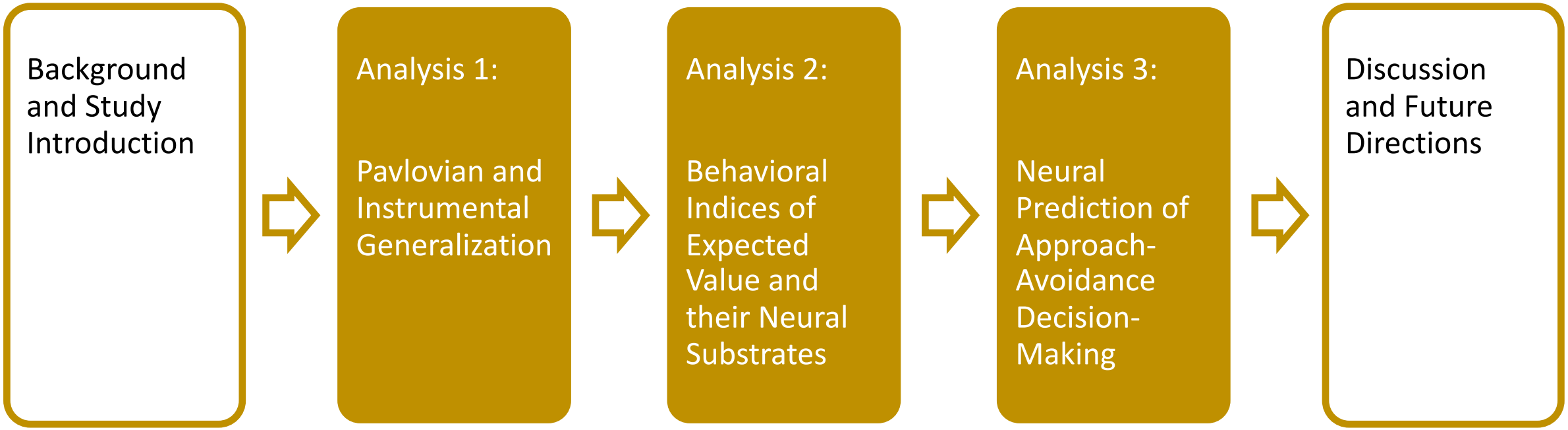
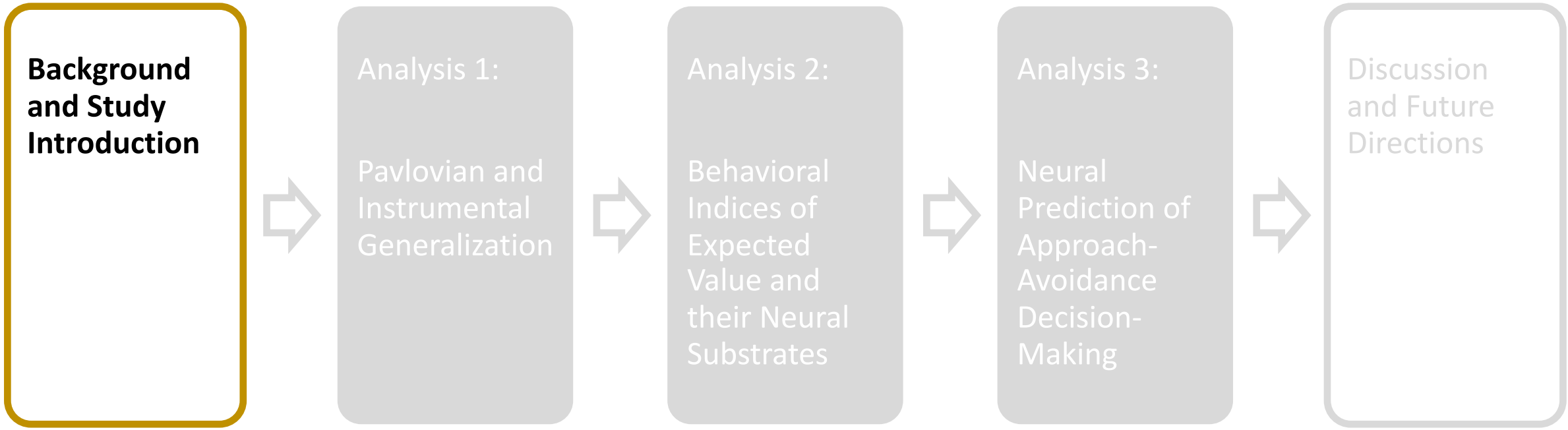
Deciding Which Fears to Face: Behavioral and Neural Mechanisms of Costly Avoidance in Clinical Anxiety

Hannah Berg

Dissertation Defense

June 21st, 2021


Background and Study Introduction
Analysis 1:
Pavlovian and Instrumental Generalization
Analysis 2:
Behavioral Indices of Expected Value and their Neural Substrates
Analysis 3:
Neural Prediction of Approach-Avoidance Decision-Making
Discussion and Future Directions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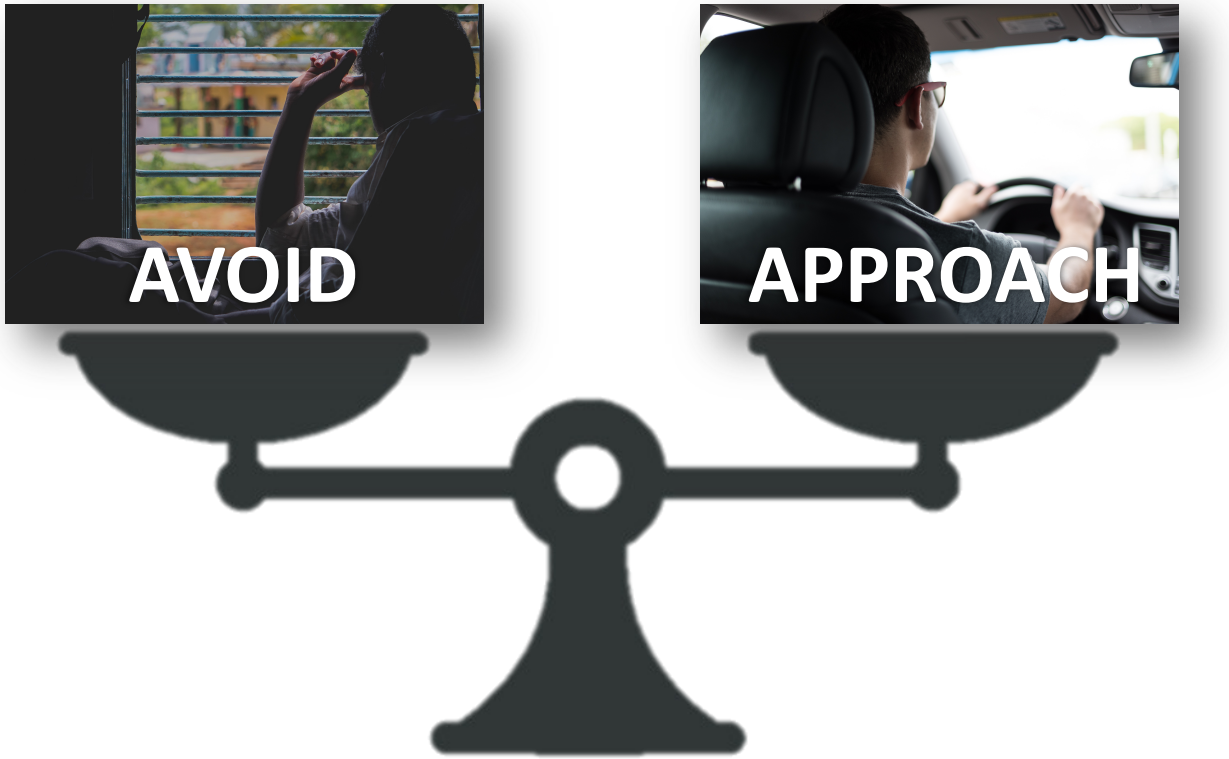
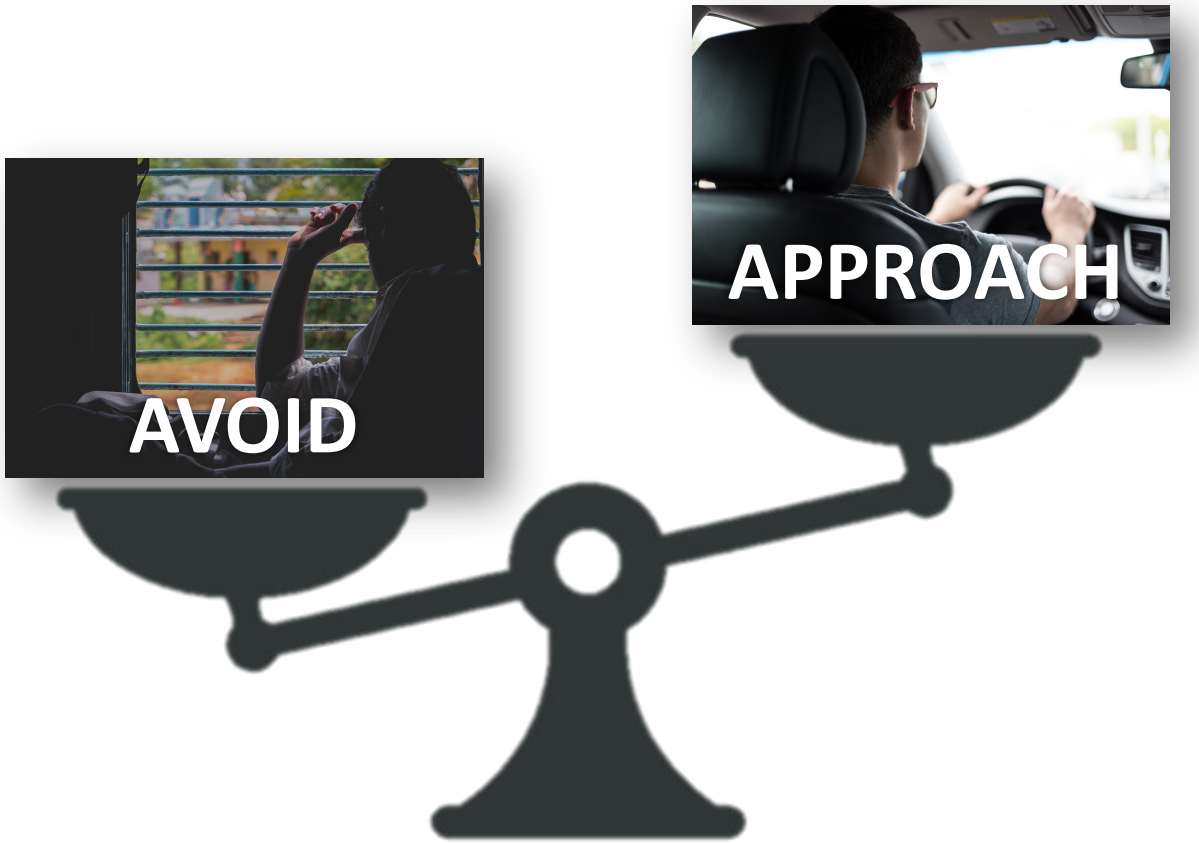
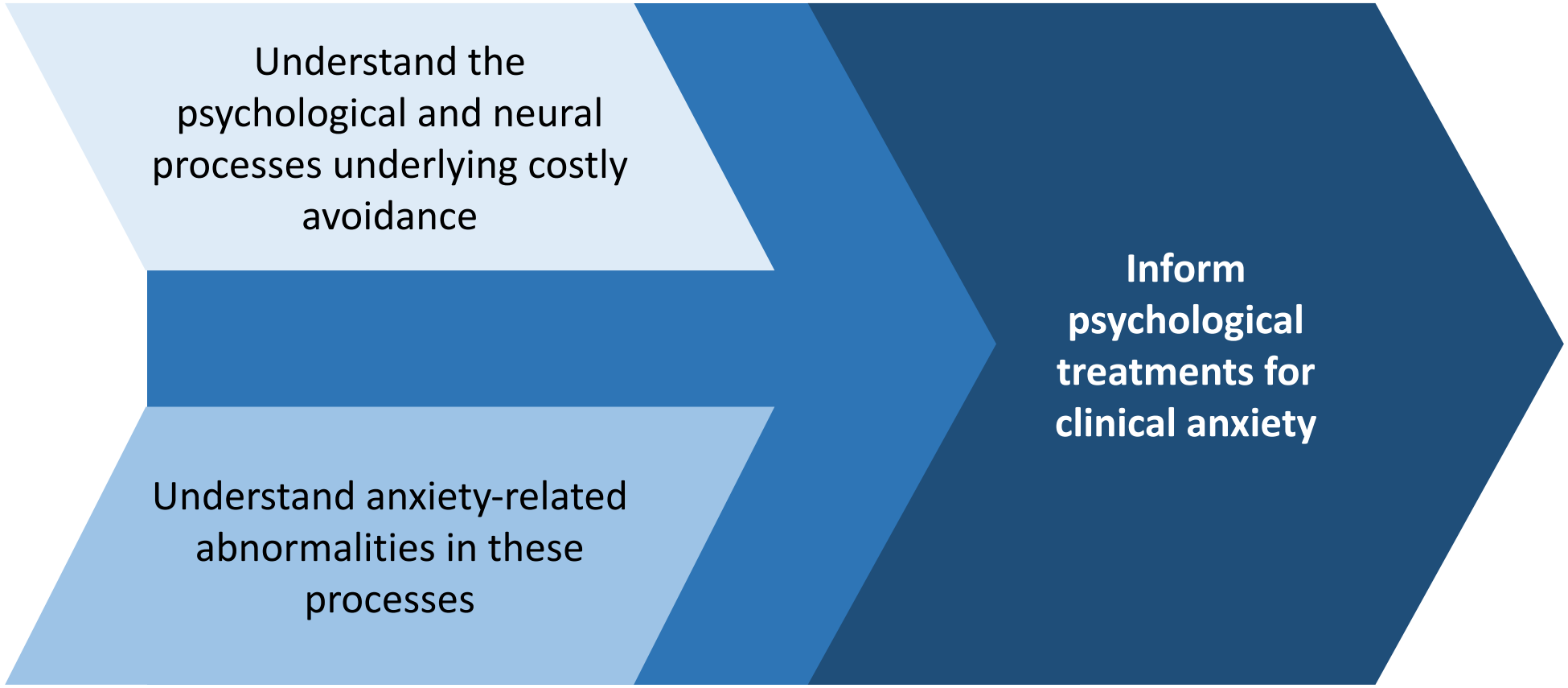
Approach-Avoidance Conflict

Approach-Avoidance Conflict



Threat-Avoidance in Clinical Anxiety

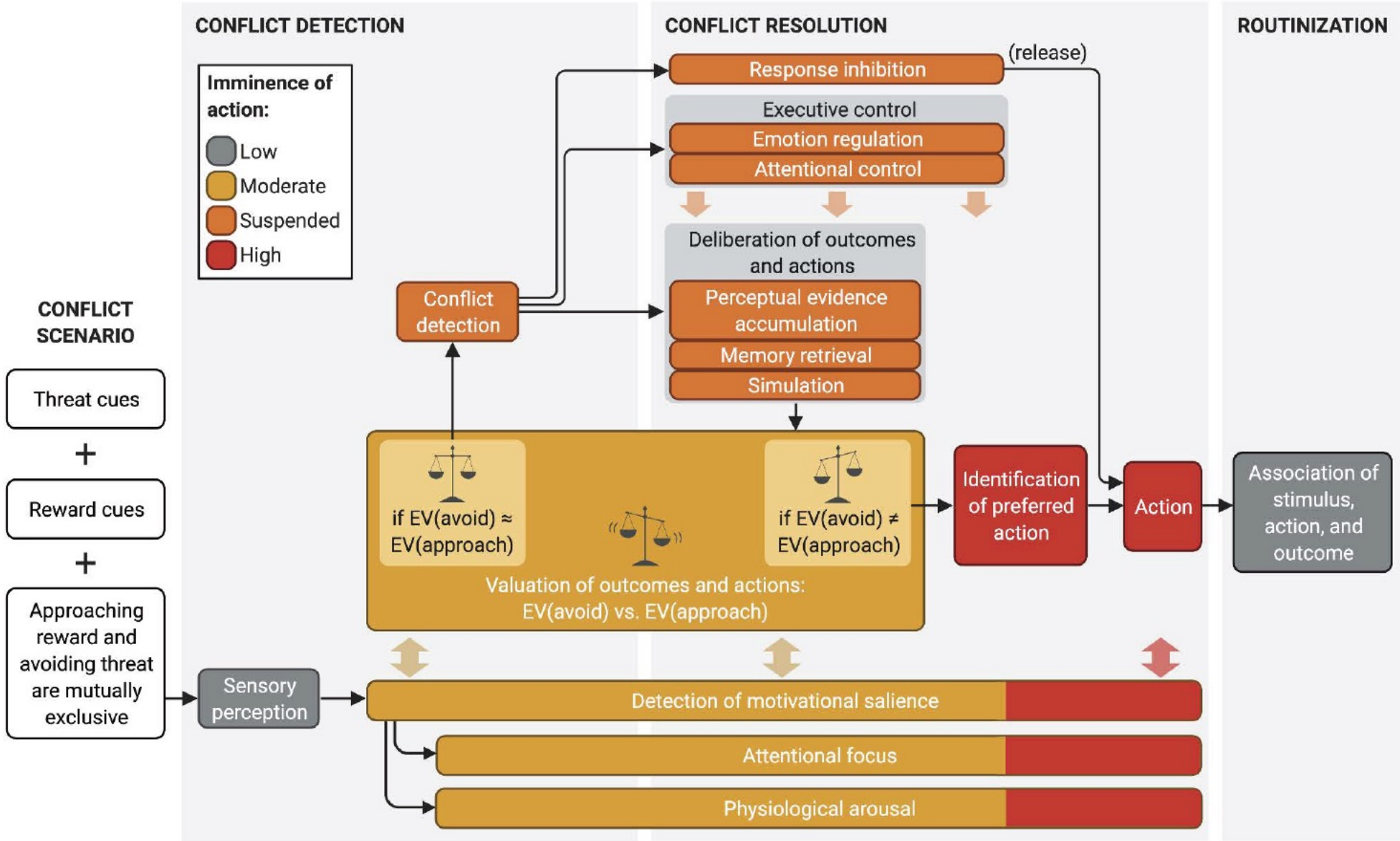



Understand the psychological and neural processes underlying costly avoidance
Understand anxiety-related abnormalities in these processes
Inform psychological treatments for clinical anxiety

