Context based prediction and memory suppression
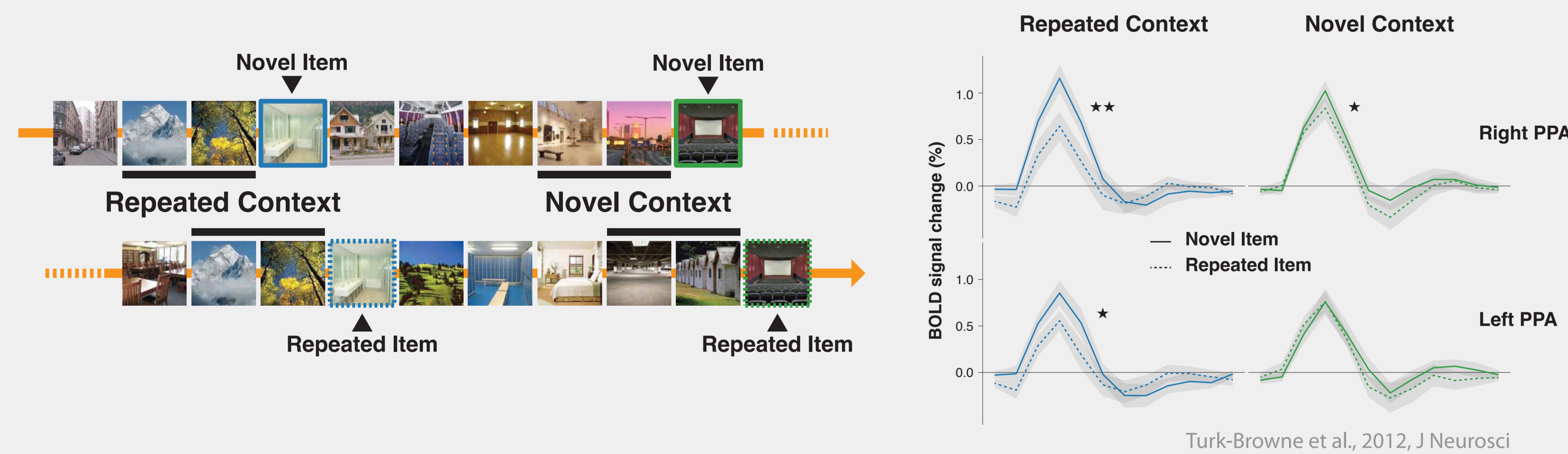
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Introduction

Predictions based on the learning of temporal and spatial regularities in the visual environment can enable more efficient perceptual processing

Repeated Context Novel Context
Novel Item Novel Item
Repeated Context Novel Context
Repeated Item Repeated Item

Right PPA
Left PPA
Novel Item
Repeated Item

BOLD signal change (%)

Turk-Browne et al., 2012, J Neurosci

What happens when visual predictions are violated?

