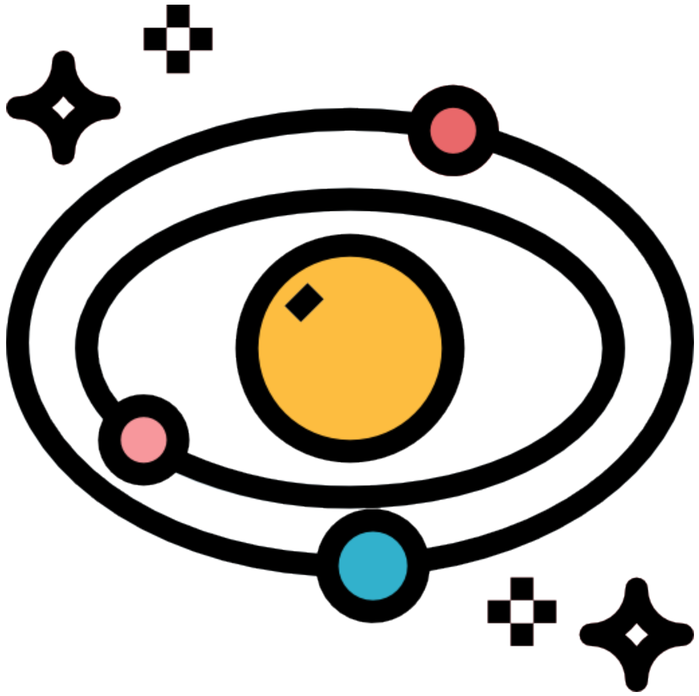
Study overview + pre-registration

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

June 8th, 2021. Heejung Jung



Spatial Topology

What's the aim of the grant?

Individualized spatial topology in functional neuroimaging

- Hyperalignment
- Naturalistic narrative experiences
- Pain, emotion, cognition

In Aim 2, we will test and validate the methods using a purpose-designed experiment (n = 120) that includes two types of naturalistic narrative experiences (movies and audio stories) and **tasks from three functional domains (pain, emotion, and cognition)**. The tasks are designed with several constraints in mind, including: (1) inclusion of naturalistic paradigms needed to compare our approach with other functional alignment methods (**e.g., 'hyperalignment'**), and which can provide a broad base of percepts and concepts for fMRI-based decoding; (2) systematic

session overview

session 01

session 02

session 03

session 04

Pain, Vicarious pain, Cognitive (PVC)

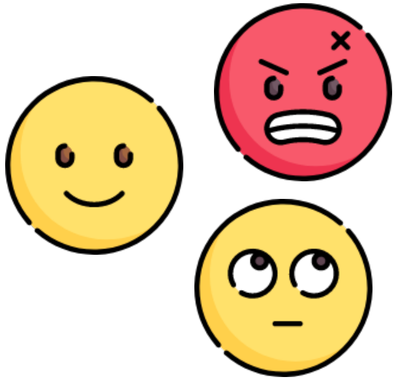
2 hrs worth of data

expectations can shape actual experience

Social influence

Expectations

Actual experiences



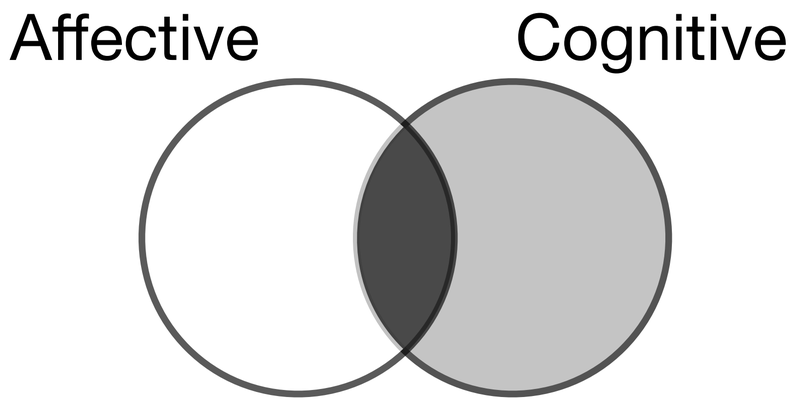
Icons made by flaticon freepik

expectations can shape actual experience

- **Pain:** Top-down expectations of pain can modulate pain experience (Wager et al., 2013; Cormier et al., 2013; Sawamoto et al., 2000; Koyama et al., 2005; Lorenz et al., 2005; Brown et al., 2008; Atlas et al., 2010; Bingel et al., 2011; Wiech et al., 2014b)

- **Cognitive:** Task expectations influence task performance (Swanson & Tricomi, 2014) Expectations on subsequent words modulate language comprehension (Pickering & Garrod, 2007; Wicha et al., 2004, van Berkum et al., 2005, Otten et al., 2007)

Main questions



1. how are expectations represented in the brain?
   Are these expectation representations domain-specific? Or domain-general?

2. how do expectations shape actual experiences?