Psychological Processes Engaged by Approach-Avoidance Conflict

Perceive stimuli → **Deliberate** → **Act**

Psychological Processes Engaged by Approach-Avoidance Conflict



Specific Questions

1. What are the neural and psychological processes that underlie initial responding to threat-related cues?

effects of anxiety

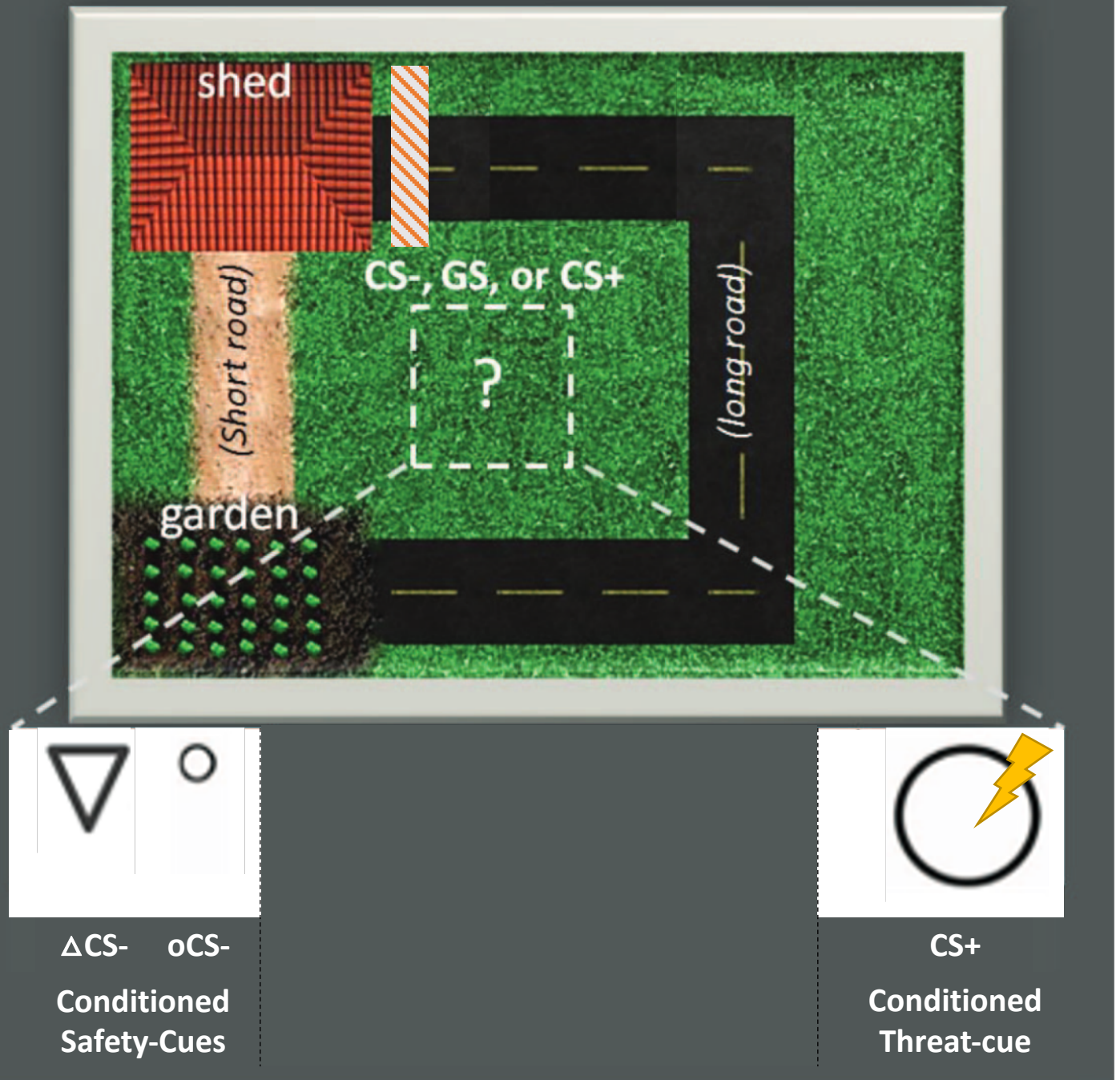
2. How are the expected values of various outcomes and options computed during deliberation, and how does this influence choice?

effects of anxiety

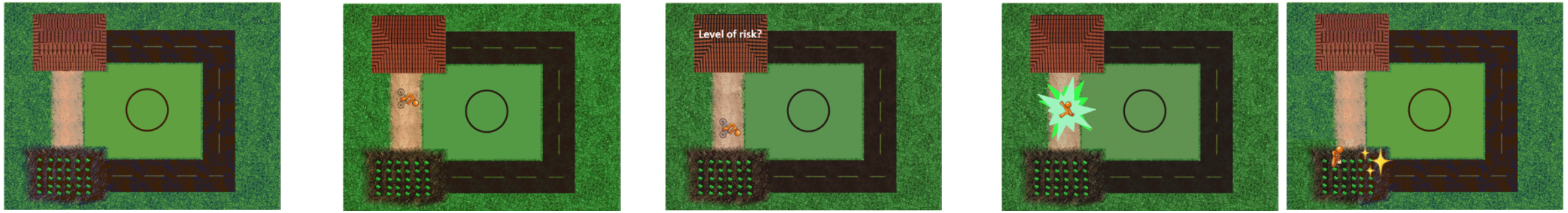
3. What deliberative brain processes are most predictive of choice?

effects of anxiety

Study Introduction

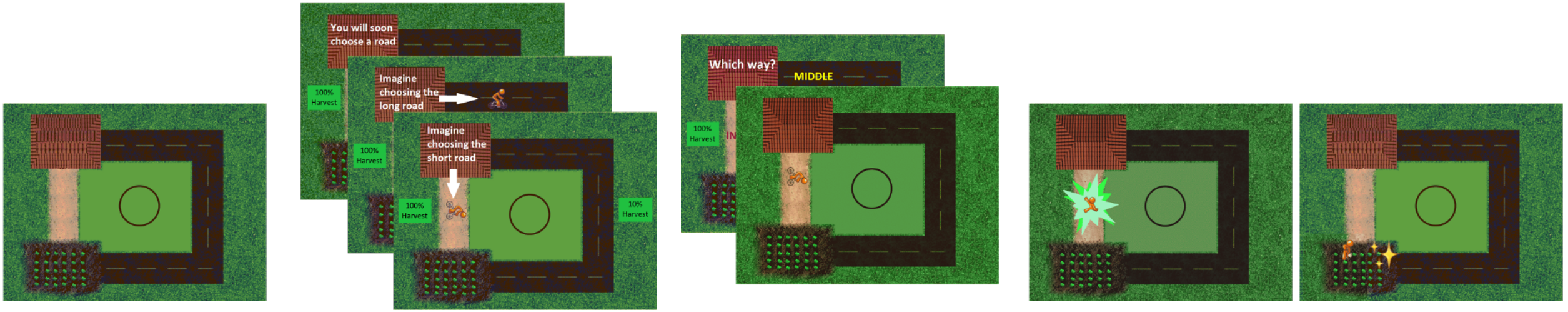


No-Choice Trial



Stimulus Onset → Passive Travel → Risk Rating → Outcome
(shock, win, both, or neither)

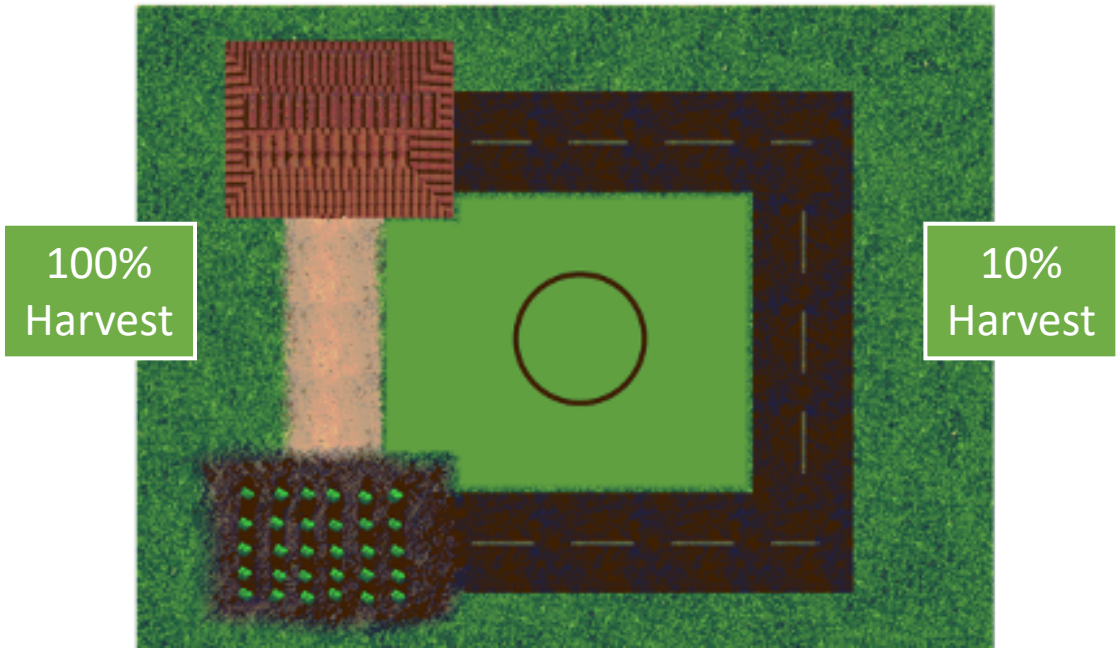
Choice Trial



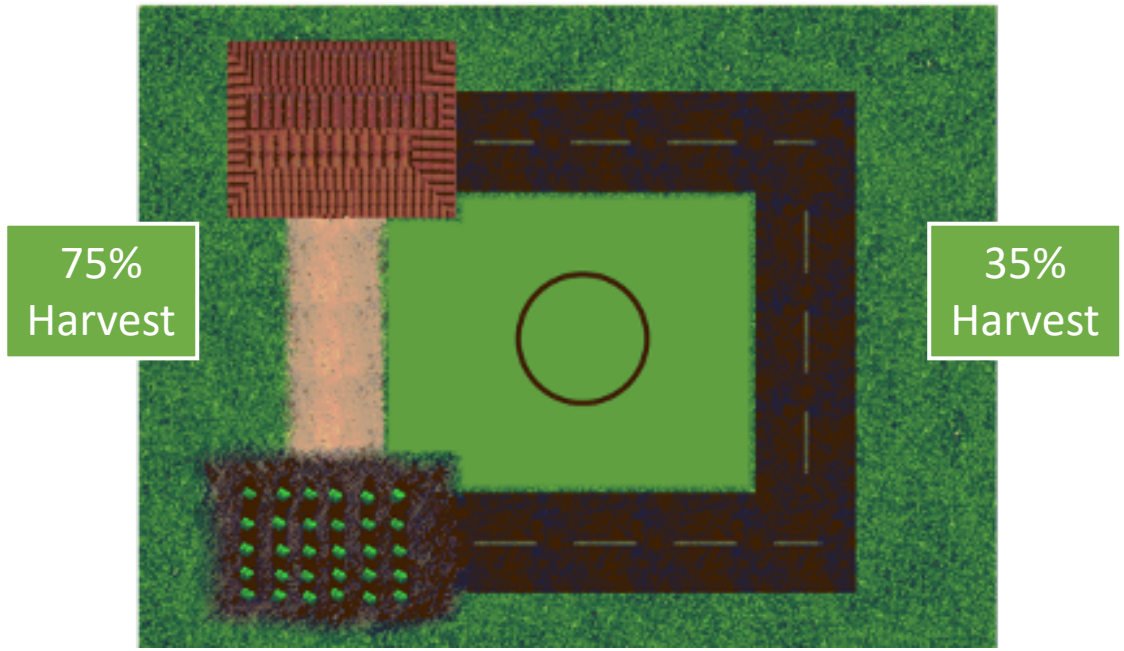
Stimulus Onset → Prepare to Choose → Choose & Travel → Outcome
(shock, win, both, or neither)