Behavioral Task and Results

Phase 1: Incidental encoding

A B C X A B C X
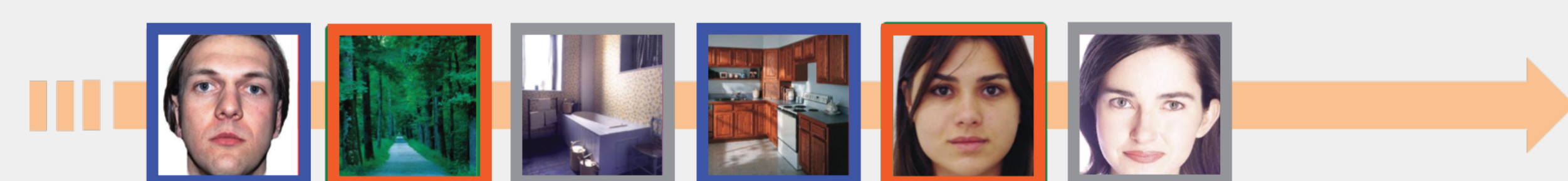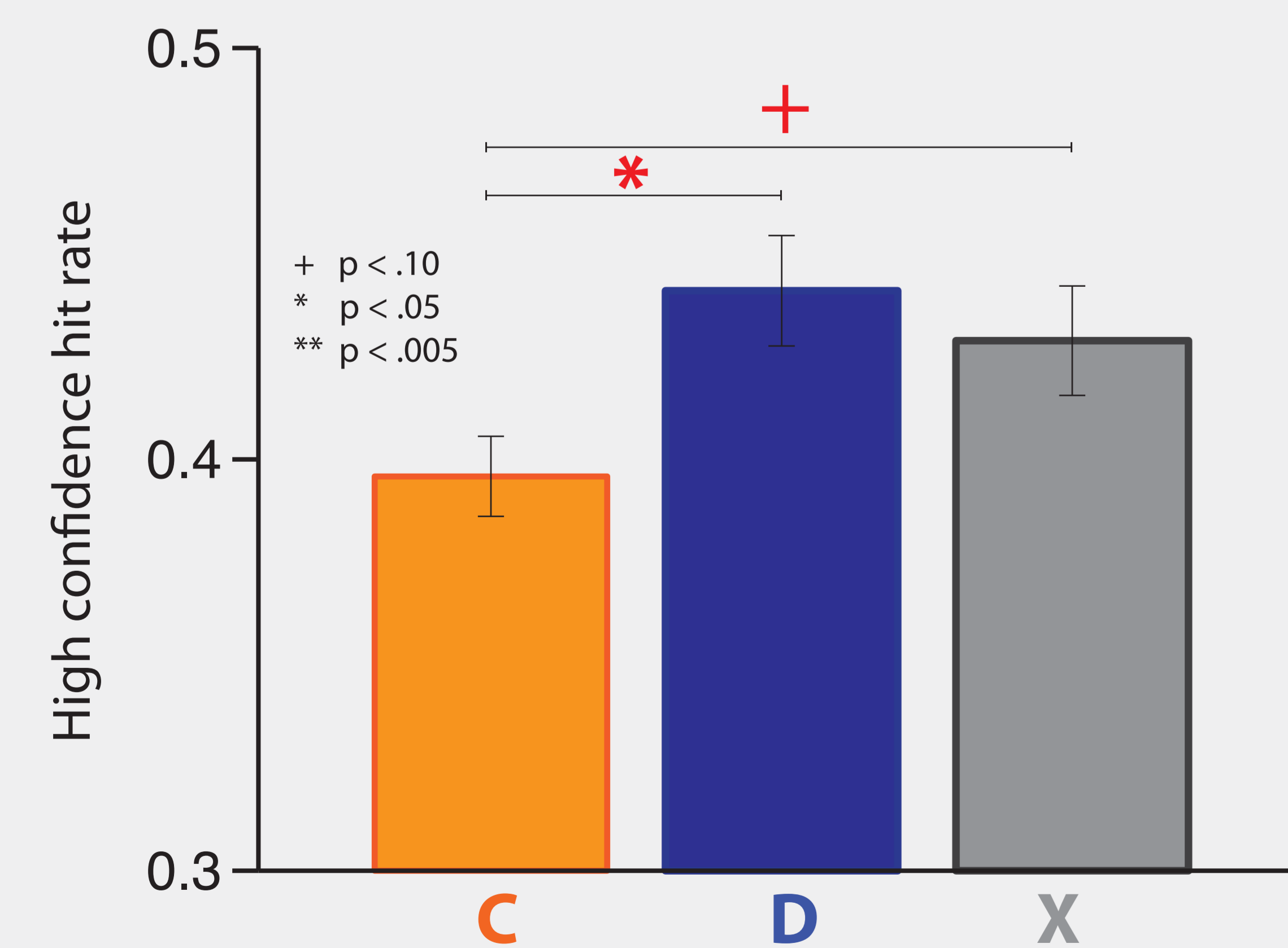
A B D A B D
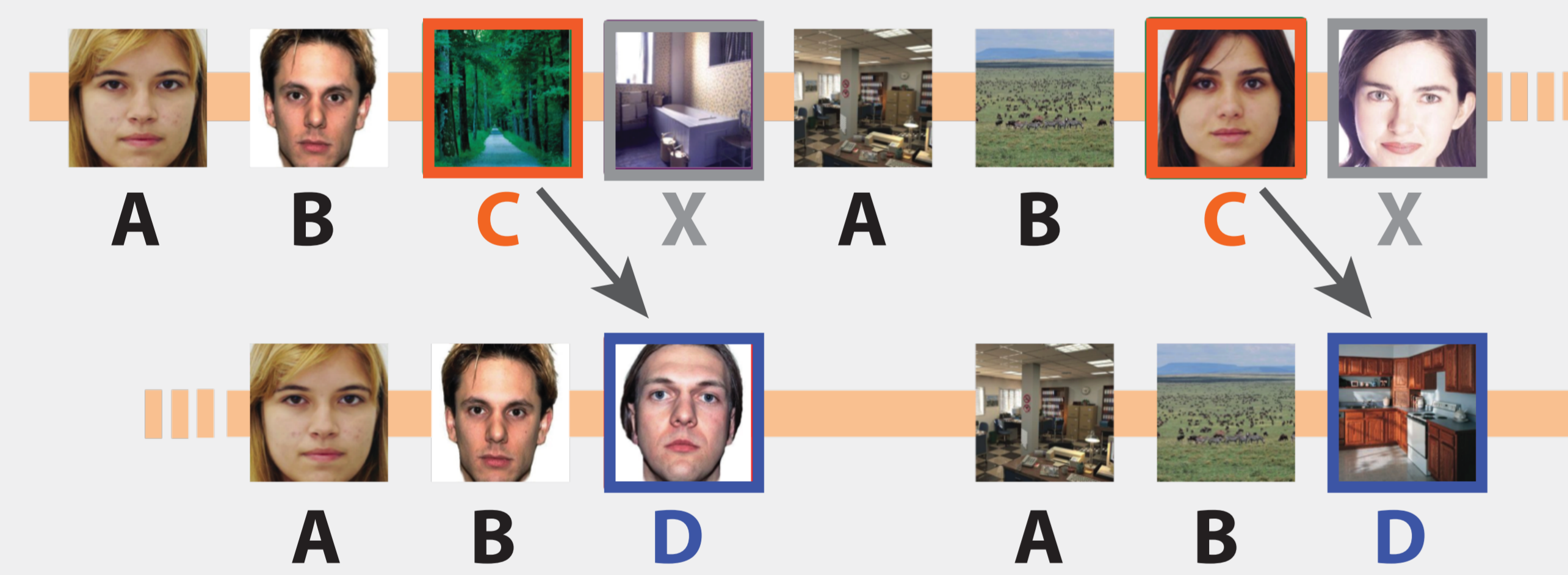
Categorization task