Design

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

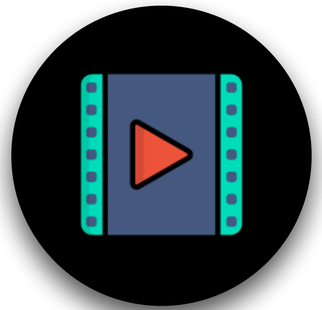
- “expect” ratings
- “actual” ratings

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

Pain

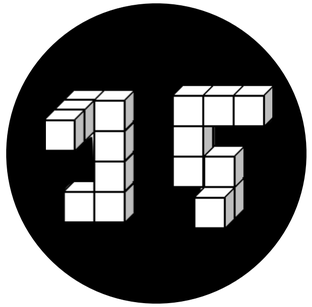
Thermal pain

Vicarious



Vicarious pain videos

Cognitive

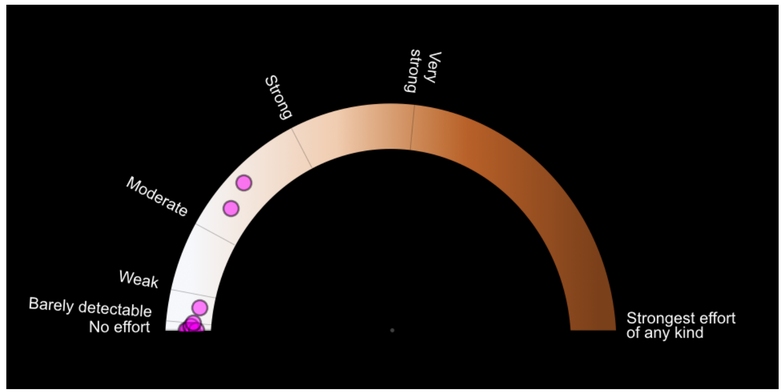


Mental rotation

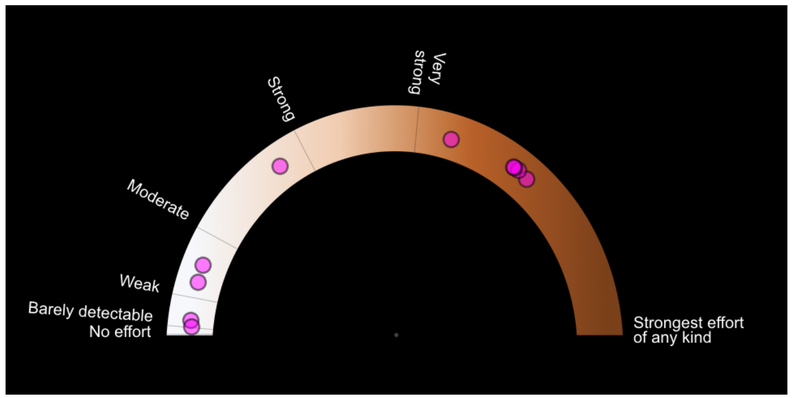
- 3 tasks
- **2 Social cue**
- 3 Stimulus intensity

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

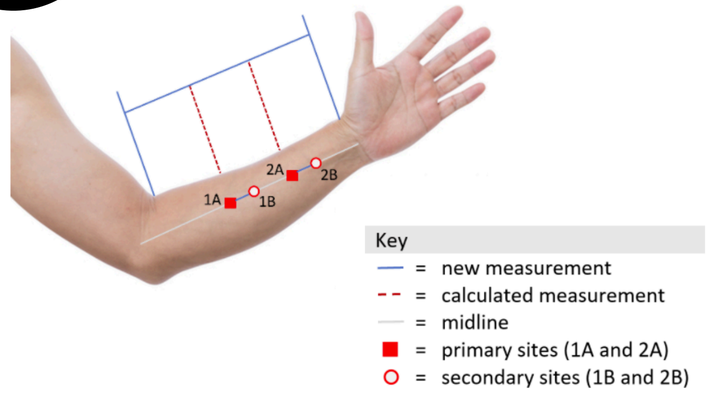
Low cue



High cue



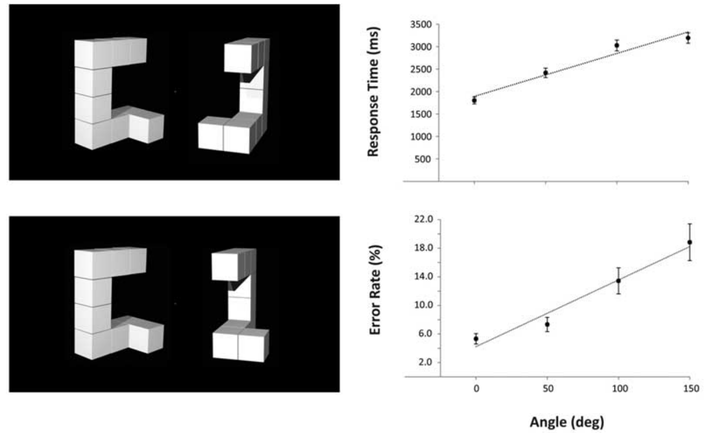
- 3 tasks
- 2 Social cue
- **3 Stimulus intensity**