Instrumental Trial Types

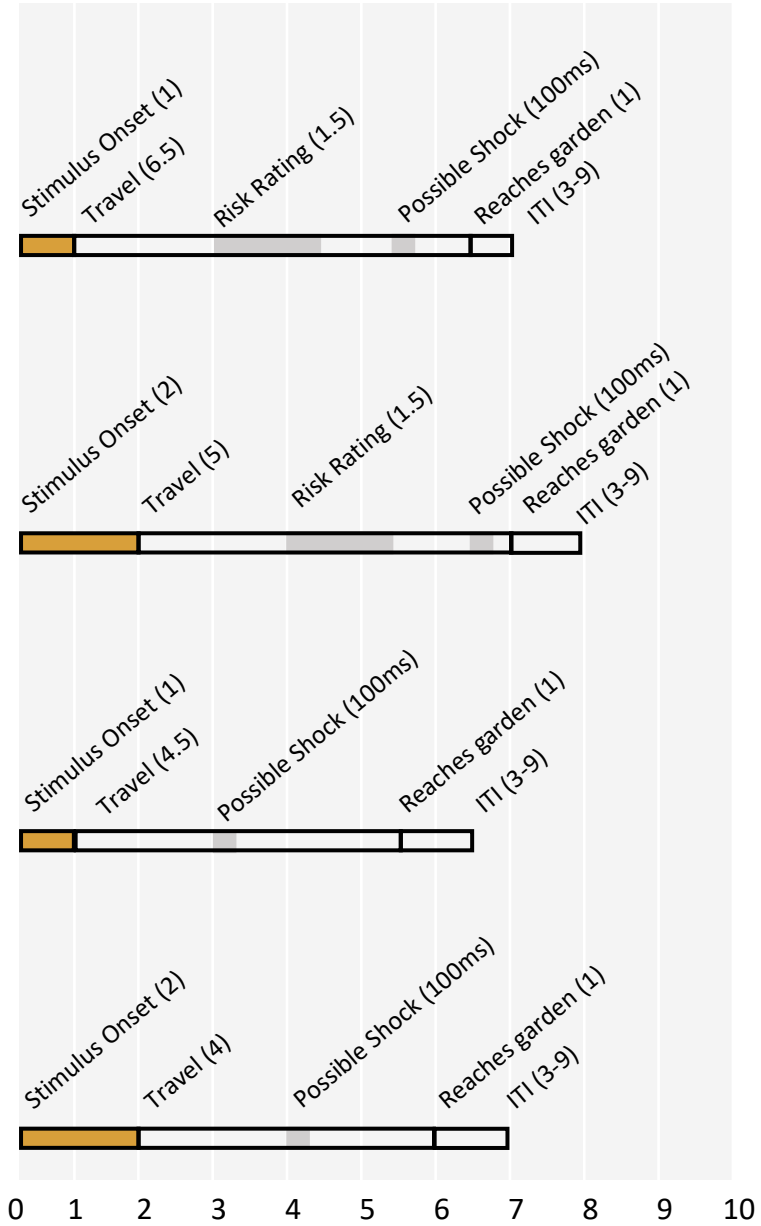
Certain Win



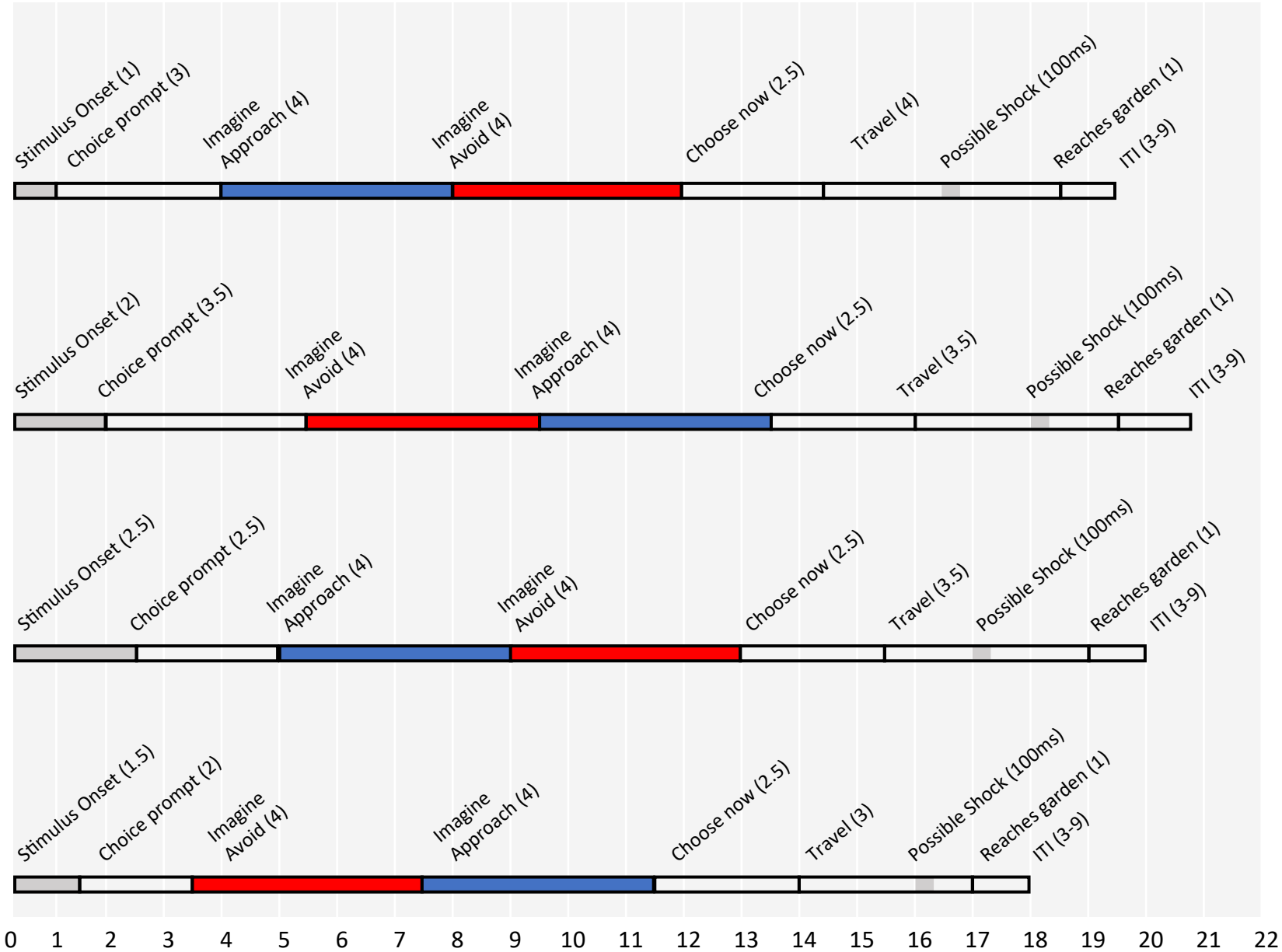
Uncertain Win



No-Choice Trials



Choice Trials



Data Collection and Analysis

Procedure

- Clinical interview
- Questionnaires
- Shock workup
- Farmer task during fMRI

fMRI Acquisition

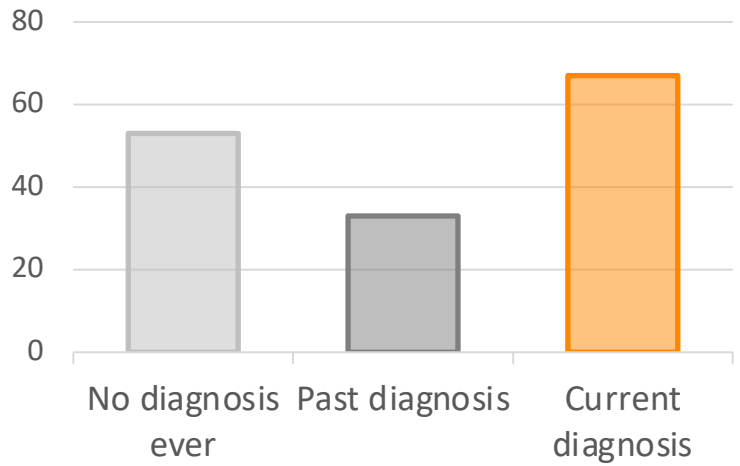
- 3T Siemens MAGNETOM Prisma with 32-channel head/neck coil
- T2*-weighted EPIs (2mm resolution, multiband sequence, whole brain, axial slices, TR: 1500ms)
- T1-weighted MP-RAGE sequences (1.0 mm sagittal slices; TR=2300ms)

fMRI Analysis

- Warp anatomical images to MNI space with AFNI's SSwarper
- Register functional volumes to warped anatomical

Participants

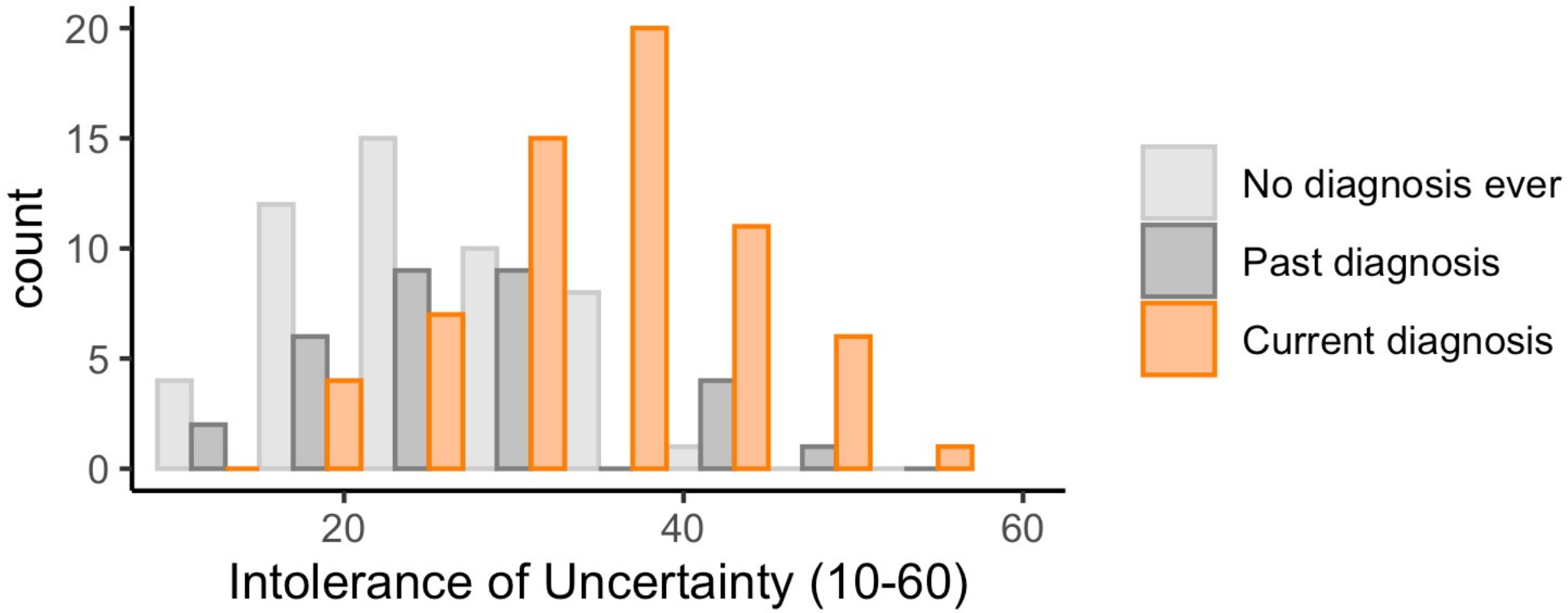
	Full Sample: n=153
Any Current Anxiety-Related Dx	67 (43.79%)
Current Generalized Anxiety Disorder	27 (17.65%)
Current Post-Traumatic Stress Disorder	18 (11.76%)
Current Social Anxiety Disorder	22 (14.38%)
Current Obsessive-Compulsive Disorder	7 (4.58%)
Current Specific Phobia	9 (5.88%)
Current Comorbid Major Depressive Disorder	16 (10.46%)
Current Comorbid Dysthymia	7 (4.58%)
No Psychiatric Dx Ever	53 (34.64%)

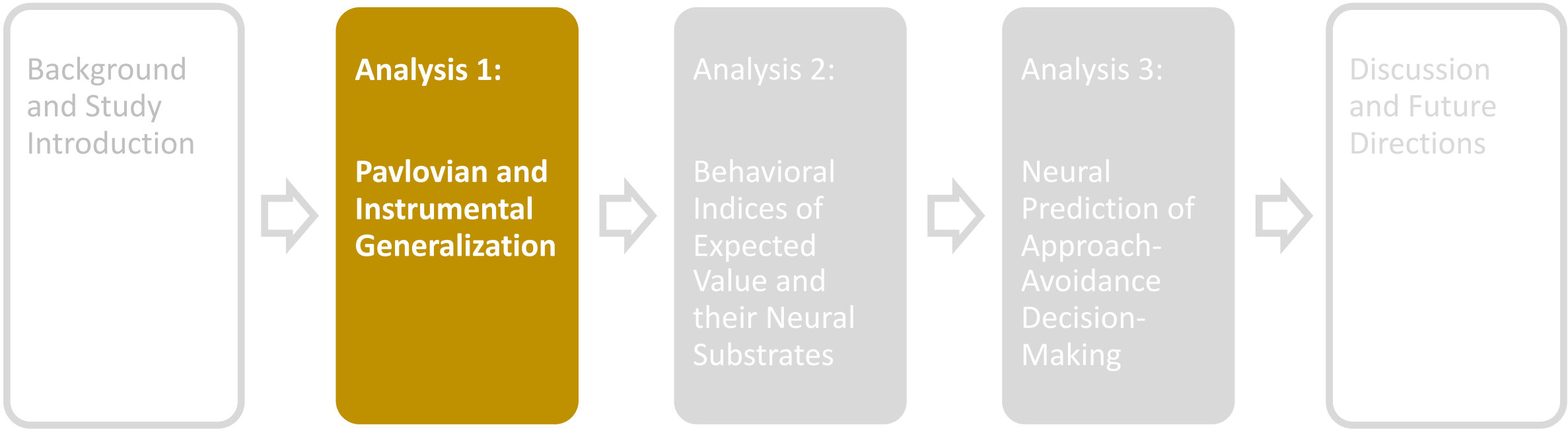


Intolerance of Uncertainty

Intolerance of Uncertainty Scale – Short Form (Carleton et al., 2007)

”Unforeseen events upset me greatly”
”One should always look ahead so as to avoid surprises”
“The smallest doubt can stop me from acting”

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Analysis 1

Behavioral Index of Pavlovian Fear

Neural Indices of Pavlovian Fear

- Standard fMRI preprocessing: slice-time correction and spatial smoothing
- GLM with AFNI's 3dDeconvolve
  - IVs: Task events
  - Covariates: baseline drift, 6 motion parameters, timecourse of shock delivery
- Group analysis with AFNI's 3dttest++
  - CS+ vs. △CS- contrast

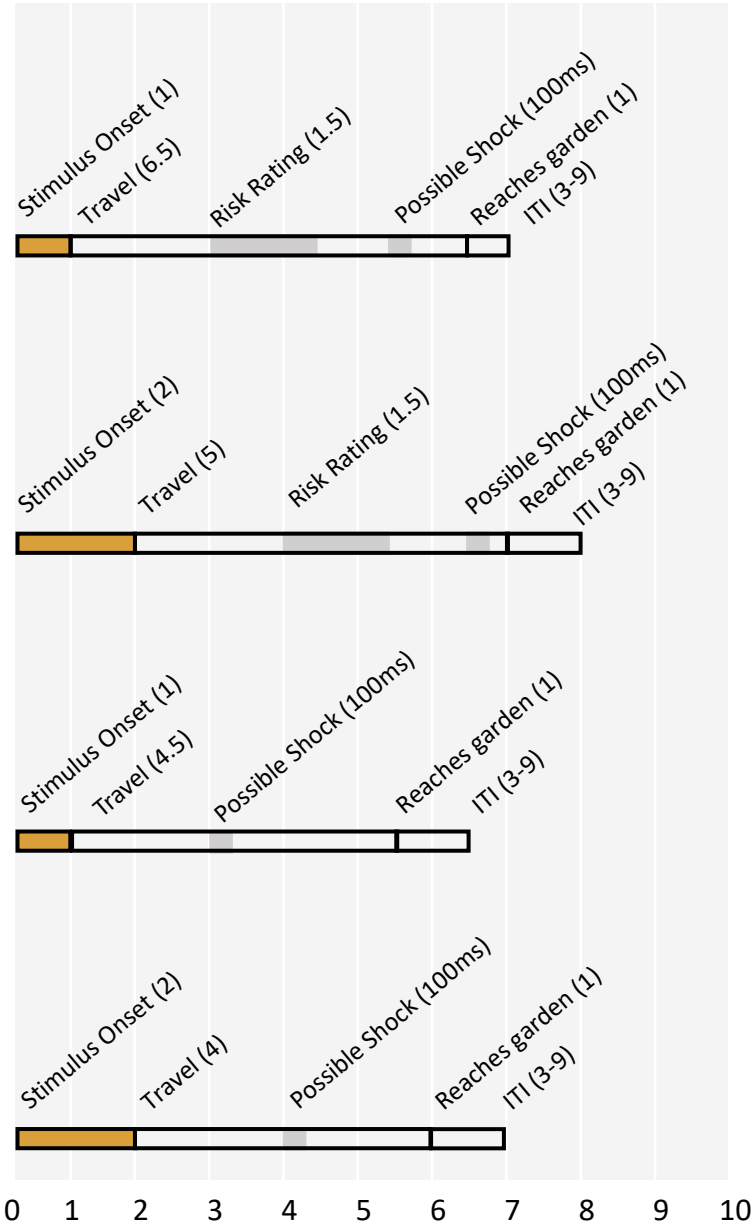
Instrumental Avoidance

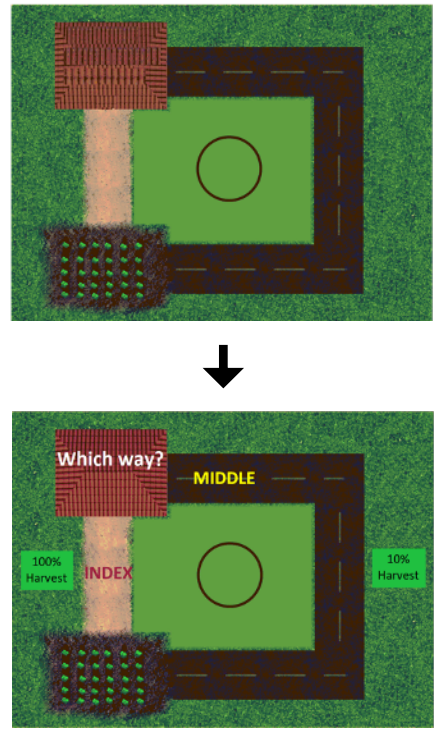
Assessing Generalization

- Compare Pavlovian and instrumental responding across stimuli

Assessing Pavlovian-Instrumental Covariation

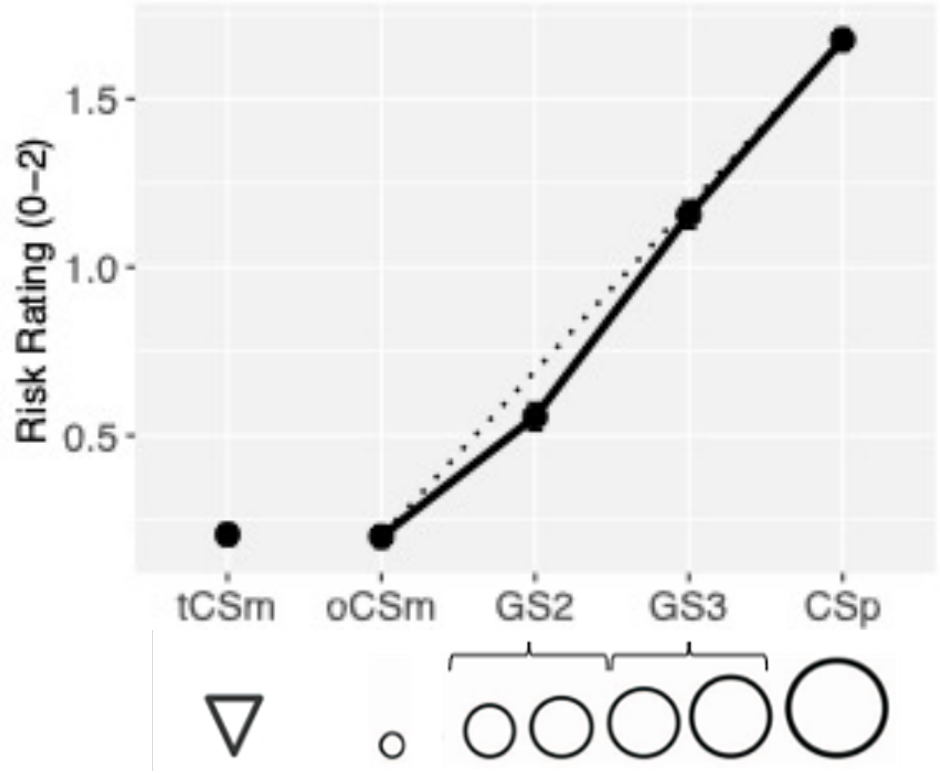
- Assess association of Pavlovian fear with avoidance