Face: female / male
Scene: indoor / outdoor

Phase 2: Subsequent memory test

Recognition test

Sure old   Sure new
Unsure old   Unsure new

High confidence hit rate

C   D   X

+ p < .10
* p < .05
** p < .005

What causes this context-based memory suppression effect?
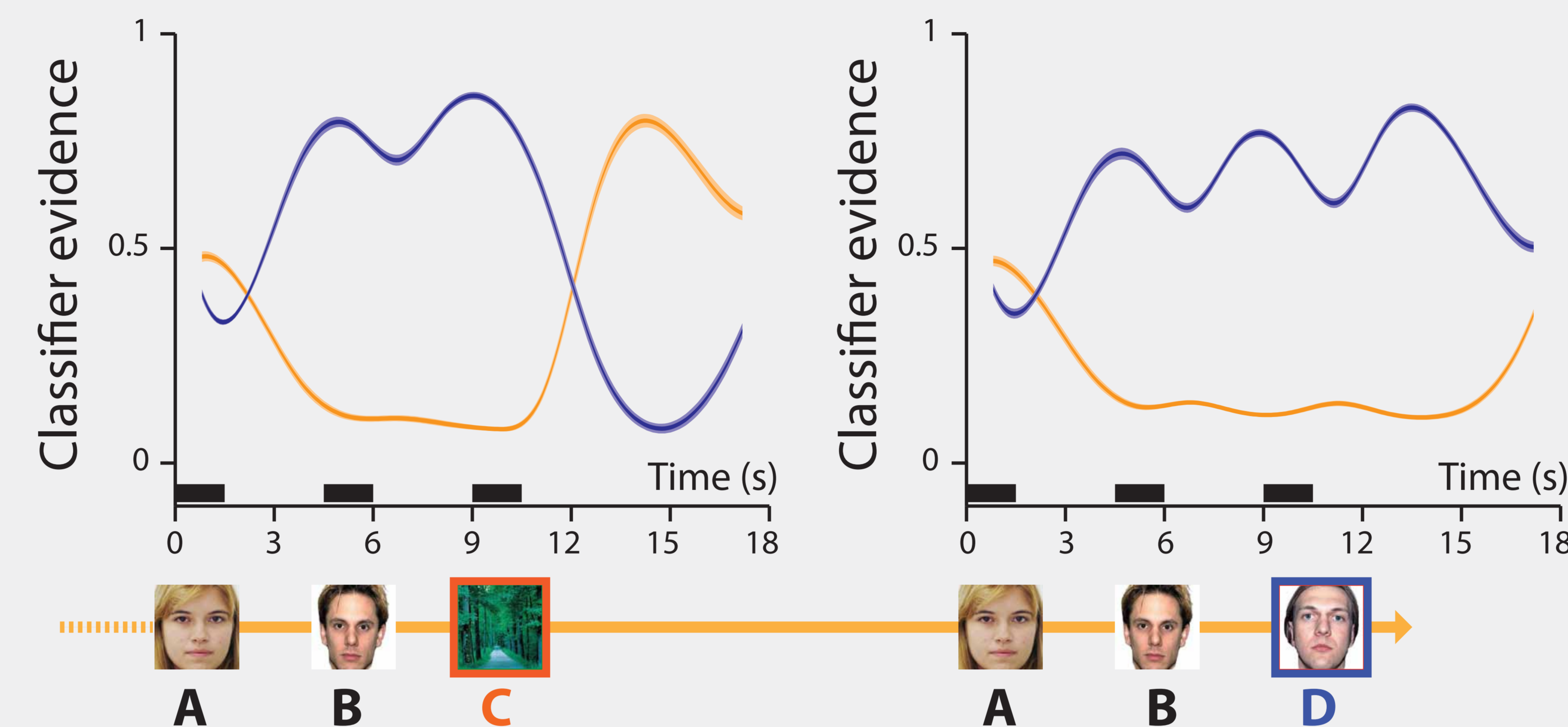
A B C → A B D
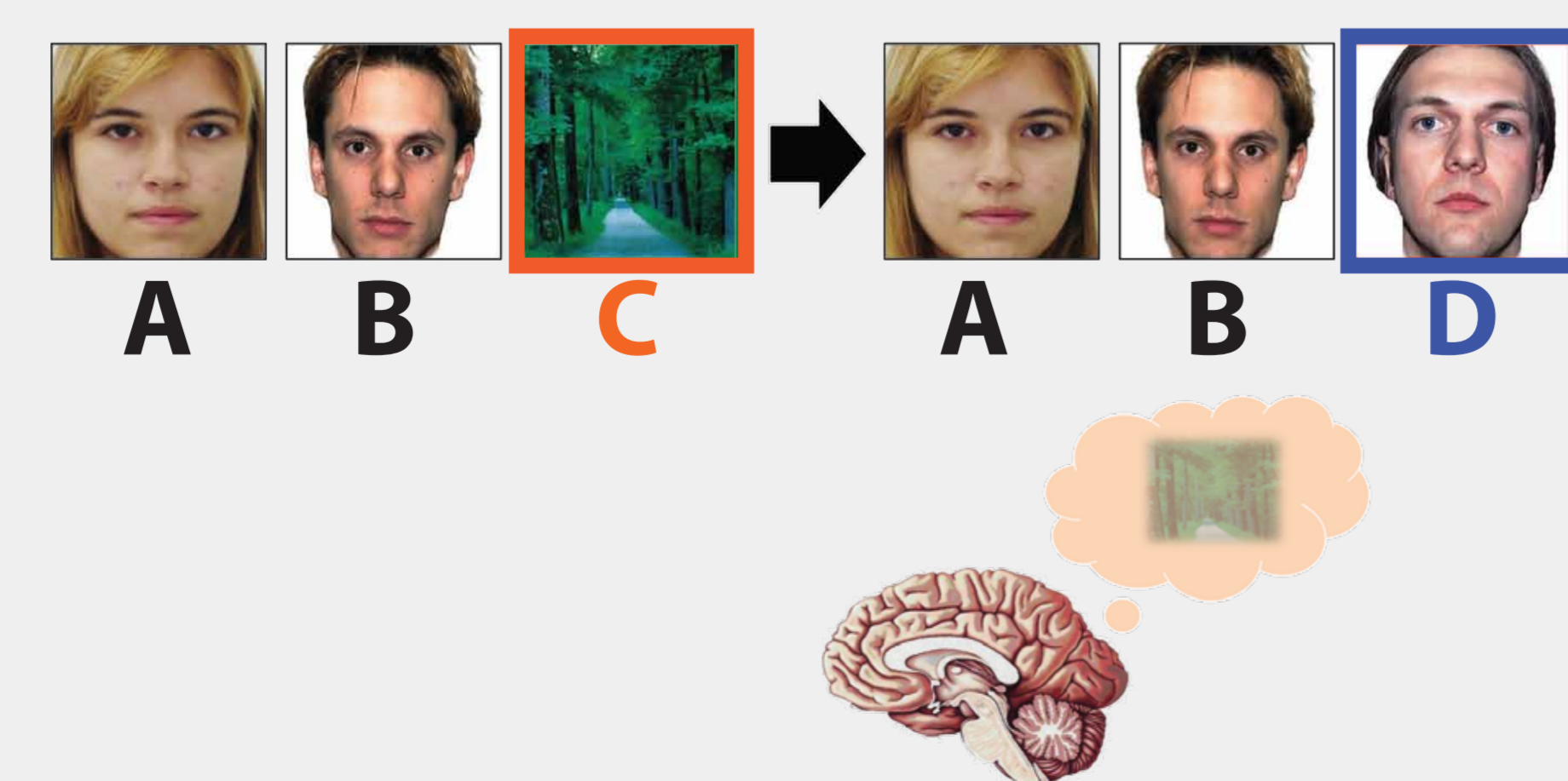
What is the relationship between prediction strength and subsequent memory?
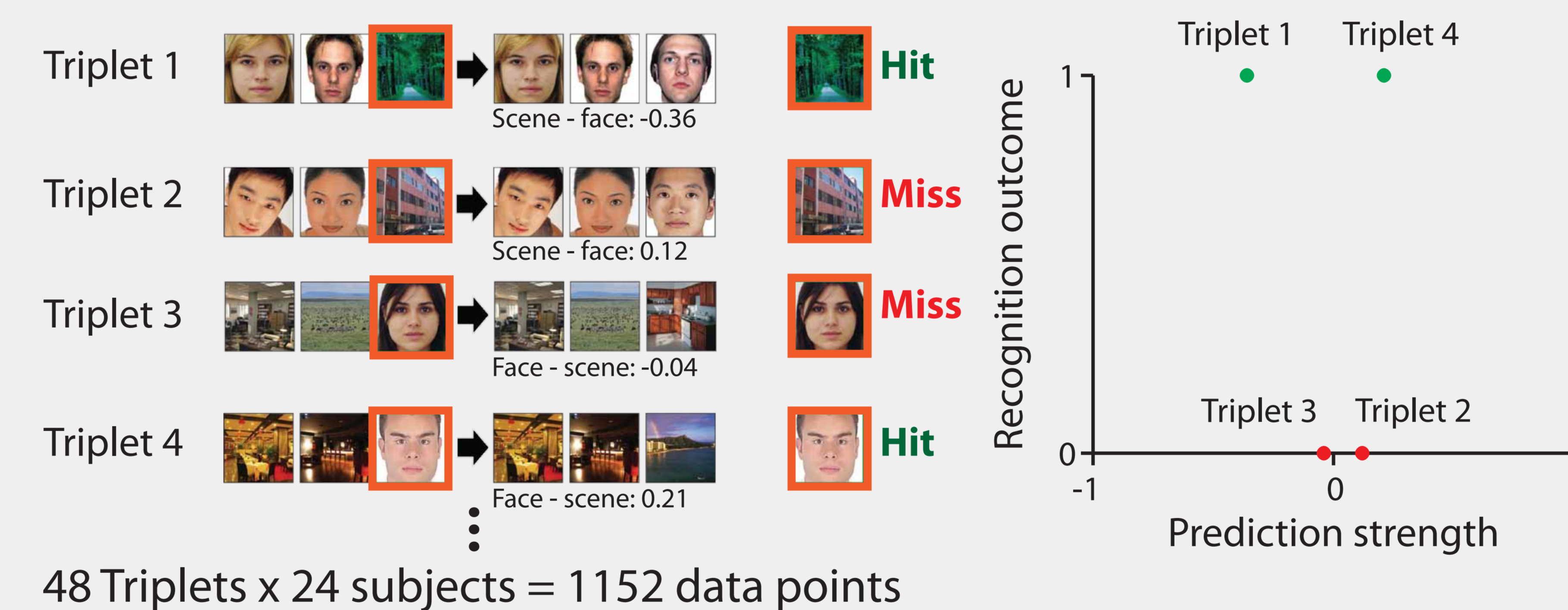
Phase 3: face/scene localizer