- Intensity: 48, 49, 50°C

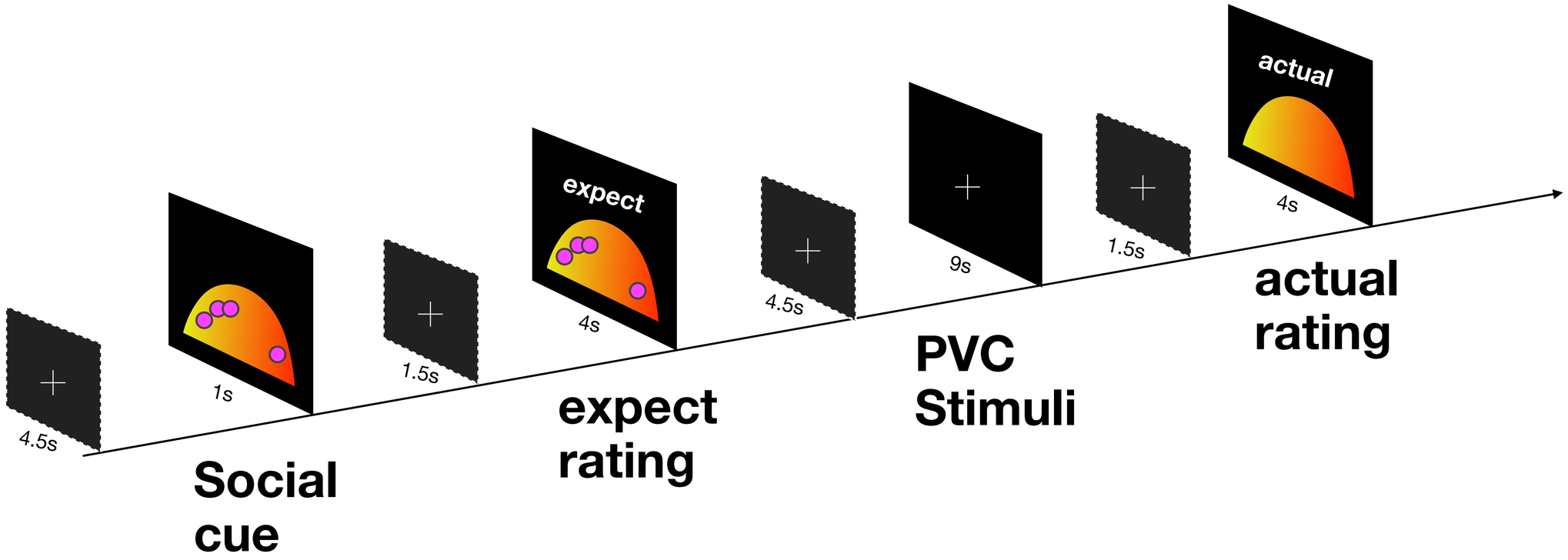
- Intensity: low, med, high

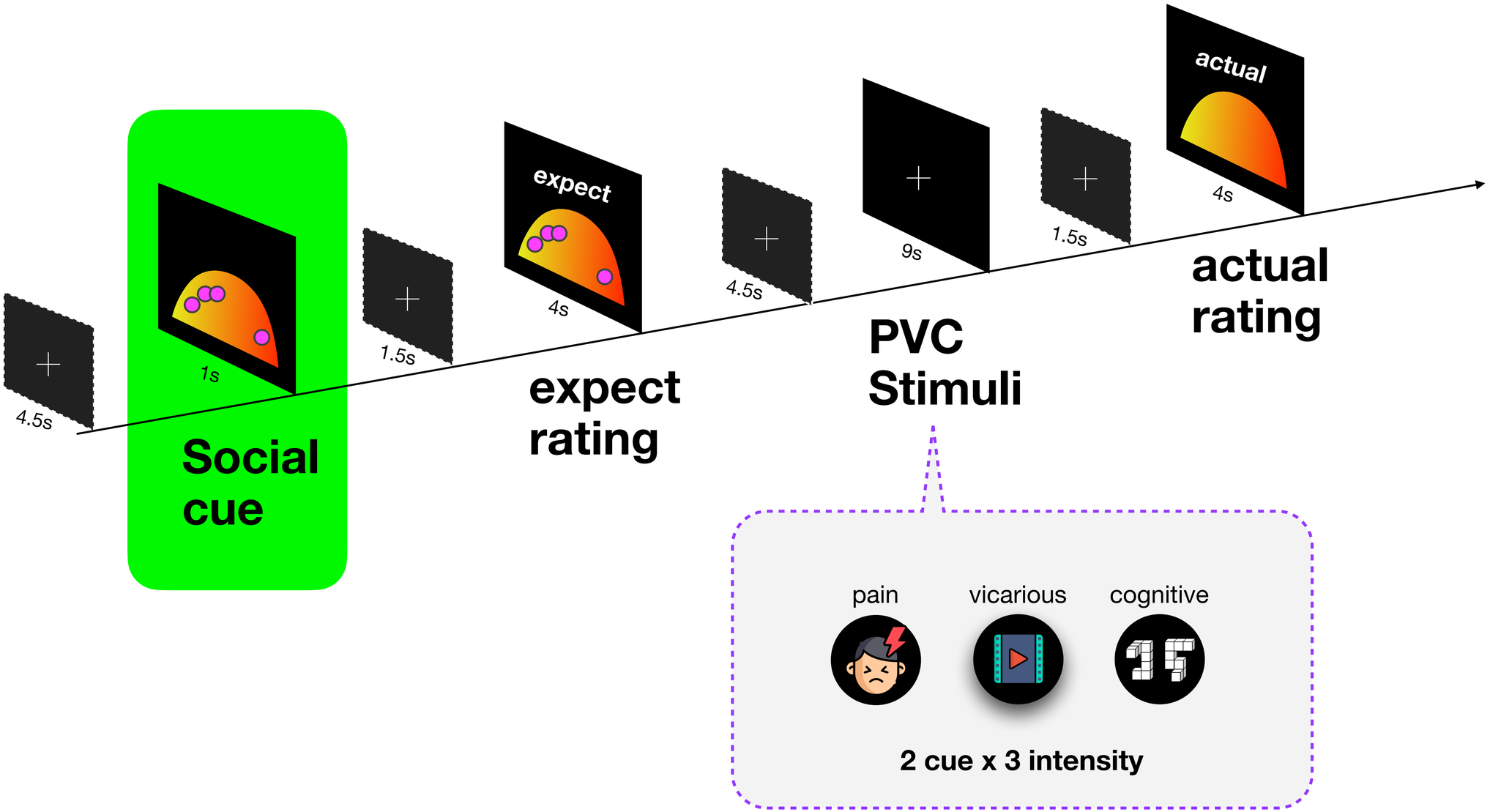
Lucey et al. (2011)

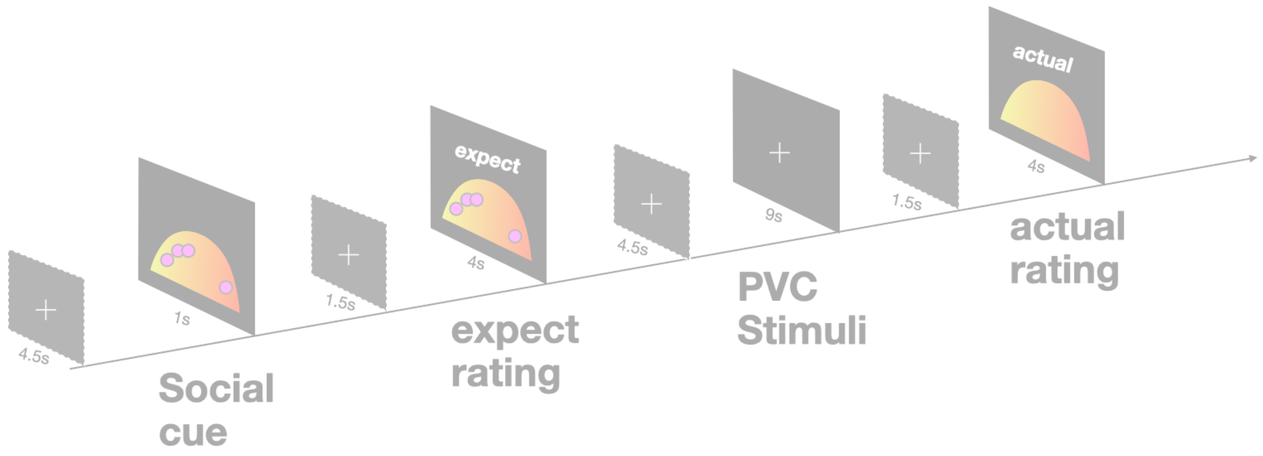


- Intensity: 50, 100, 150°

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


4.5s
1s
Social cue
1.5s
expect
4s
expect rating
4.5s
9s
PVC Stimuli
1.5s
actual
4s
actual rating
pain
vicarious
cognitive
2 cue x 3 intensity