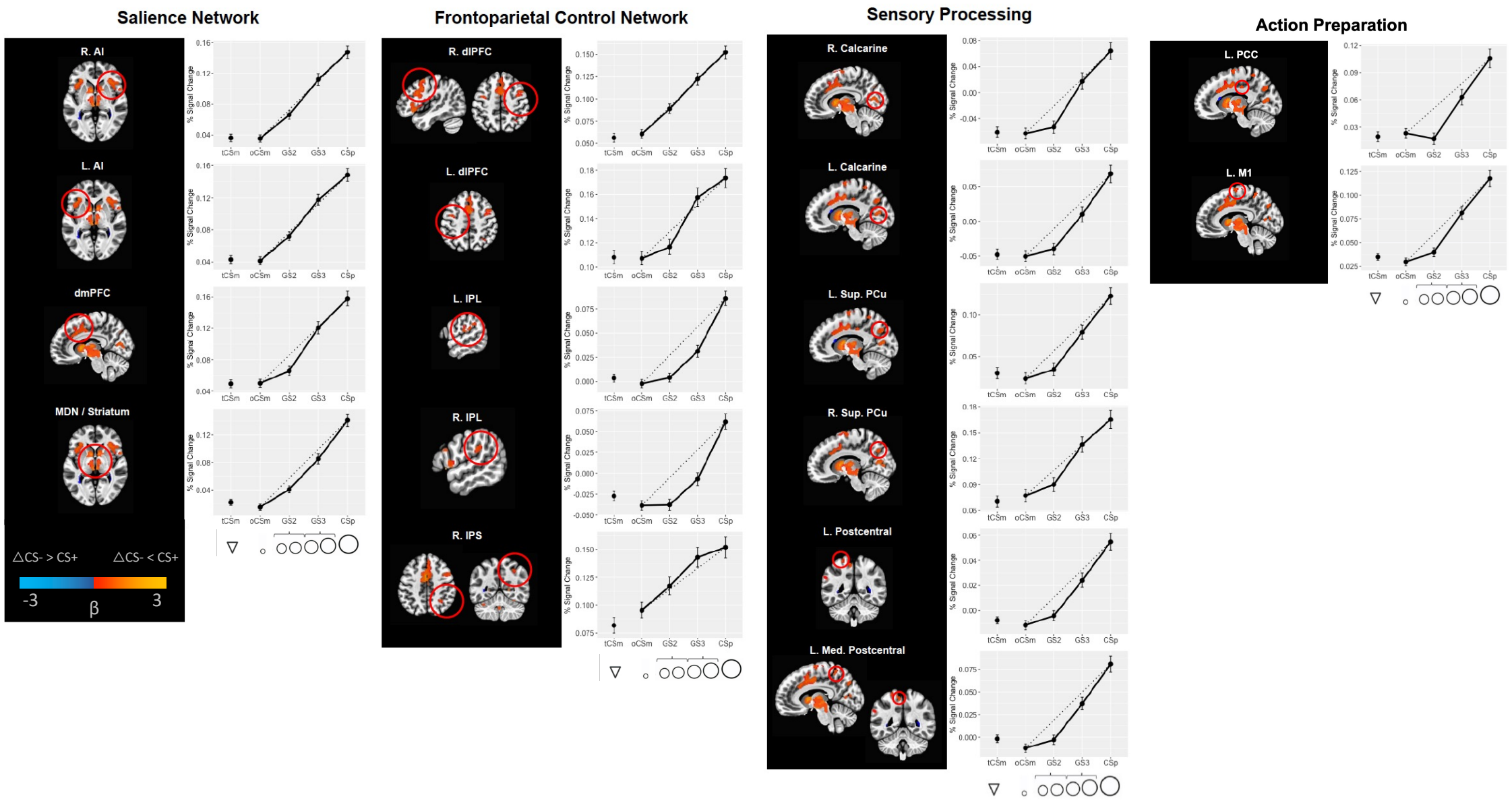
Analysis 1

Generalization of Conditioned Shock-Expectancy



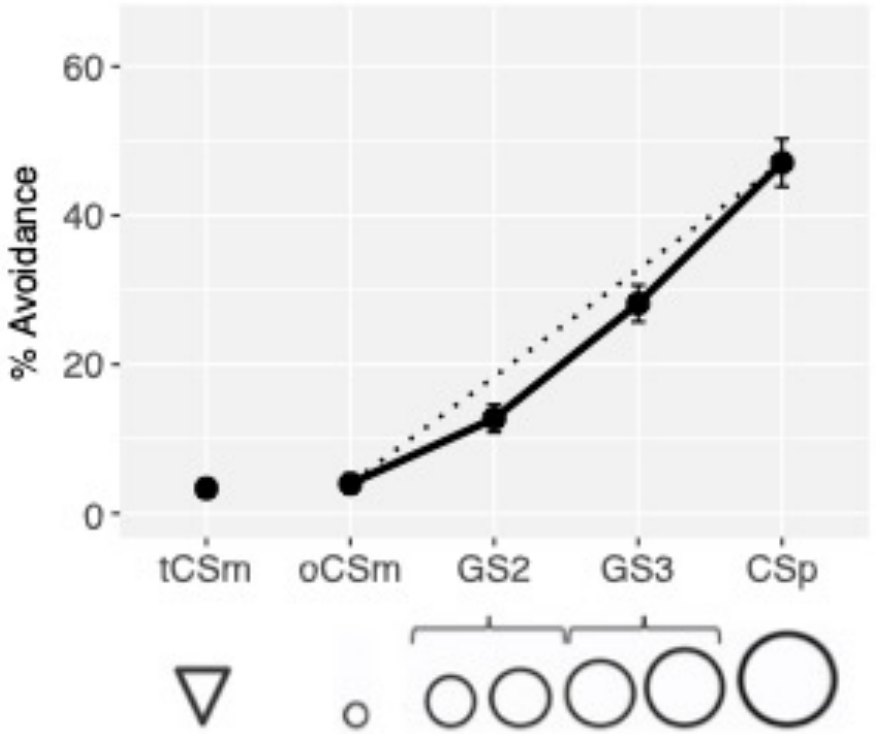
Analysis 1

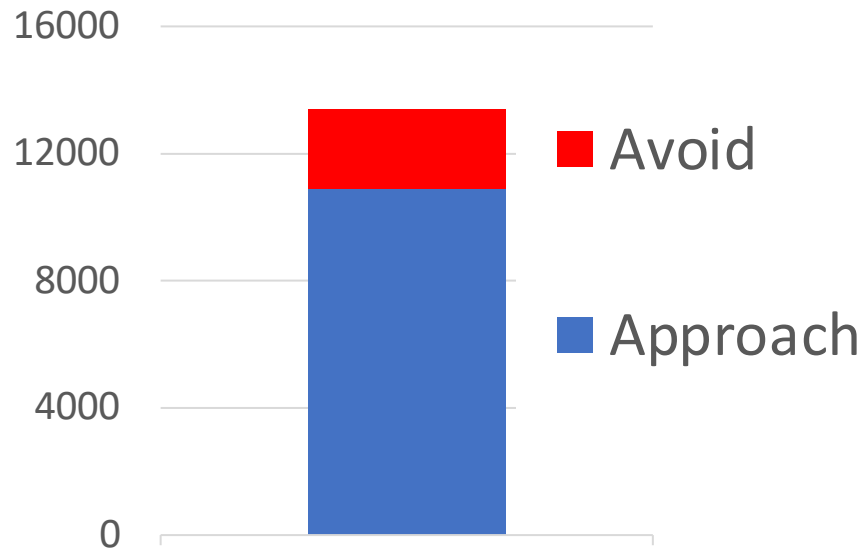
Neural Substrates of Pavlovian Fear



Analysis 1

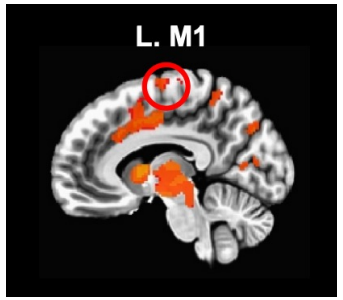
Instrumental Avoidance

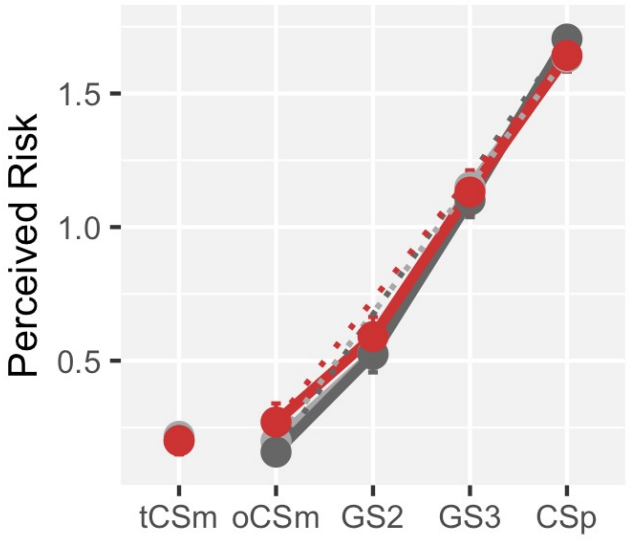


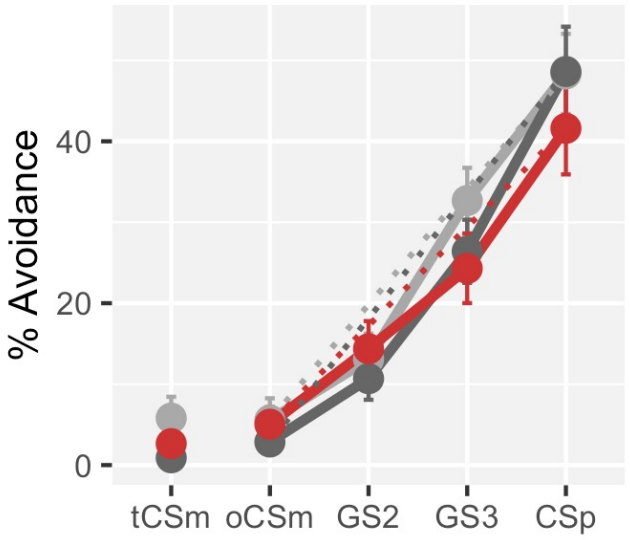


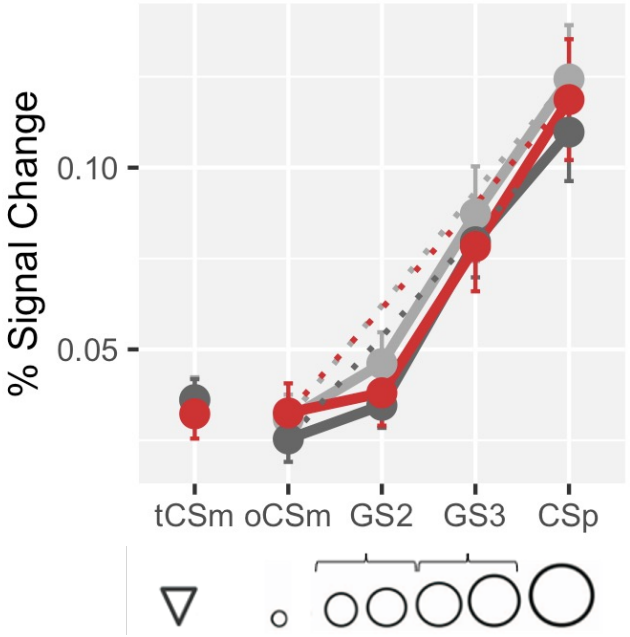
Analysis 1

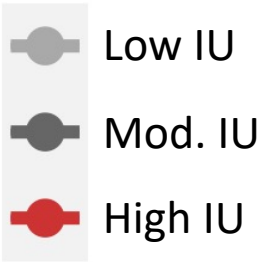
Effects of Intolerance of Uncertainty





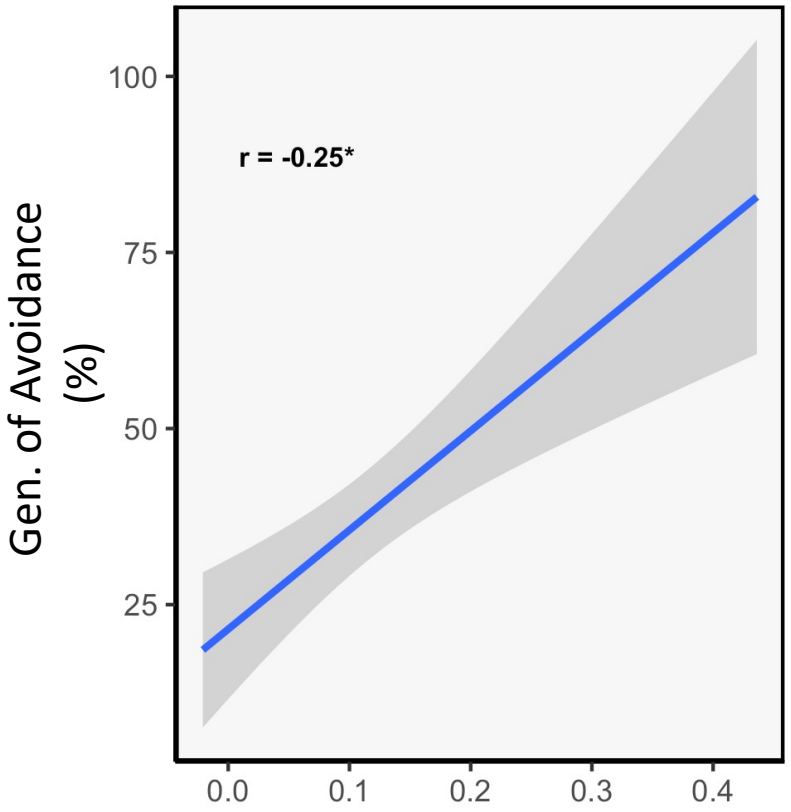


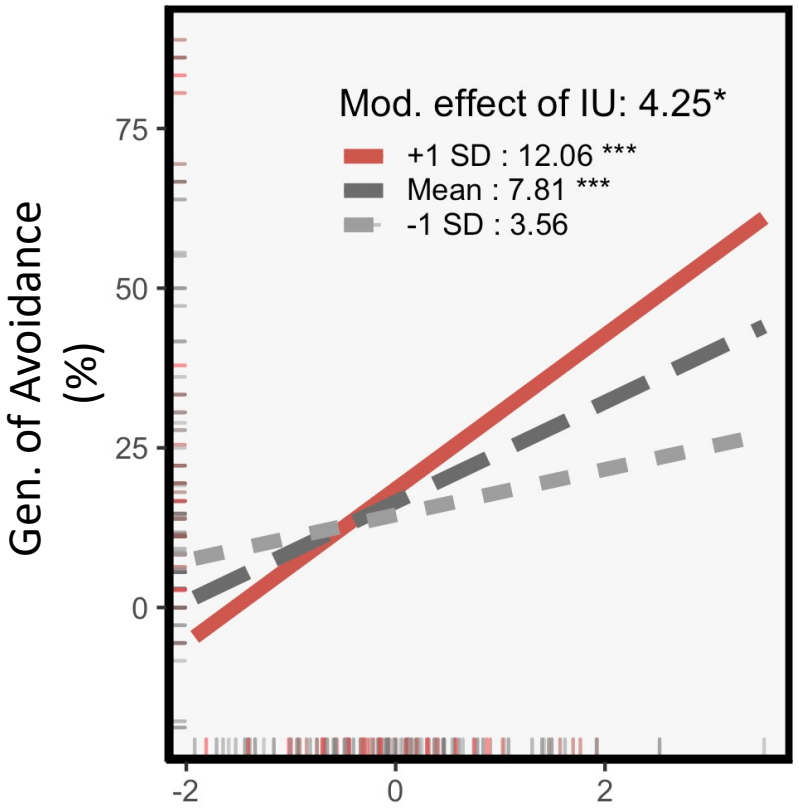




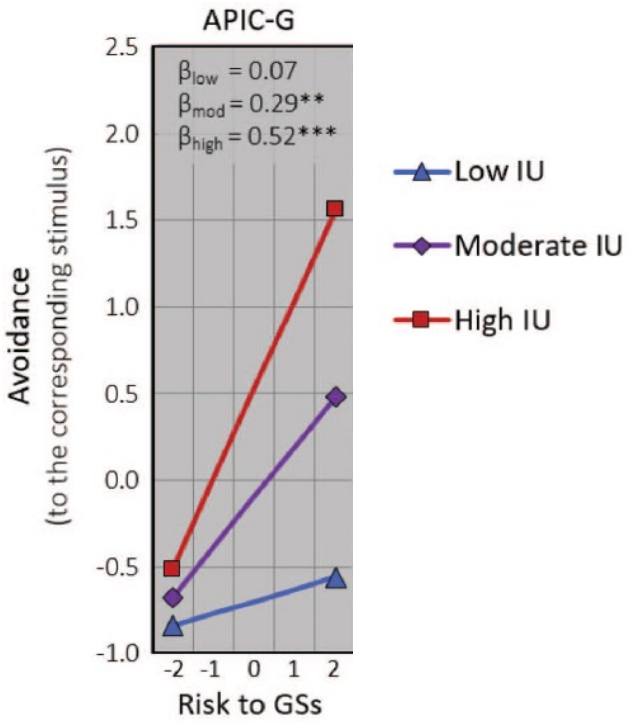
Analysis 1

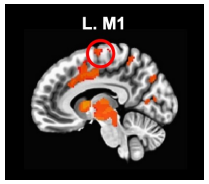
Pavlovian-Instrumental Covariation





Hunt et al., 2018:

