = \tau x + e_y$$

$$m_1 = \beta_1 x + e_{m_1}$$

$$m_2 = \beta_2 m_1 + \beta_5 x + e_{m_2}$$

$$y = \beta_4 x + \beta_3 m_2 + \beta_6 m_1 + e'_y$$

Behavioral/Systems/Cognitive

Isolating the Modulatory Effect of Expectation on Pain Transmission: A Functional Magnetic Resonance Imaging Study

John R. Keltner,[1] Ansgar Furst,[2] Catherine Fan,[2] Rick Redfern,[2] Ben Inglis,[2] and Howard L. Fields[3]

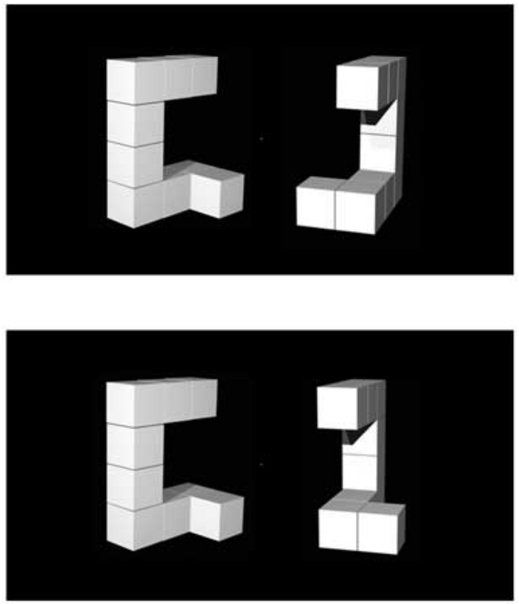
[1]Pain Management Center, Department of Anesthesia and Perioperative Care, University of California San Francisco, San Francisco, California 94143, [2]Henry H. Wheeler, Jr. Brain Imaging Center, Helen Wills Neuroscience Institute, University of California Berkeley, Berkeley, California 94608, and [3]Wheeler Center for the Neurobiology of Addiction, Department of Neurology, University of California San Francisco, Emeryville, California 94608

We use a novel balanced experimental design to specifically investigate brain mechanisms underlying the modulating effect of expected pain intensity on afferent nociceptive processing and pain perception. We used two visual cues, each conditioned to one of two noxious thermal stimuli [~48°C (high) or 47°C (low)]. The visual cues were presented just before and during application of the noxious thermal stimulus. Subjects reported significantly higher pain when the noxious stimulus was preceded by the high-intensity visual cue. To control for expectancy effects, for one-half of the runs, the noxious thermal stimuli were accompanied by the cue conditioned to the other stimulus. Comparing functional magnetic resonance imaging blood oxygenation level-dependent activations produced by the high and low thermal stimulus intensities presented with a high-intensity visual cue showed significant activations in nociceptive regions of the

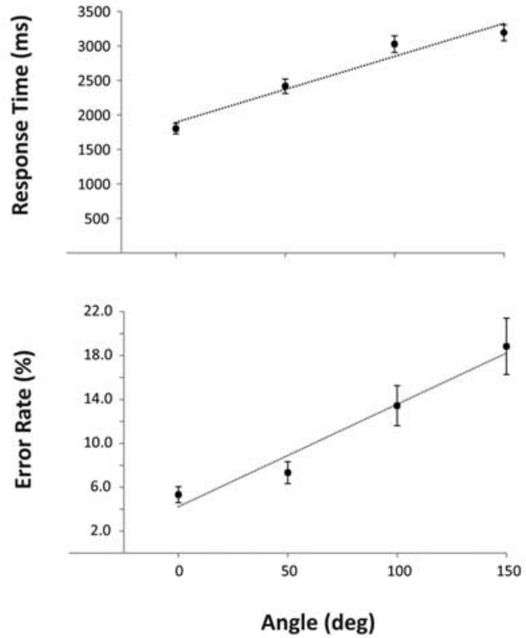
We use datasets will normed ratings

Cognitive - mental rotation dataset (Ganis & Kievit, 2015)

Example



Normed results from Ganis & Kievity (2015)



We use datasets will normed ratings

Vicarious - McMaster shoulder pain dataset

What McMaster pain dataset offers

1) Temporal Spontaneous Expressions:
2) Manual FACS codes:
3) Self-Report and Observer Ratings
4) Tracked Landmarks: 66 point Active Appearance Model (AAM) landmarks.

High

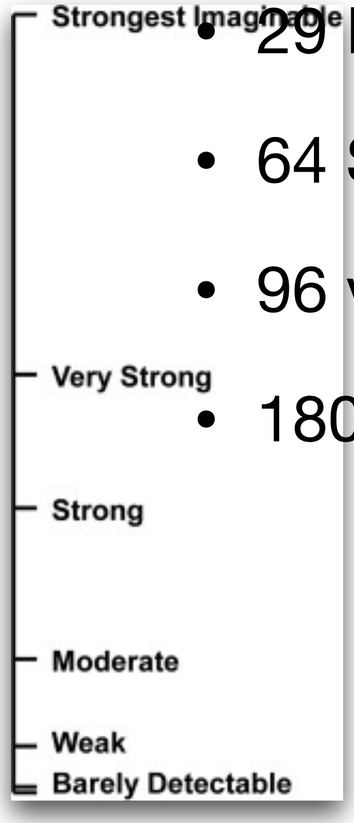
Med

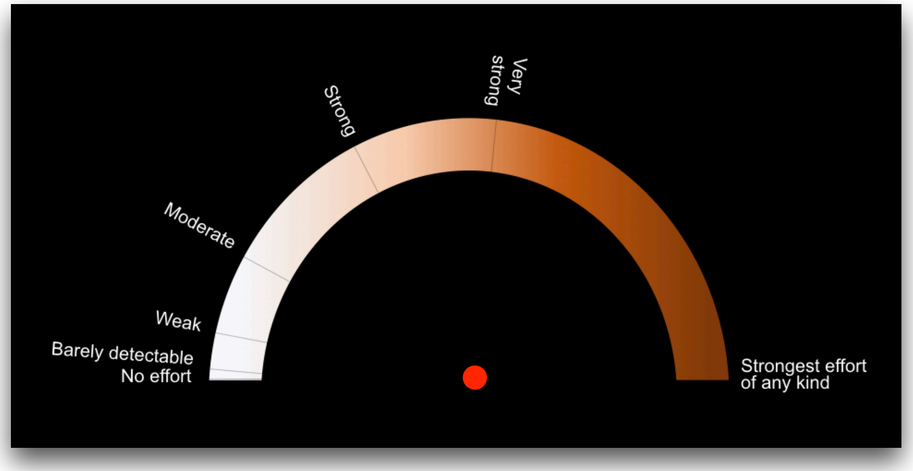
Low

gLMS

General Labeled Magnitude scale + semi-circular

- 0 No effort 0
- 3 Barely detectable
- Weak: 10
- 29 Moderate: 29
- 64 Strong: 64
- 96 very strong: 96
- 180 strongest effort





Benefits of circular rating

- Equidistant
- Mouse trajectory

(e.g., Bartoshuk et al., 2002, Green et al., 1993, Green et al., 1996)