Independent variables

- 3 tasks (pain vs. vicarious vs. cognitive)
- 2 Social Cue (high vs. low)
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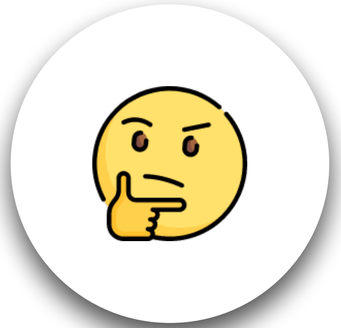
Dependent variables

- “expect” ratings
- “actual” ratings

Behavioral analysis

2 Social cues



expect rating

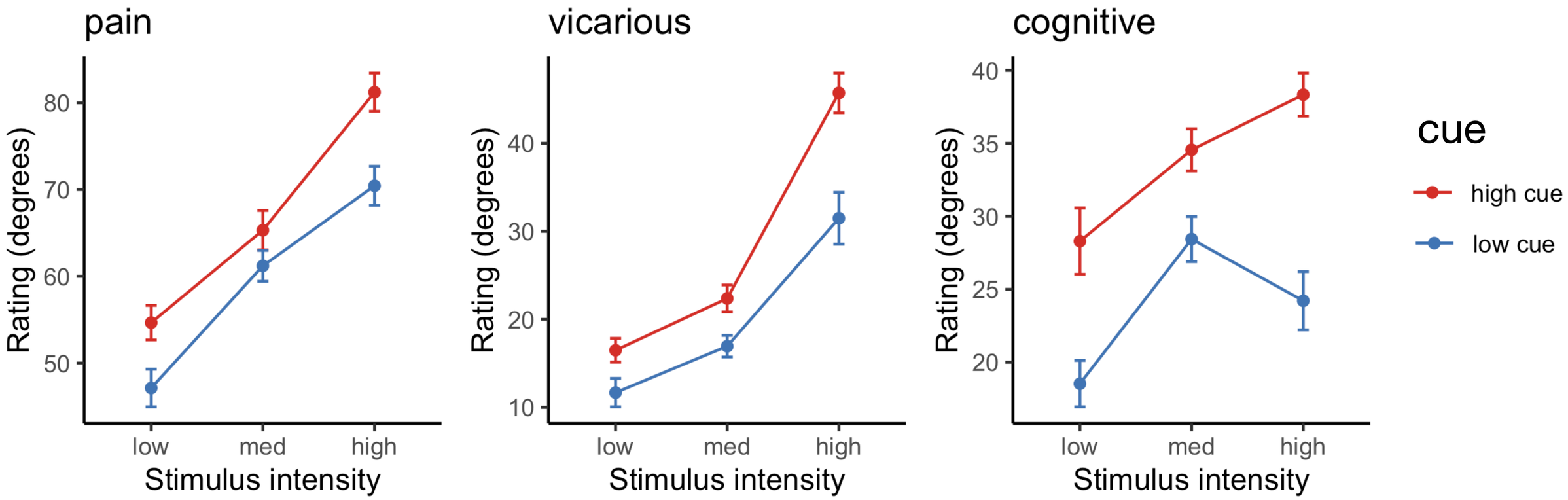
3 stimulus intensity

Actual experience

Can social cues modulate actual experiences?

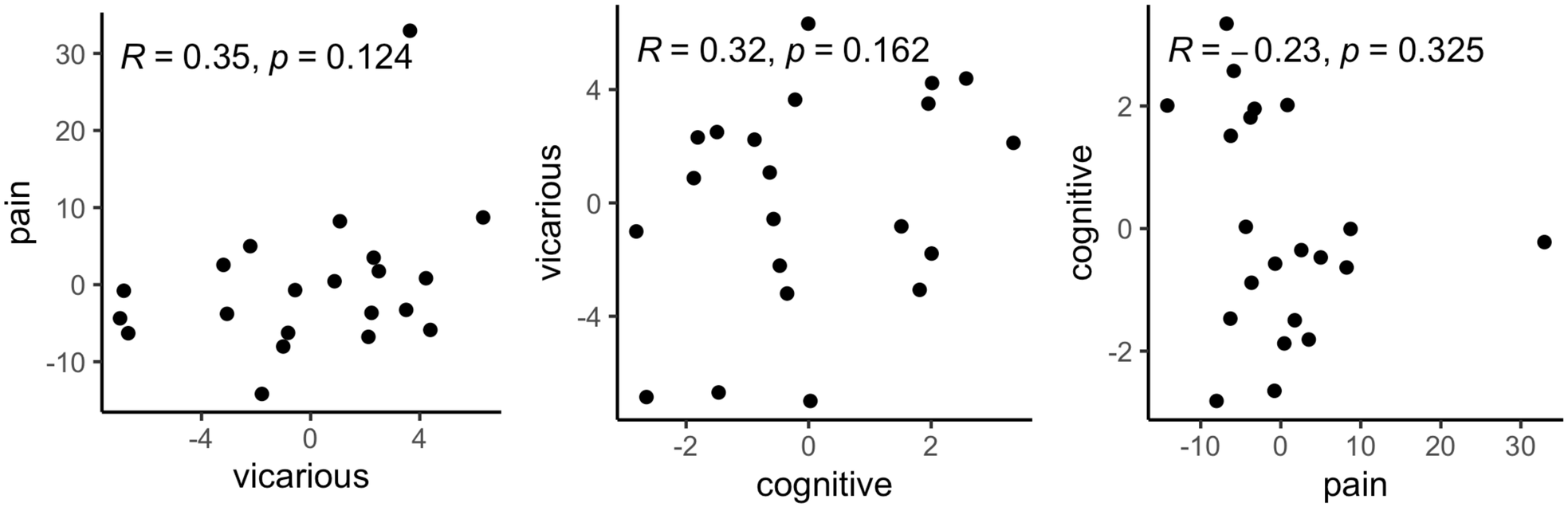
Can social cues modulate actual experiences?