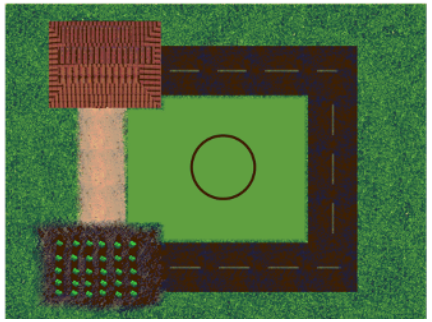




Analysis 1

Interpretation of Results

Approach-avoidance conflict:



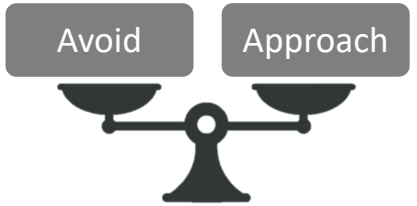
Low IU:

Initial fear excitation

Other processes

Avoidance motivation

Avoidance decision



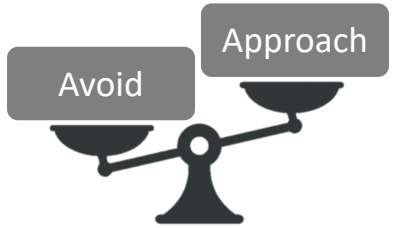
High IU:

Initial fear excitation

Other processes

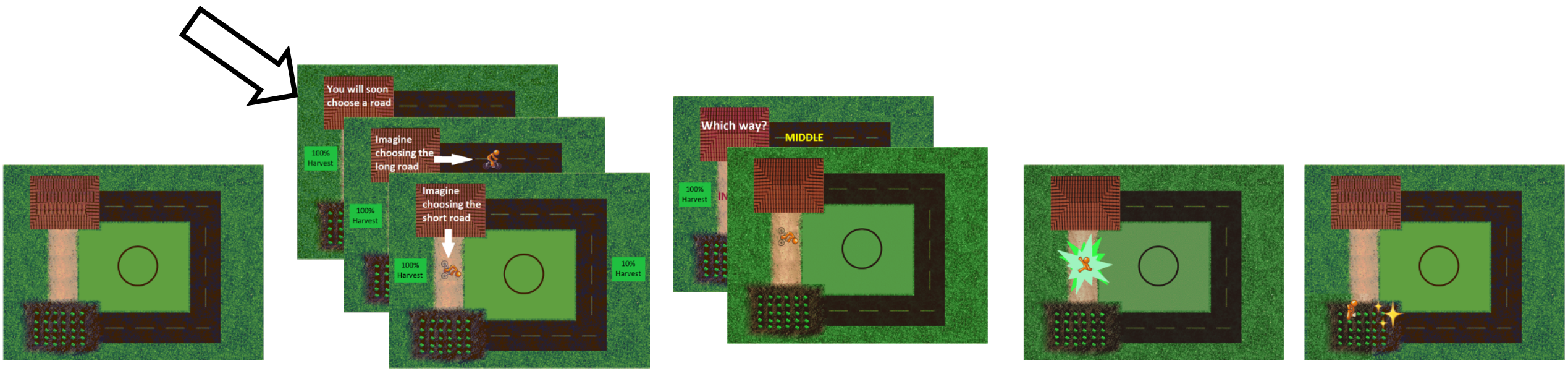
Avoidance motivation

Avoidance decision

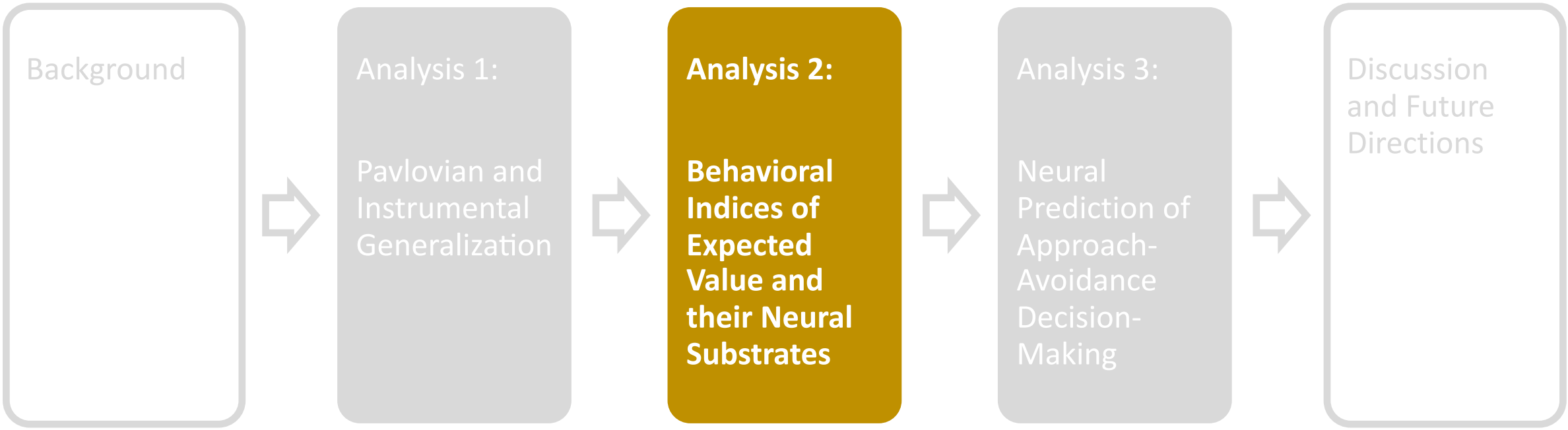


Analysis 1

Perceive stimuli → **Deliberate** → **Act**



Stimulus Onset → Prepare to Choose → Choose & Travel → Outcome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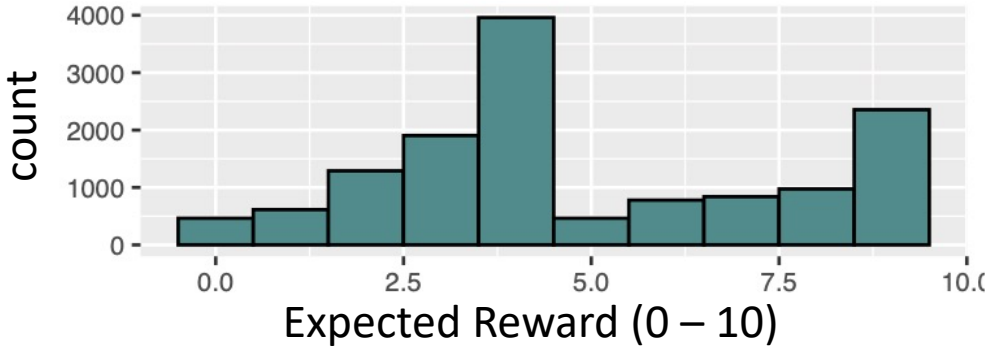
Analysis 2

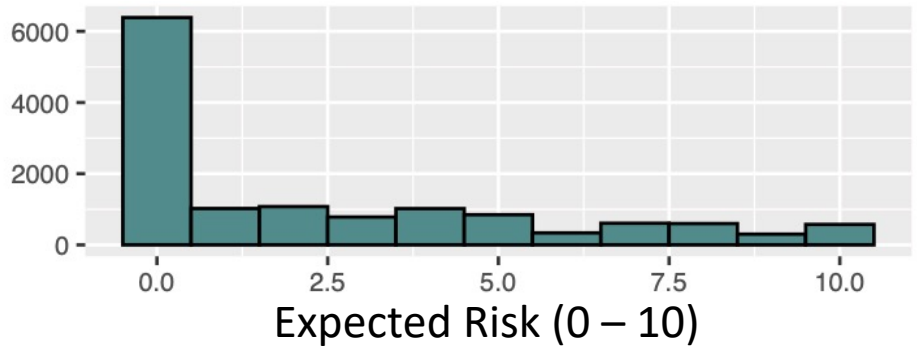
Computing Expected Value

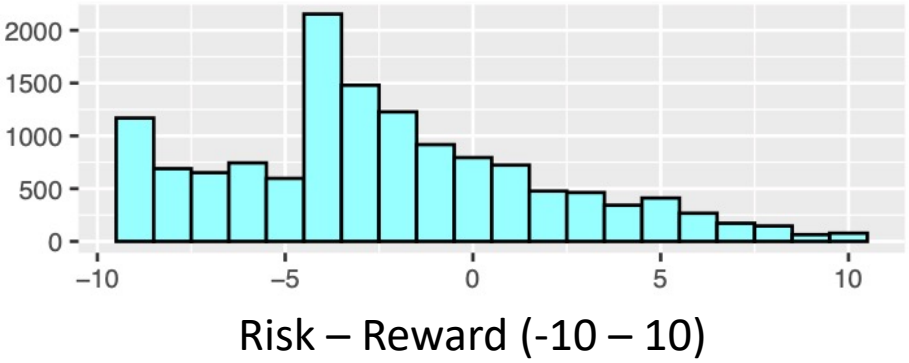
Expected Value	Expected Value = Value * Probability
Expected Value for an action	Expected Value (action) = Value (outcome) * Probability (outcome | action)
Expected Value for an action relative to another action	Expected Value (action A) = Value (outcome) * [Probability (outcome | action A) - Probability (outcome | action B)]
Expected Value for an action in the present experiment	Expected Risk (approach) = Value(shock) * [Probability (shock | approach) - Probability (shock | avoid)] Expected Reward (approach) = Value(win) * [Probability (win | approach) - Probability (win | avoid)]

Analysis 2

Distributions of Expected Value Parameters

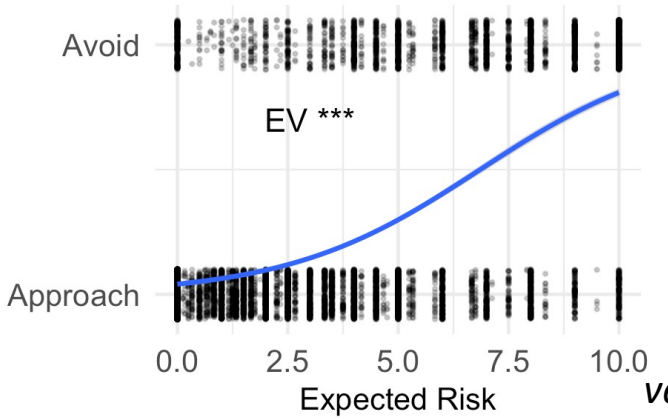




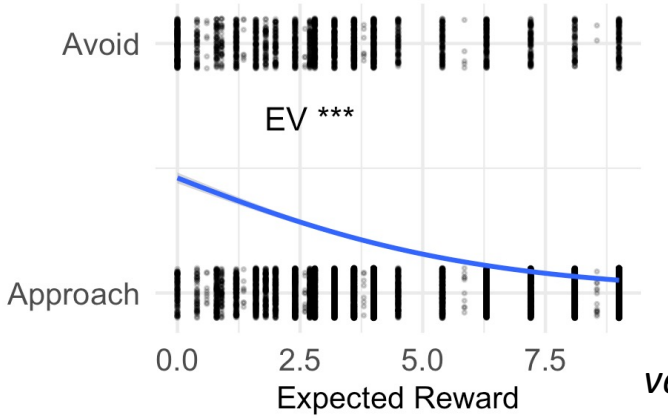


Analysis 2

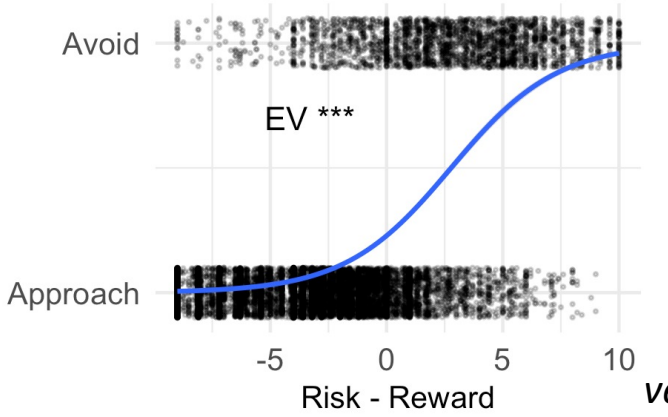
Logistic Effects of Expected Value on Choice