N = 21



Are individual differences in cue effects domain-general?

Plot random slopes of “cue effect on actual ratings”

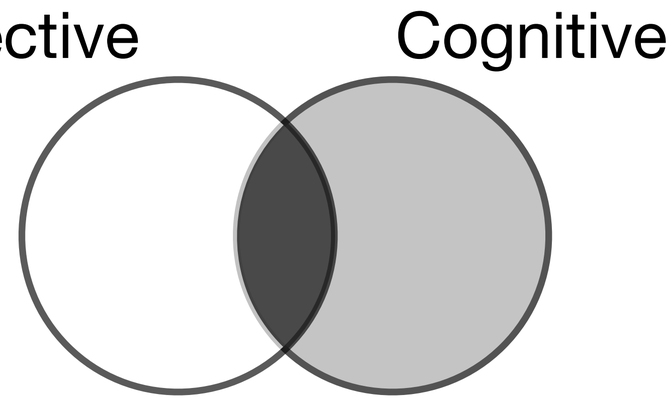


Pre-registration

Pre-registration 1) analysis

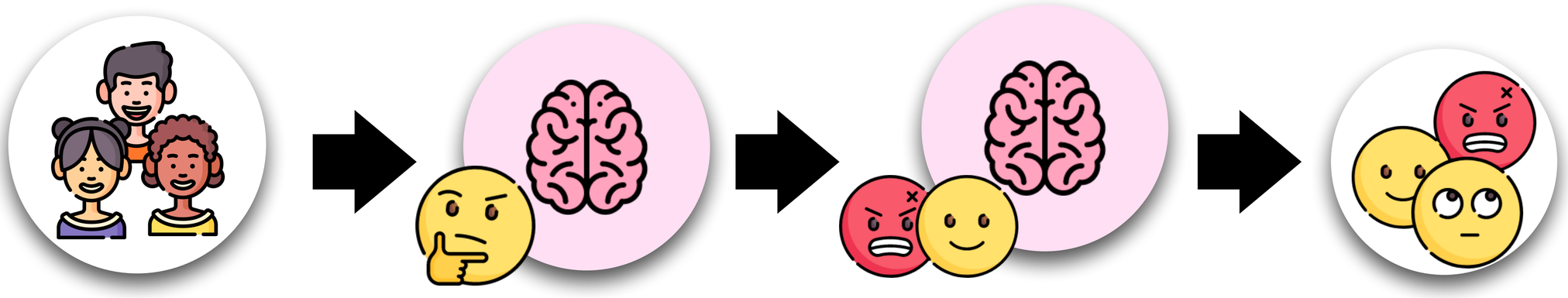
Main questions

“Within-subject”



1. how are expectations represented in the brain?
   Are these expectation representations domain-specific? Or domain-general?

2. how do expectations shape actual experiences?



Cues

brain(expectation)

brain(experience)

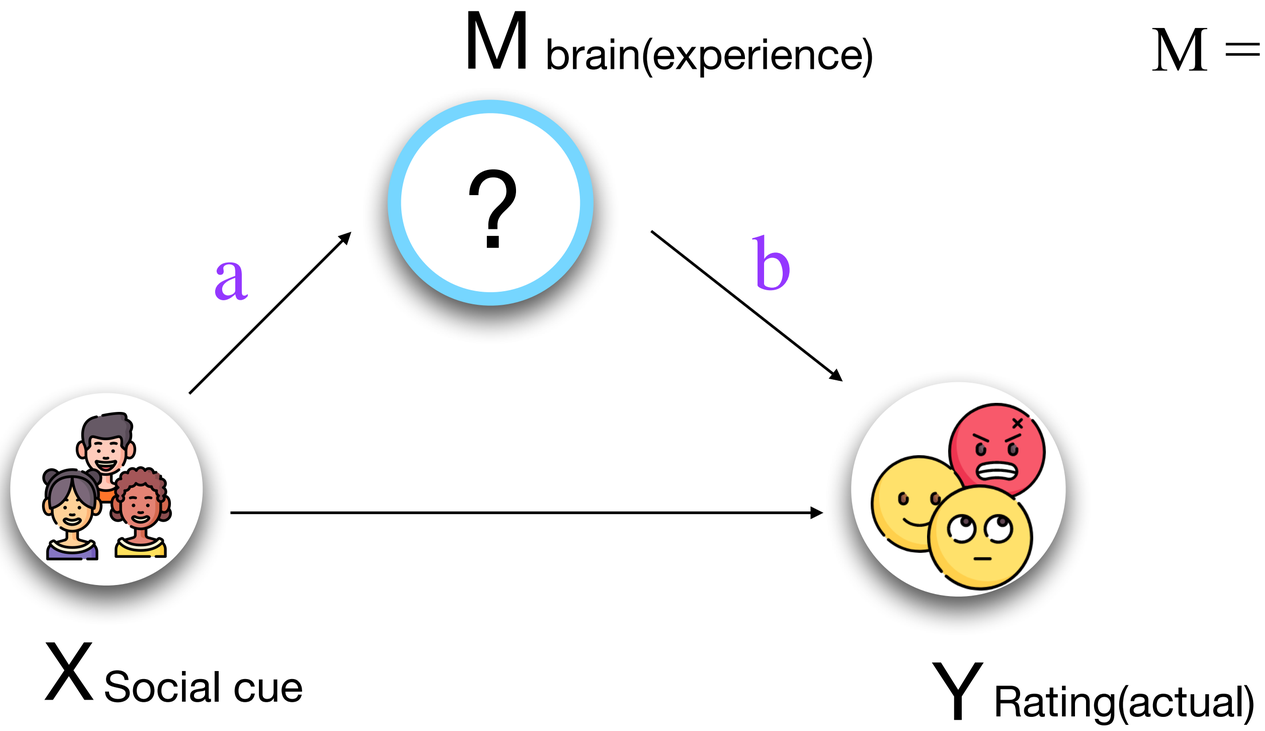
Actual ratings

how do expectations shape actual experiences?

Analysis 1. **two-path mediation analysis** (Atlas, 2010)
Analysis 2. **multi-path mediation analysis** (Woo, 2015)

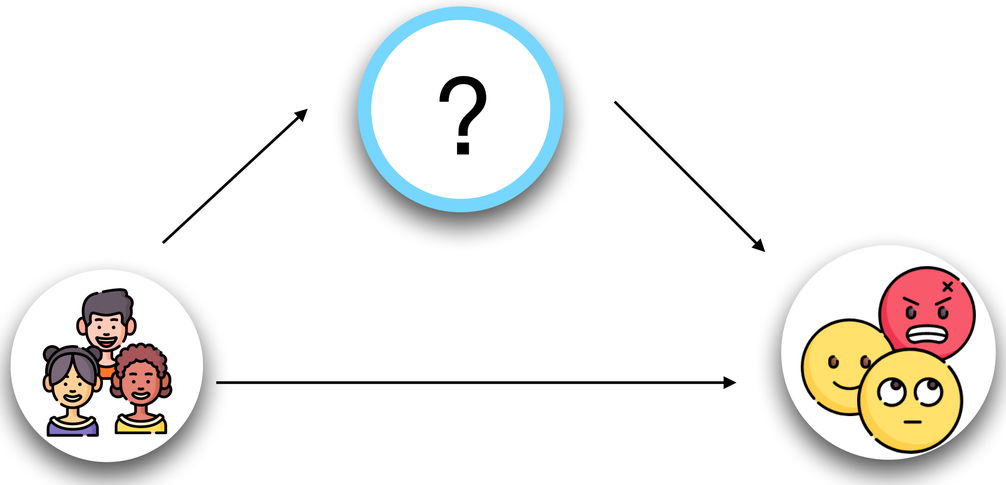
Two-path mediation

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

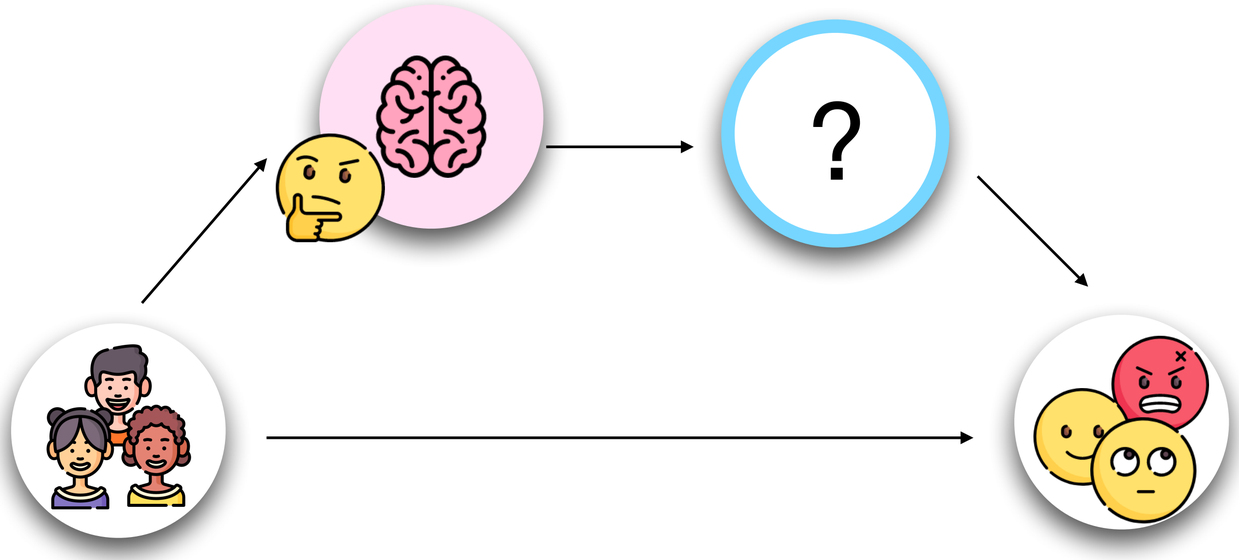


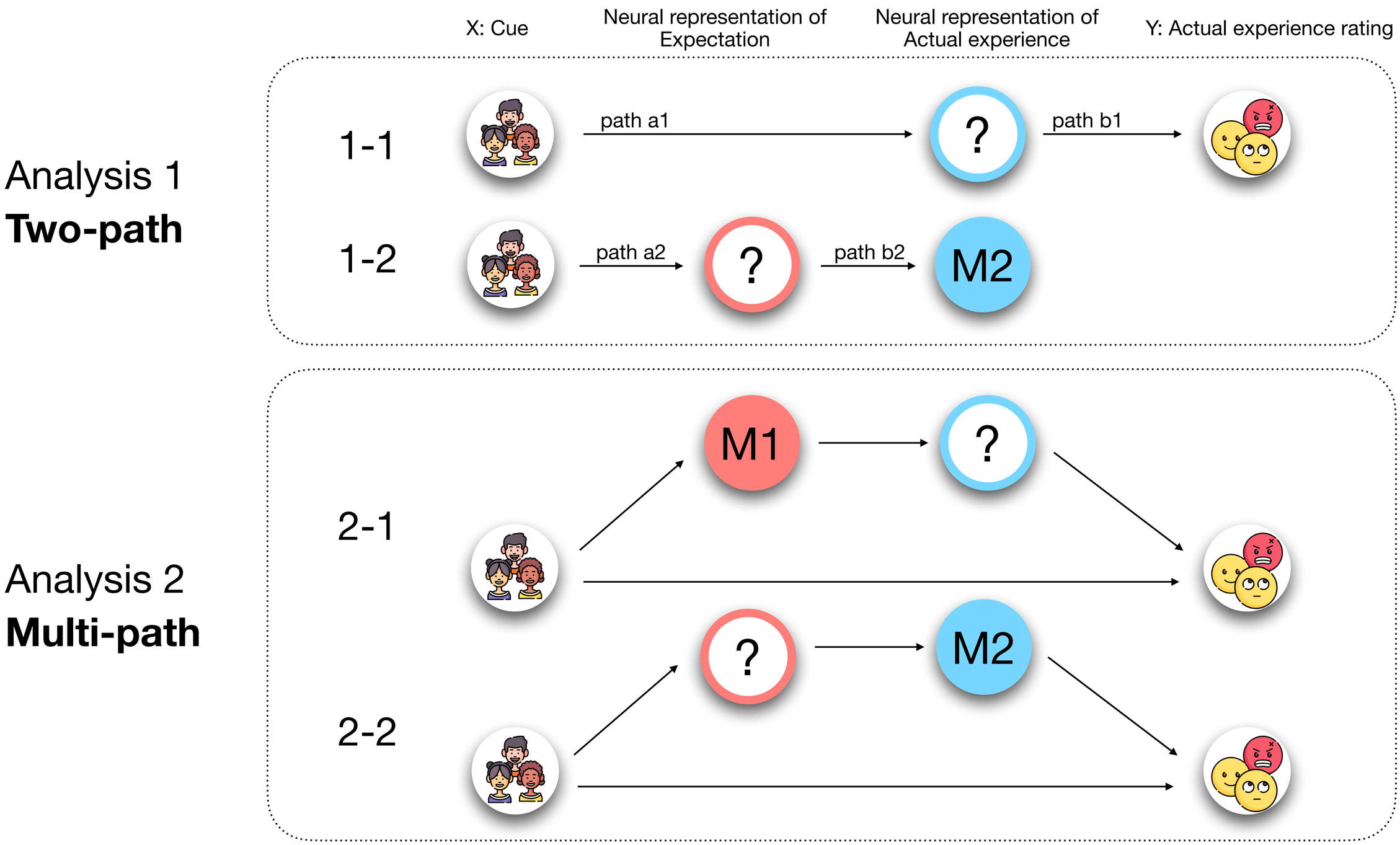
$$\therefore ab = \textit{indirect effect (mediation)}$$