very risky

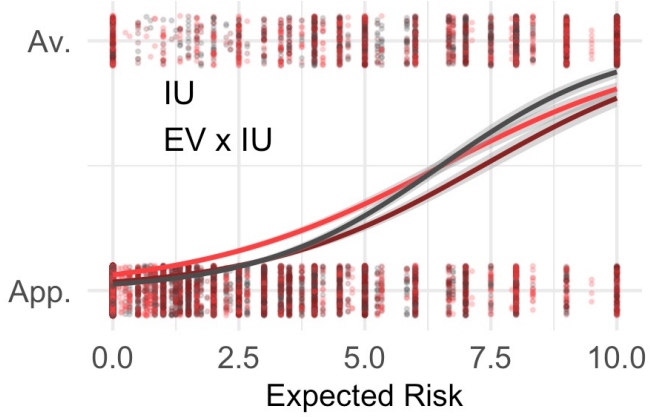


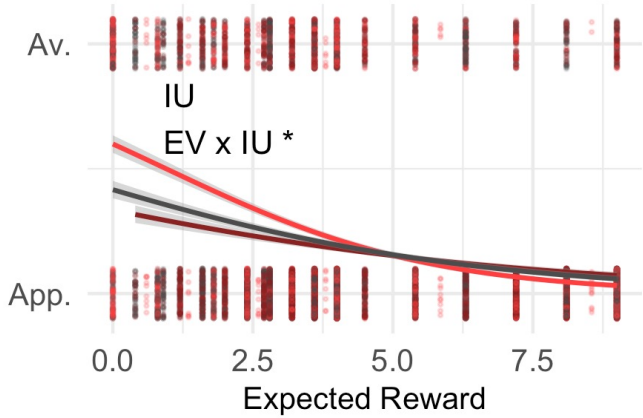
very rewarding

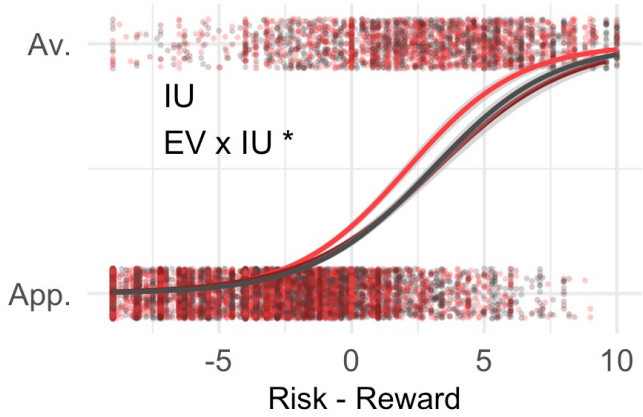


very risky, no reward

Effects of Expected Value and Intolerance of Uncertainty on Choice







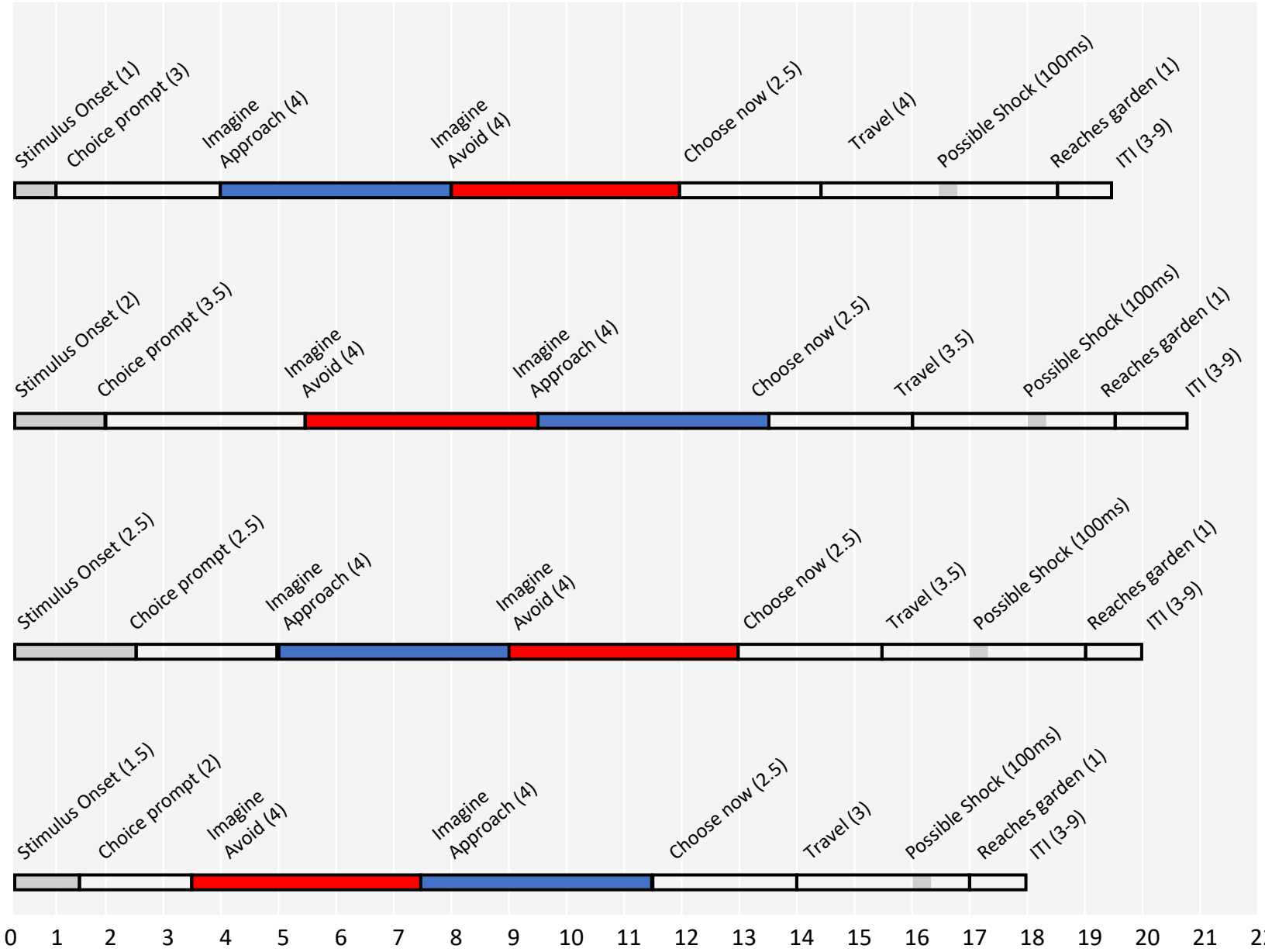
High IU

Moderate IU

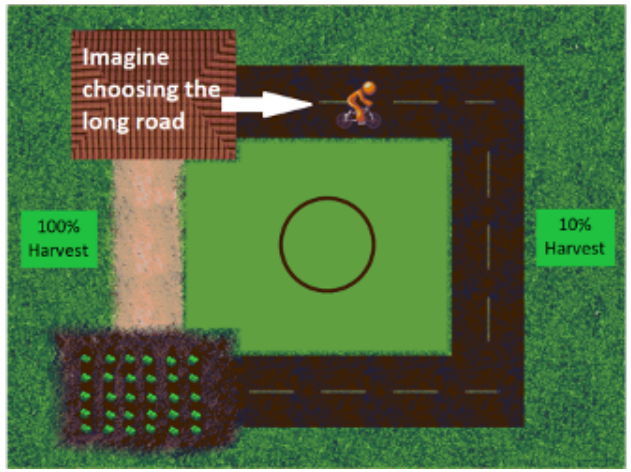
Low IU

Analysis 2

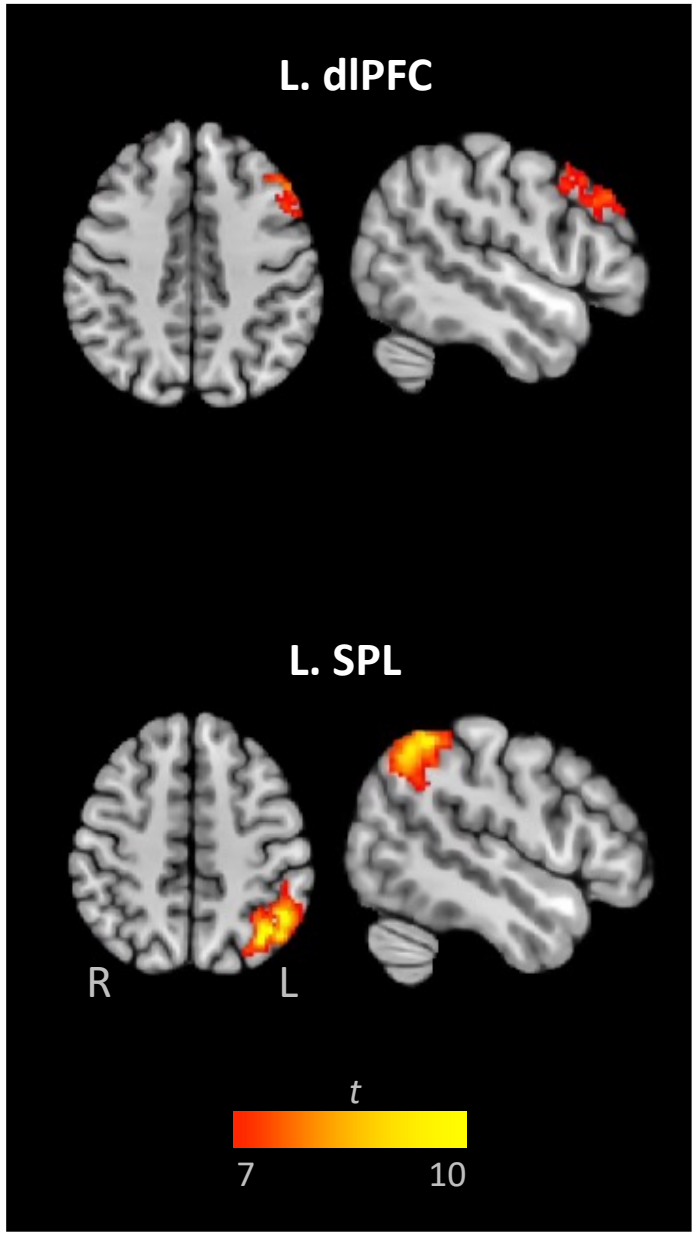
Neural Substrates of Expected Value



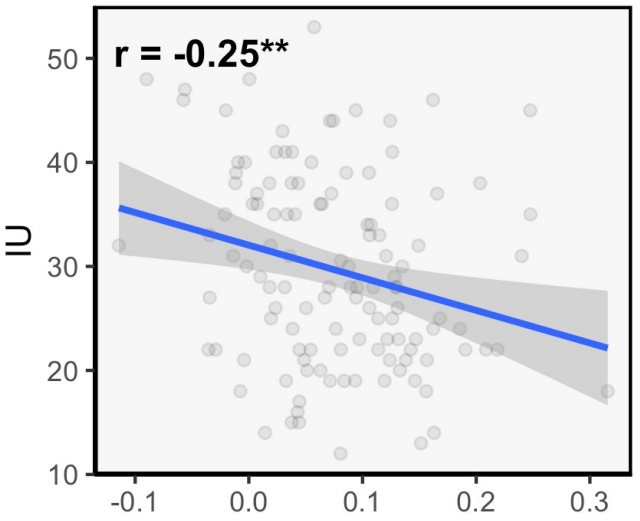
Analysis 2



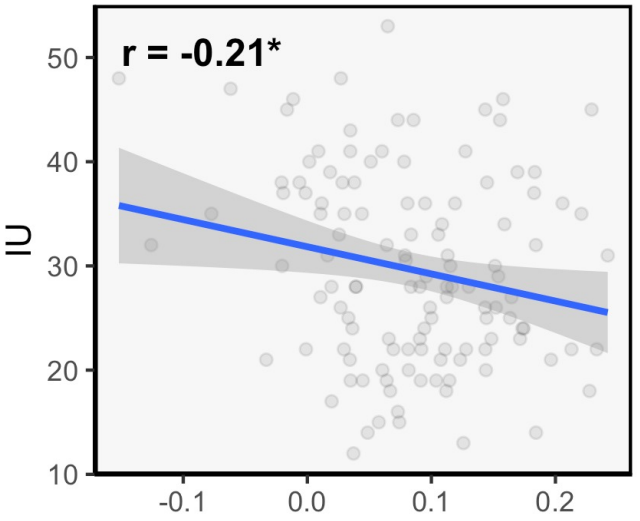
Neural Substrates of Expected Risk



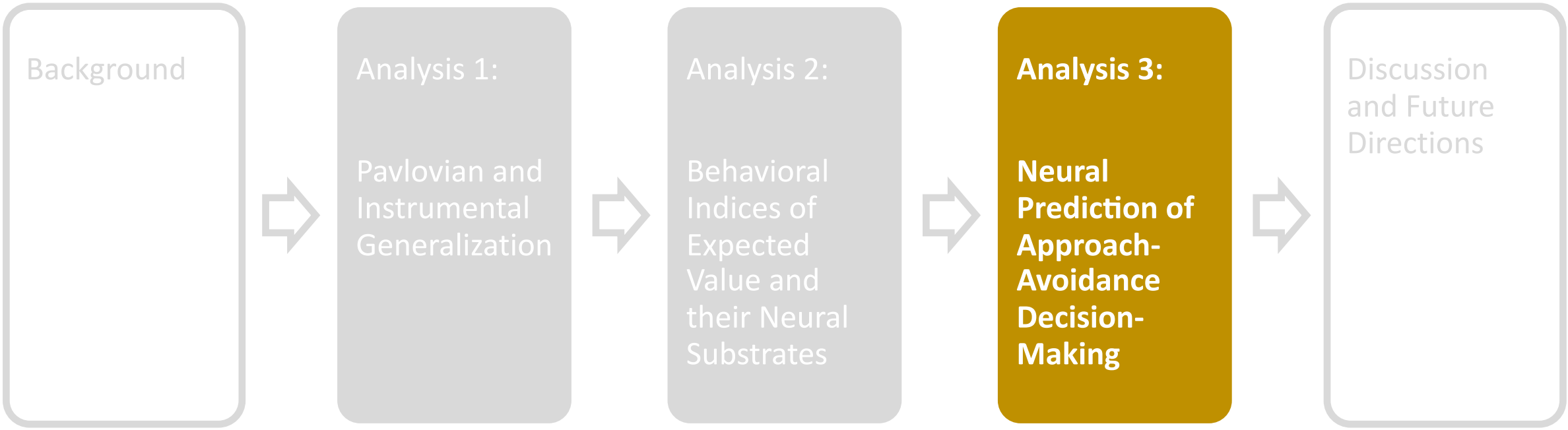
Effects of Intolerance of Uncertainty



Association of L. dlPFC with Expected Risk



Association of L. dlPFC with Expected Risk


Background
Analysis 1:
Pavlovian and Instrumental Generalization
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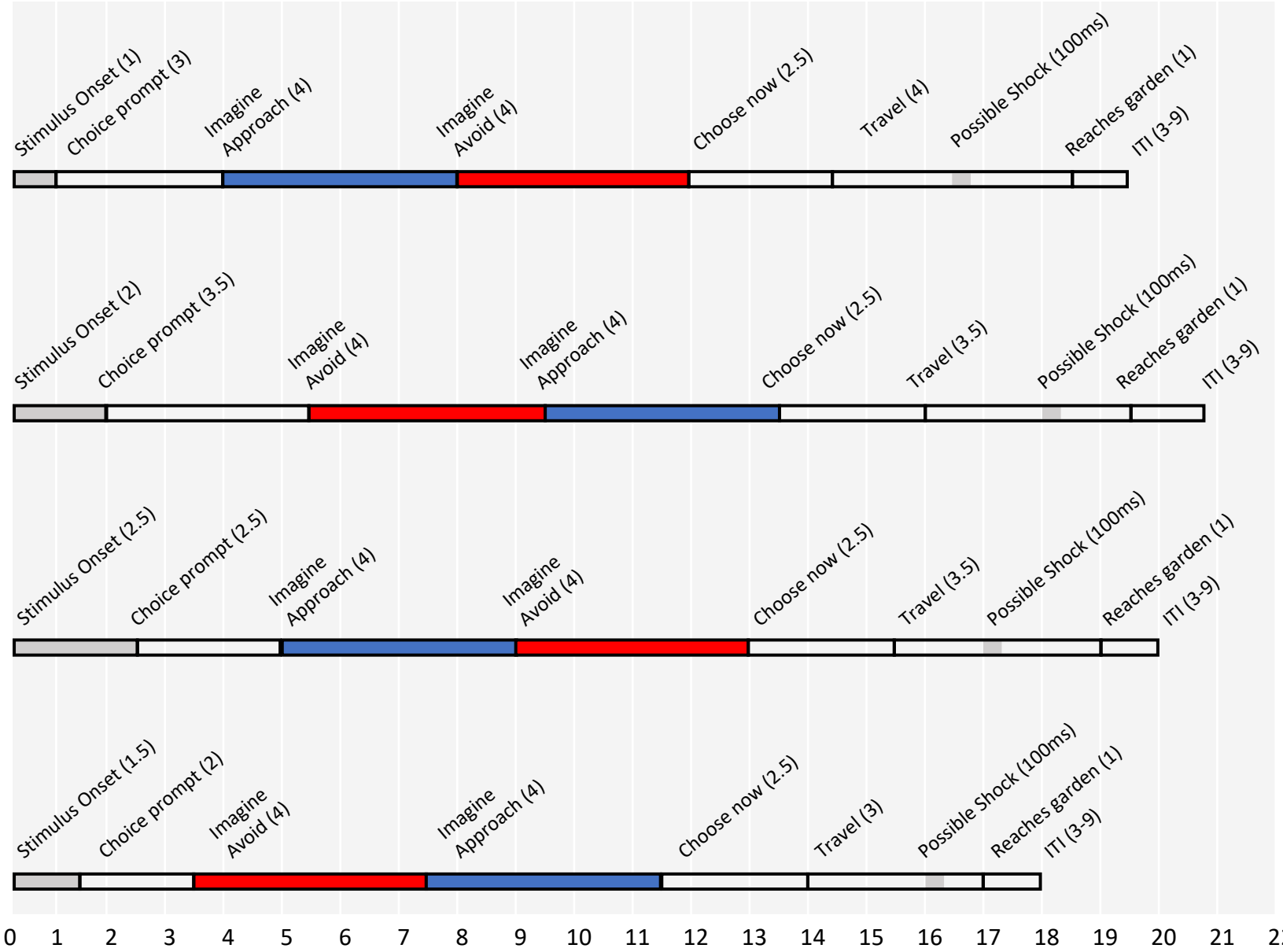
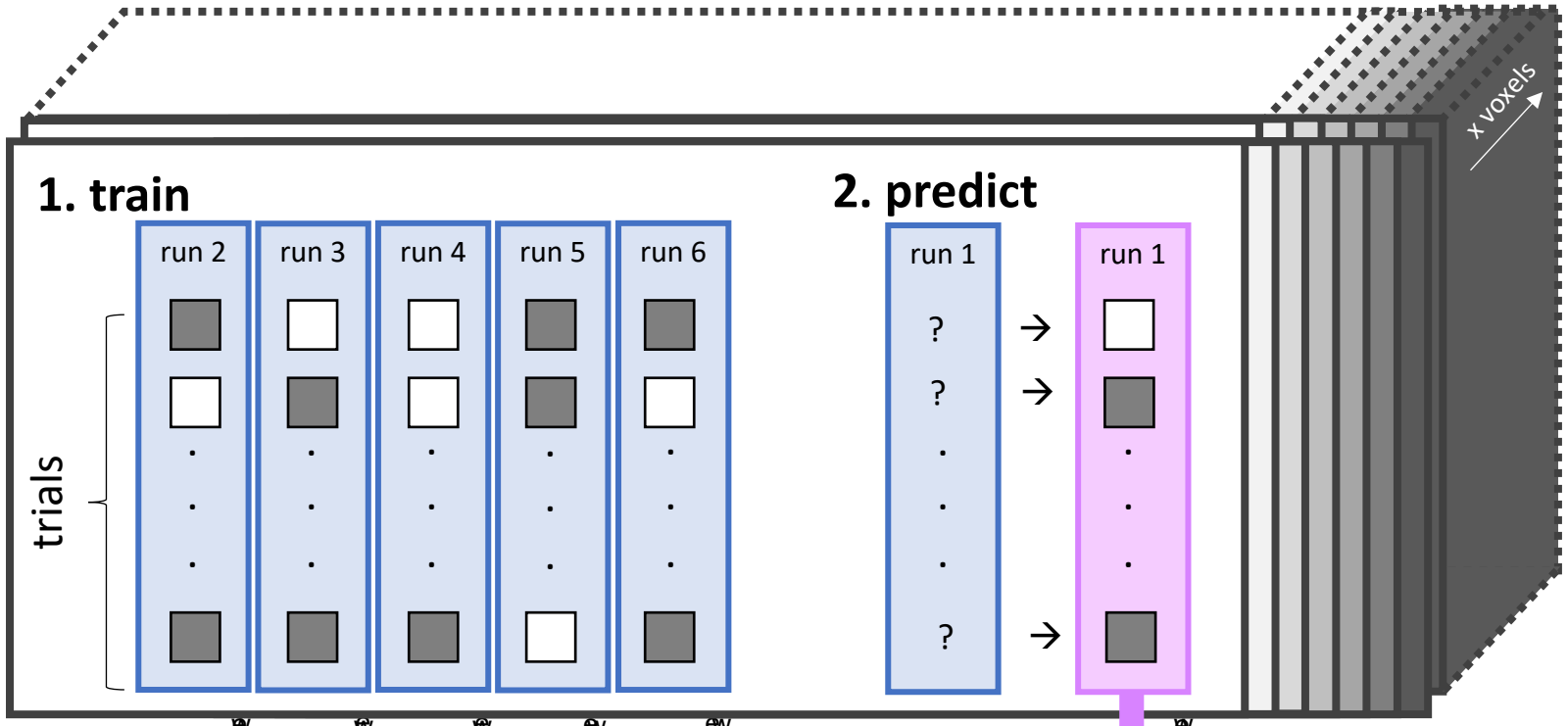
Analysis 3