Two-path mediation



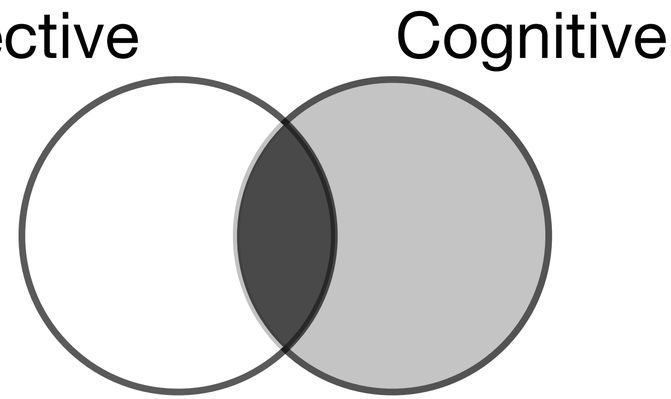
Multi-path mediation




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

Main questions

“Within-subject”



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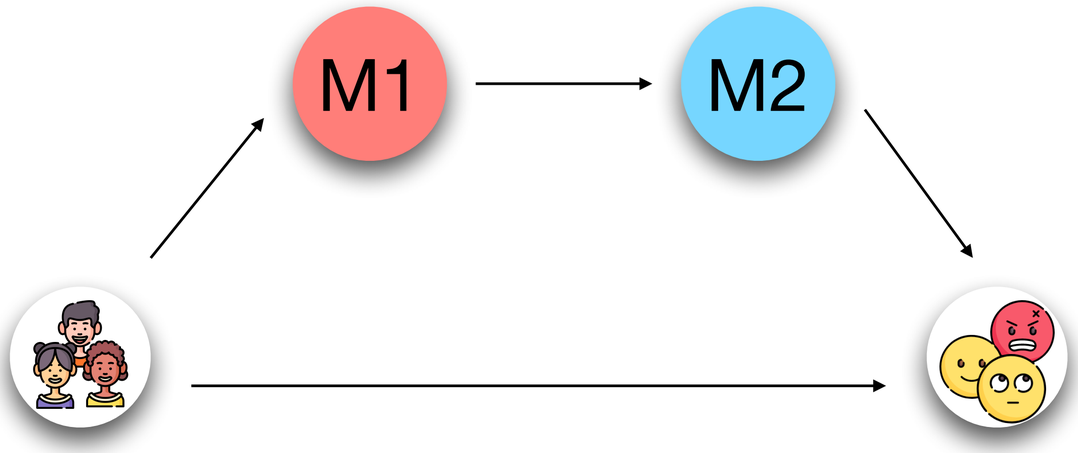
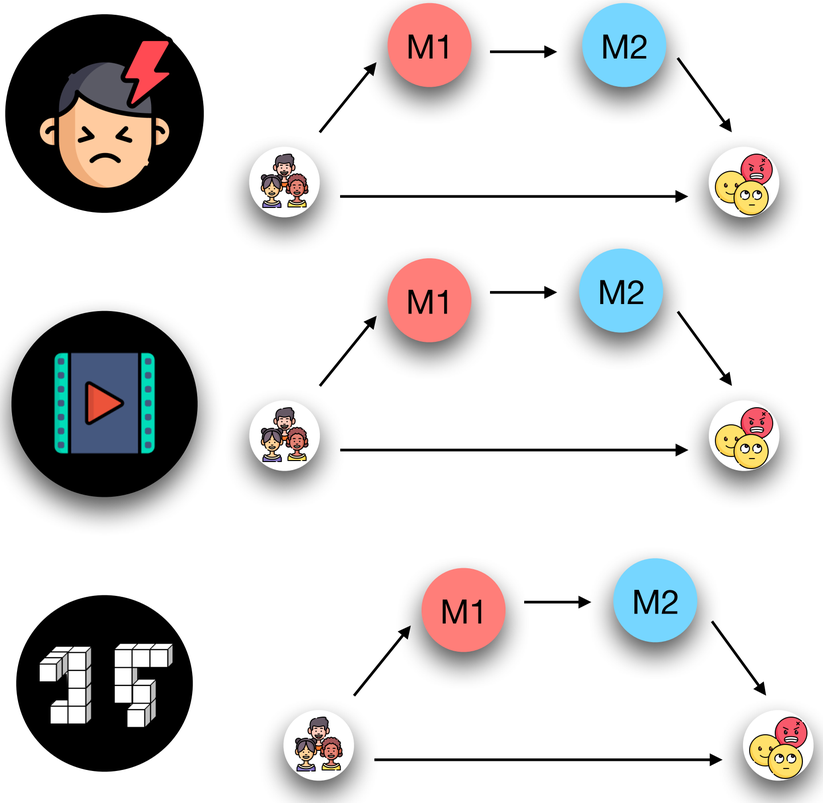
Domain-general

Include all PVC trials



Domain-specific

Include P, V, C trials respectively



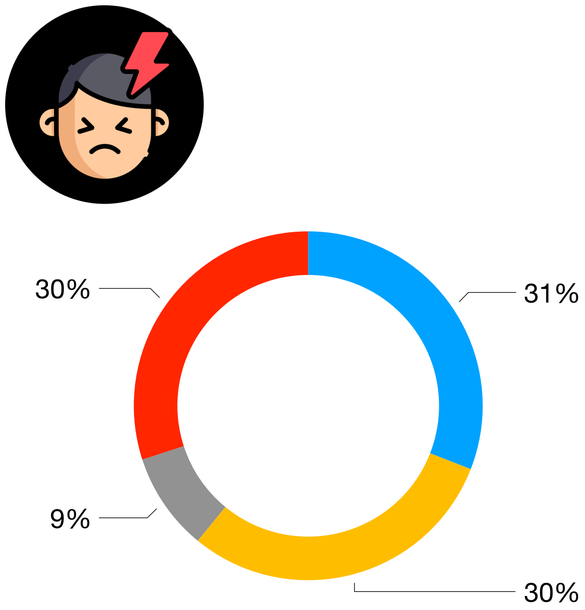
1. Multi-path Mediation

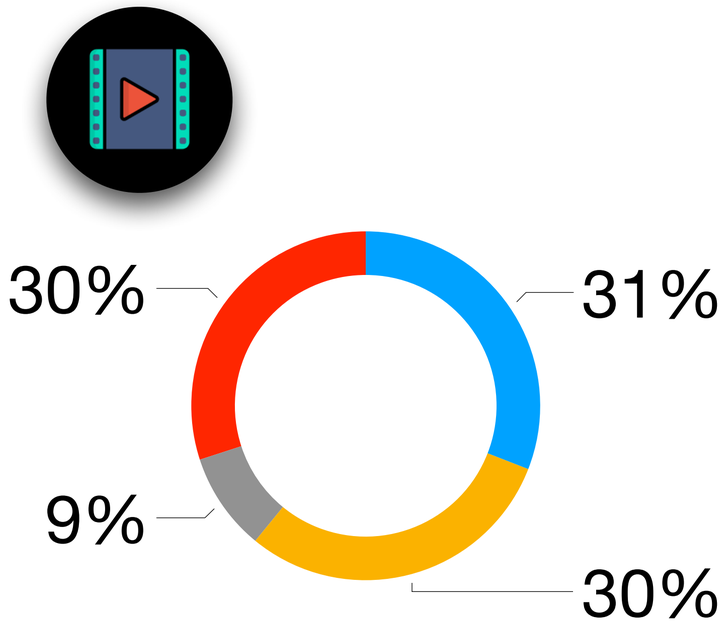
- Univariate vs. multivariate
- Domain-general vs. domain-specific

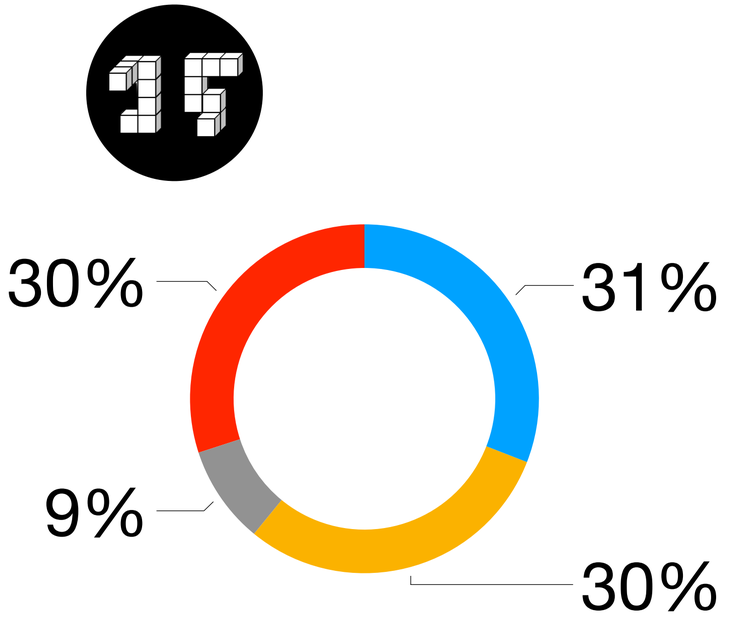
2. Variance decomposition

Variance decomposition

Actual Ratings = β0 + β1 domain-general + β2 domain-specific







Pre-registration

2) transformations

Additional Transformations

Spline fit

- Different stimuli lead to different hemodynamic responses
- Fitting a canonical HRF can be misleading

- **Hyperalignment mappers**
  - Using the 90 minutes of align videos, create hyper alignment mappers
  - Compare hyperalignment vs. anatomical alignment

Feedback & Questions