Neural Predictors of Choice



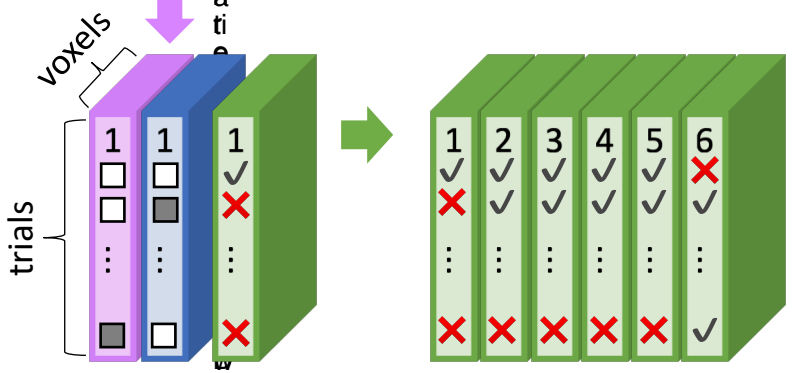
Analysis 3

Multivariate pattern analysis with leave-one-out cross-validation

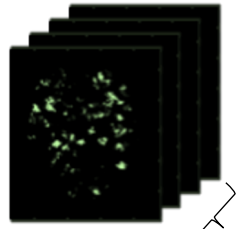


Choice trials:

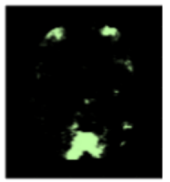
- Chose Approach
- Chose Avoidance



For each voxel:
z(hits) – z (false alarms)
= **d'**



Across sample:
d' > 0?



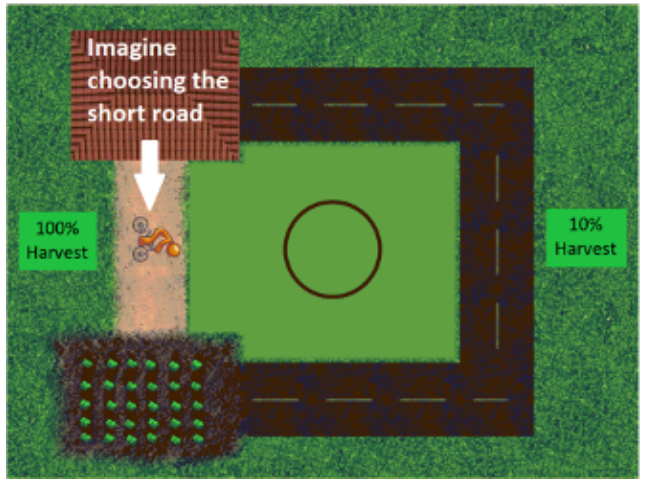
3. compare

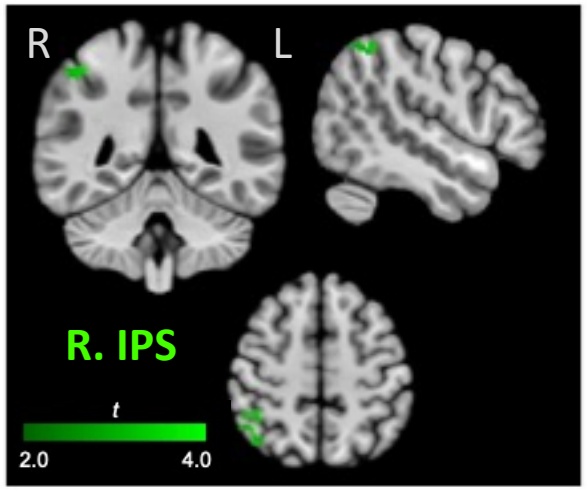
predicted choices vs.
held-out actual choices

Analysis 3

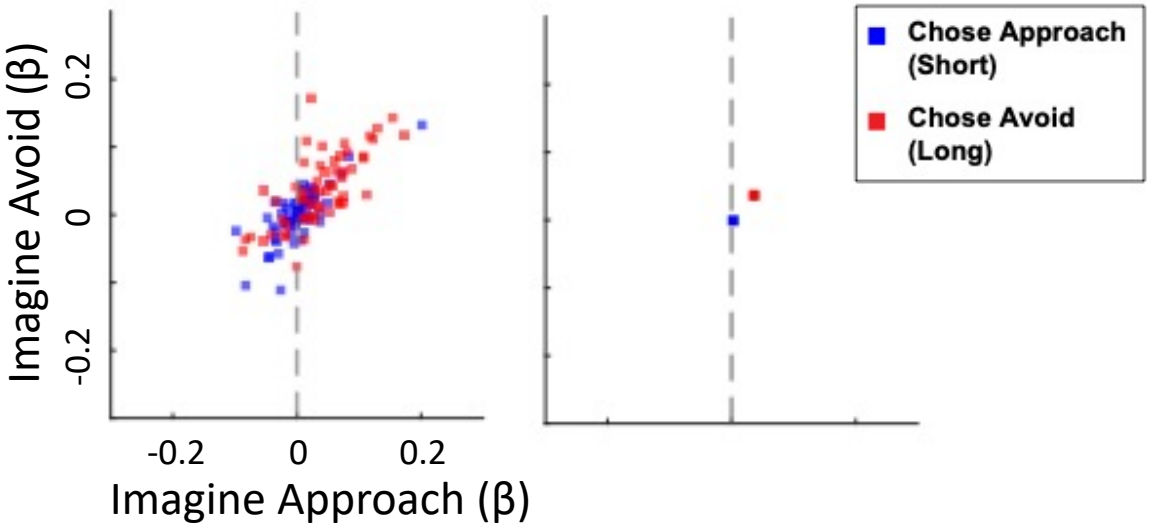
Neural Predictors of Choice

Imagine Approach

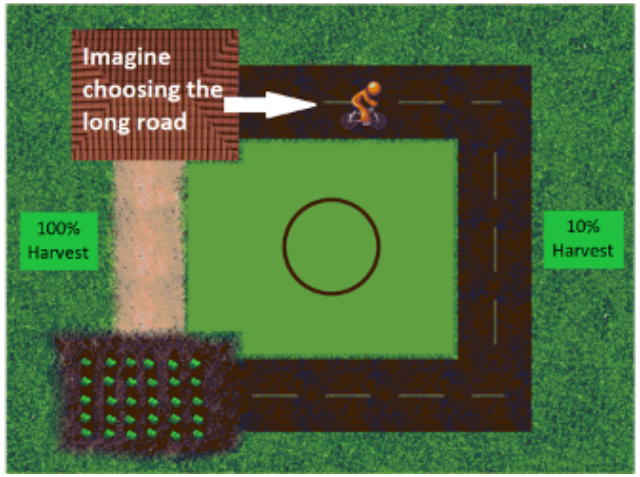


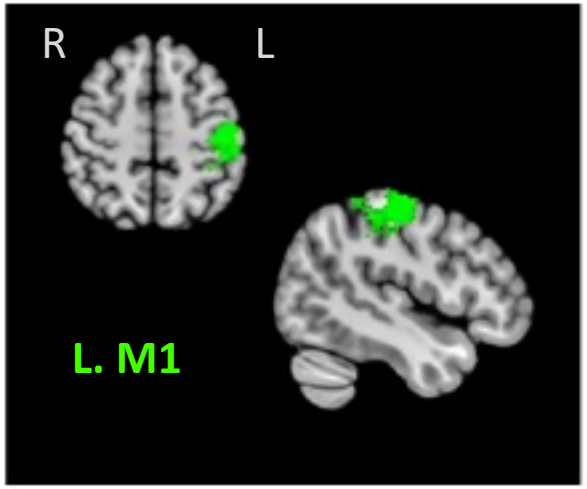


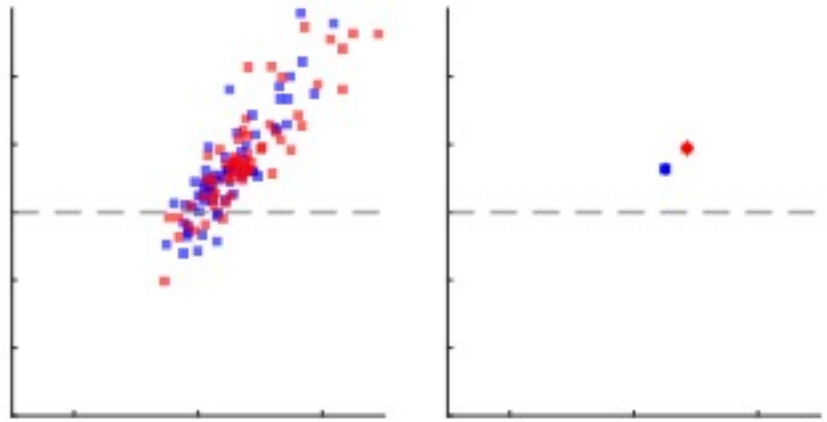
Subject-level average Group-level average



Imagine Avoid



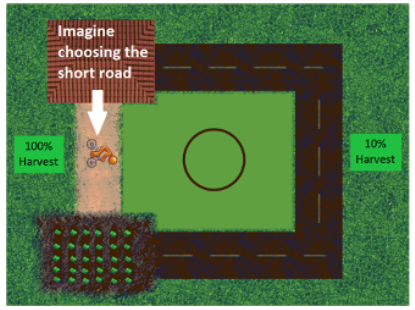


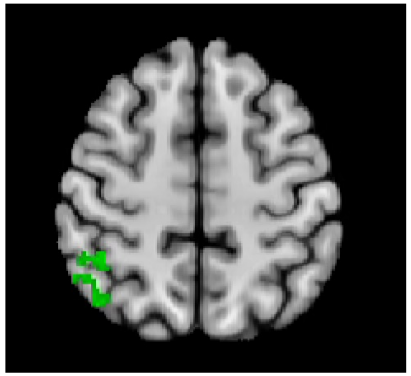


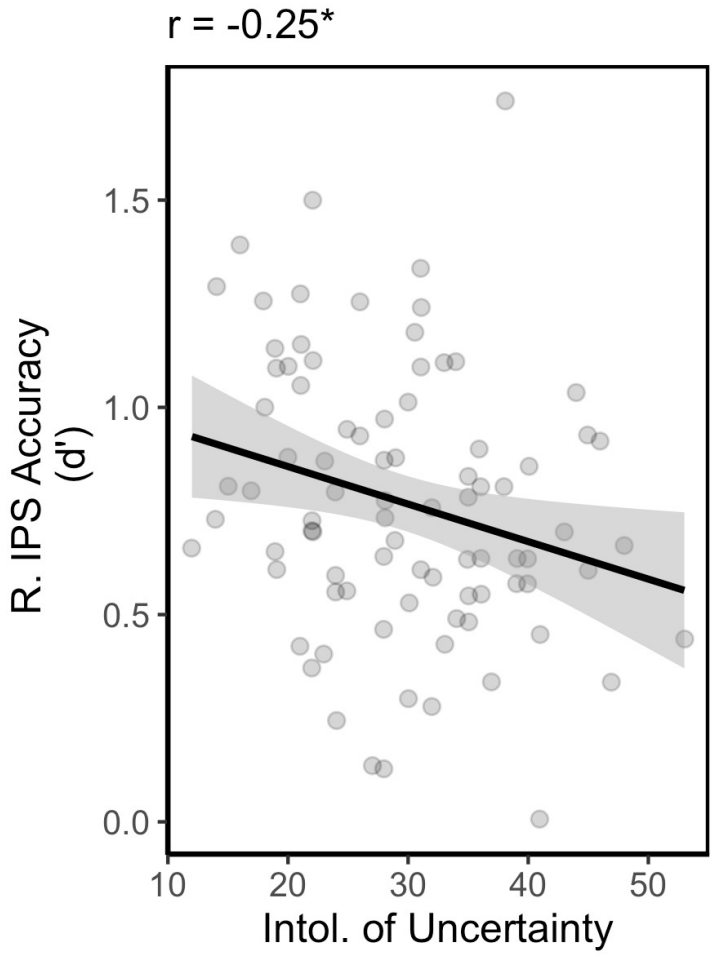
Analysis 3

Effects of Intolerance of Uncertainty

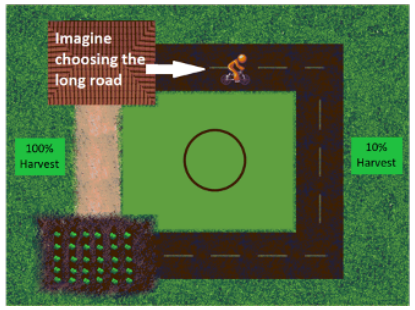
Imagine Approach

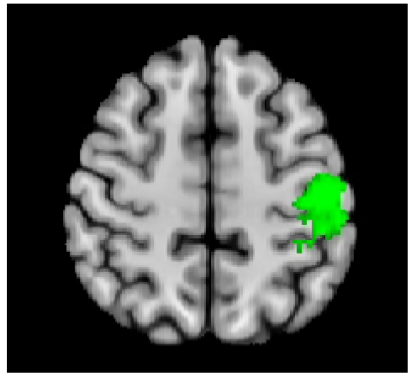


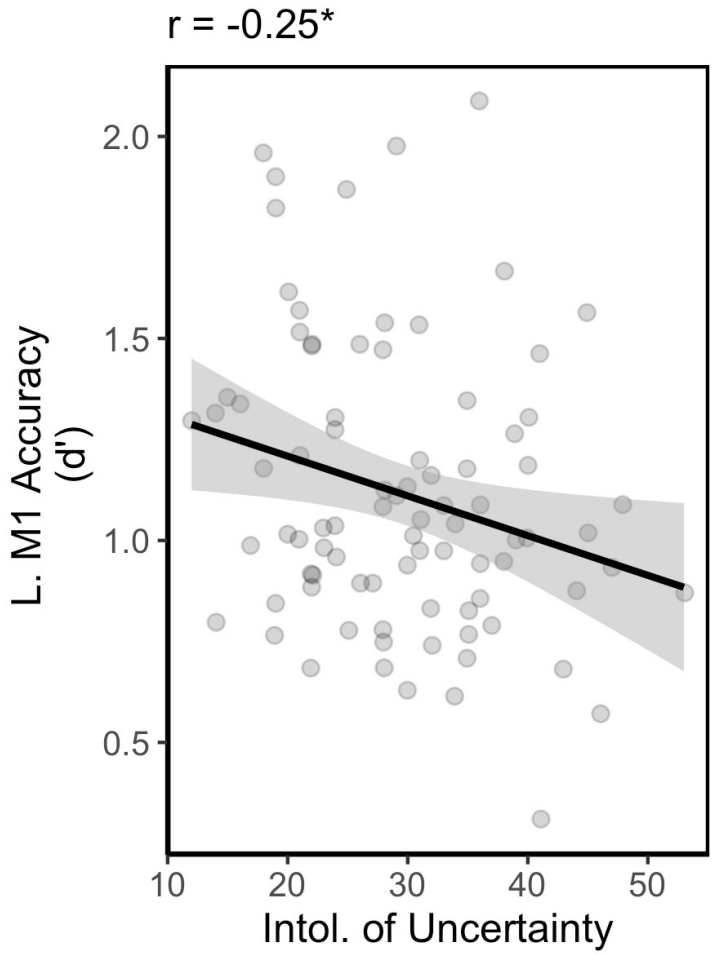


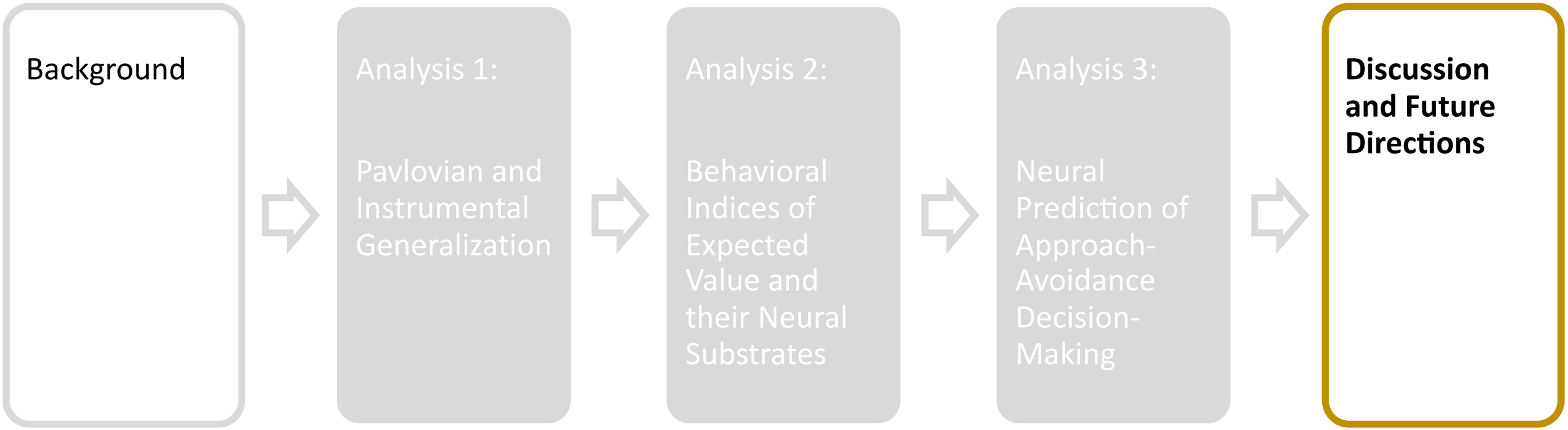


Imagine Avoid





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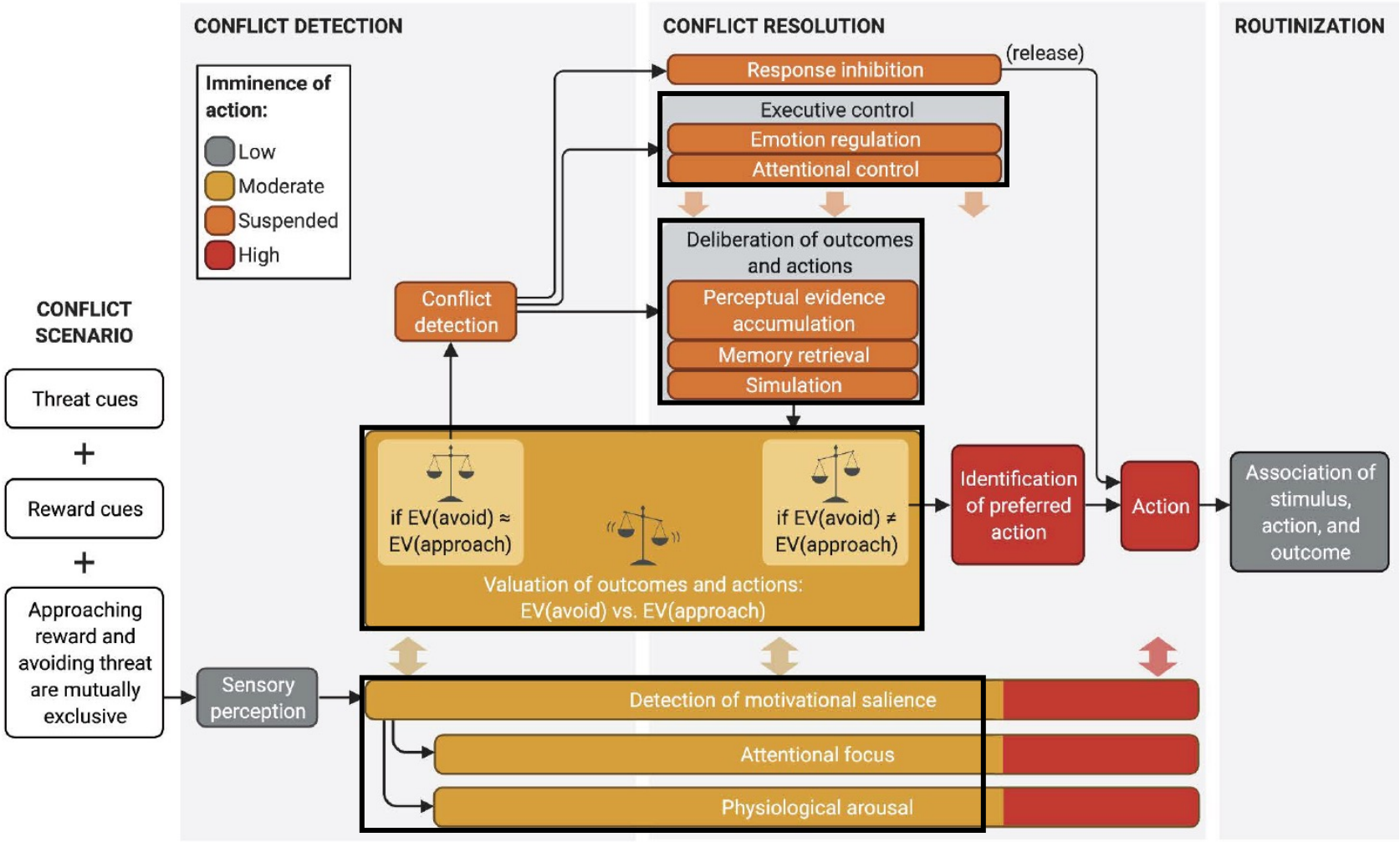
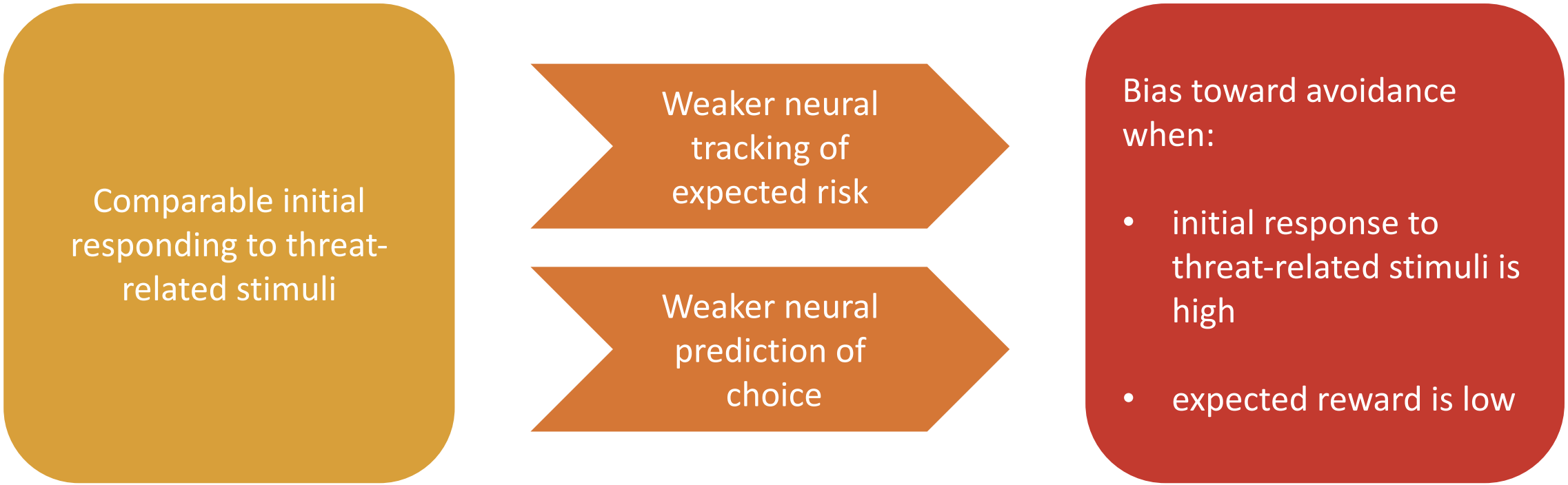
Summary of Findings:
How Avoidance Decisions are Made



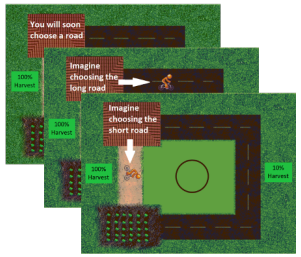
Summary of Findings:
Effects of Anxiety-Related Traits



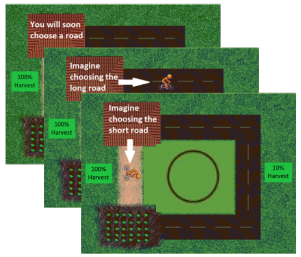
Inconsistent, Ineffective Deliberation

Low IU

Routinized, Prepotent Approach Response
Deliberate Only When Needed
Act According to Results of Deliberation



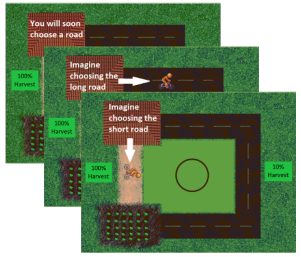
→ Approach



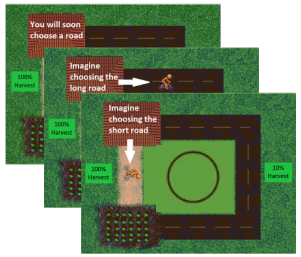
→ Deliberate → Avoid

High IU

Routinized, Prepotent Approach Response
Deliberate Often
Act According to Results of Deliberation

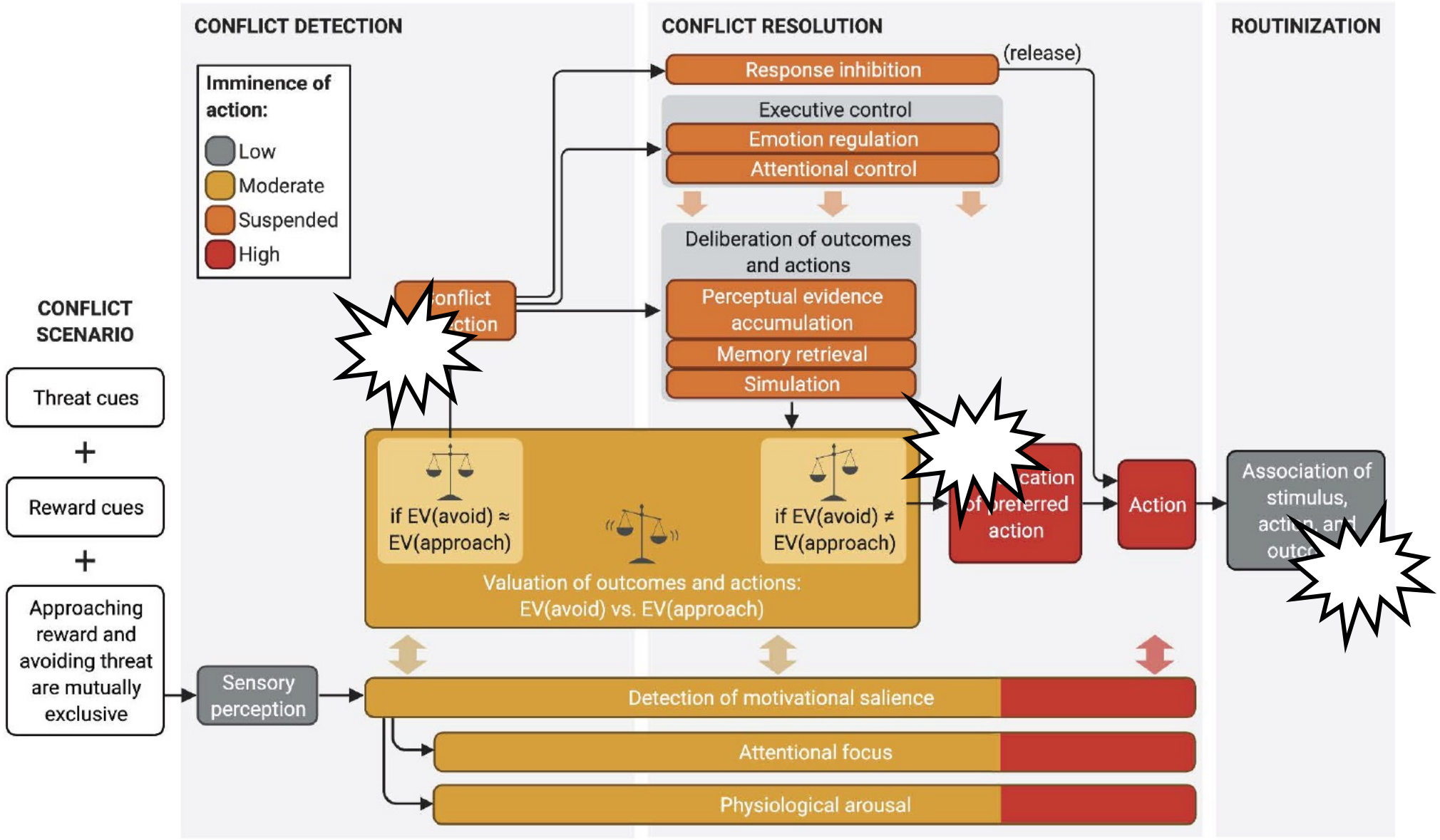


→ Deliberate → Approach
→ Deliberate → Avoid



→ Deliberate → Avoid

Inconsistent, Ineffective Deliberation



Future Directions

Compare contributions of various anxiety-related traits to excessive avoidance

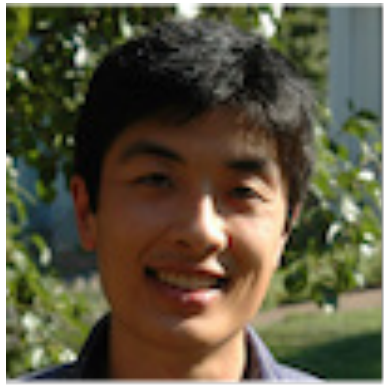
Identify the relevance of anxiety-related abnormalities in decision-making for symptom severity and treatment response

Develop and test targeted treatments

Acknowledgments

Shmuel Lissek

Kendrick Kay



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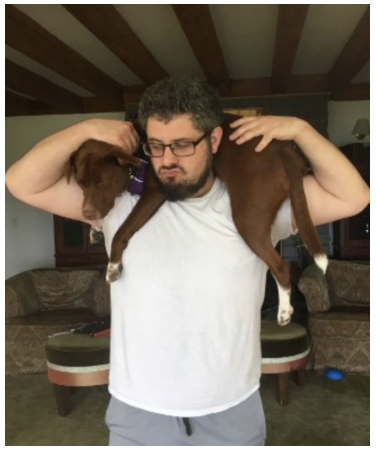
National Institute of Mental Health
R01MH107382

Adrienne Manbeck

Ryan Webler

Abbey Hammell

Chris Hunt

Sam Cooper