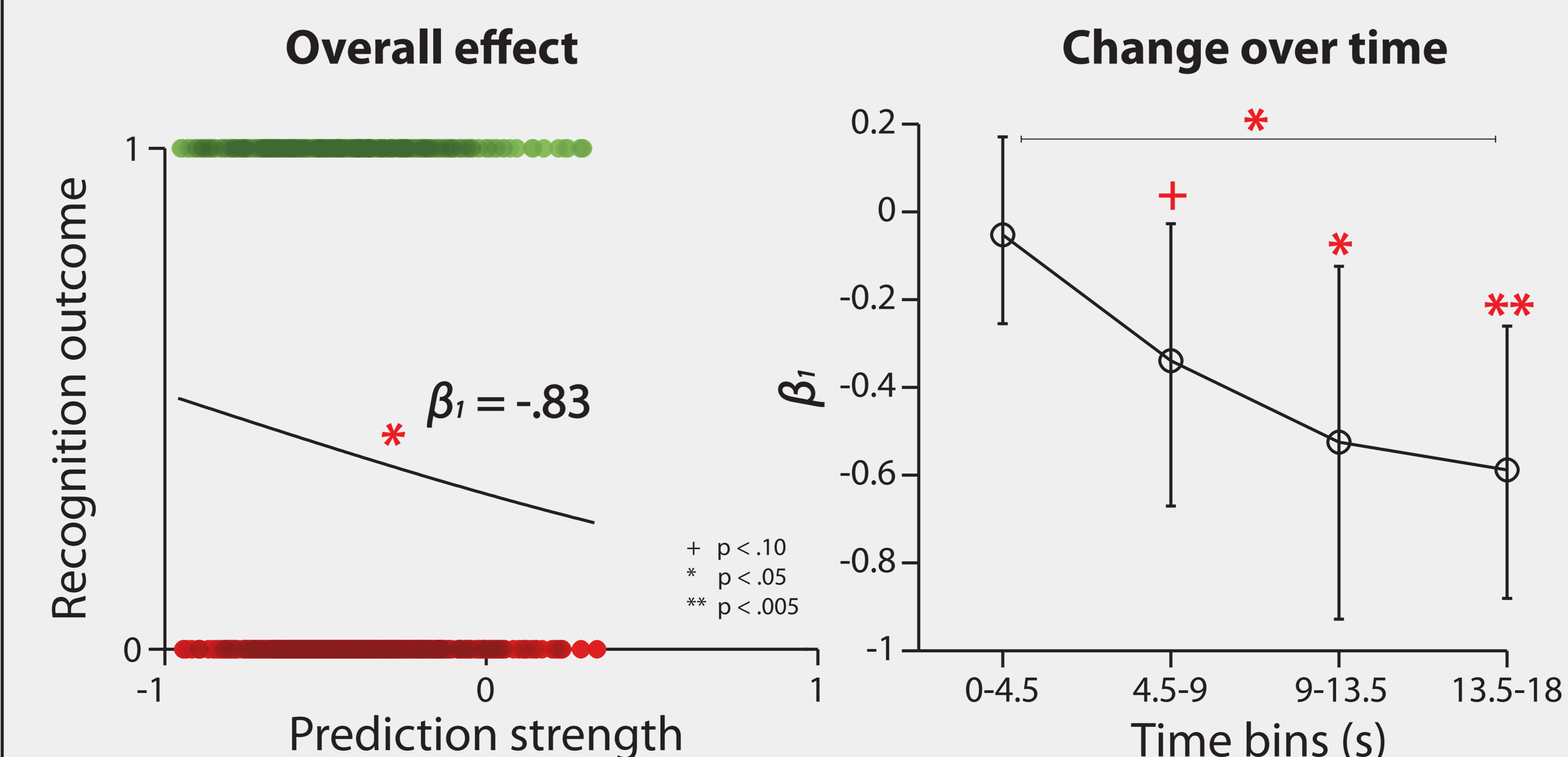## Analysis Approach

Trial-by-trial MVPA readout trajectory
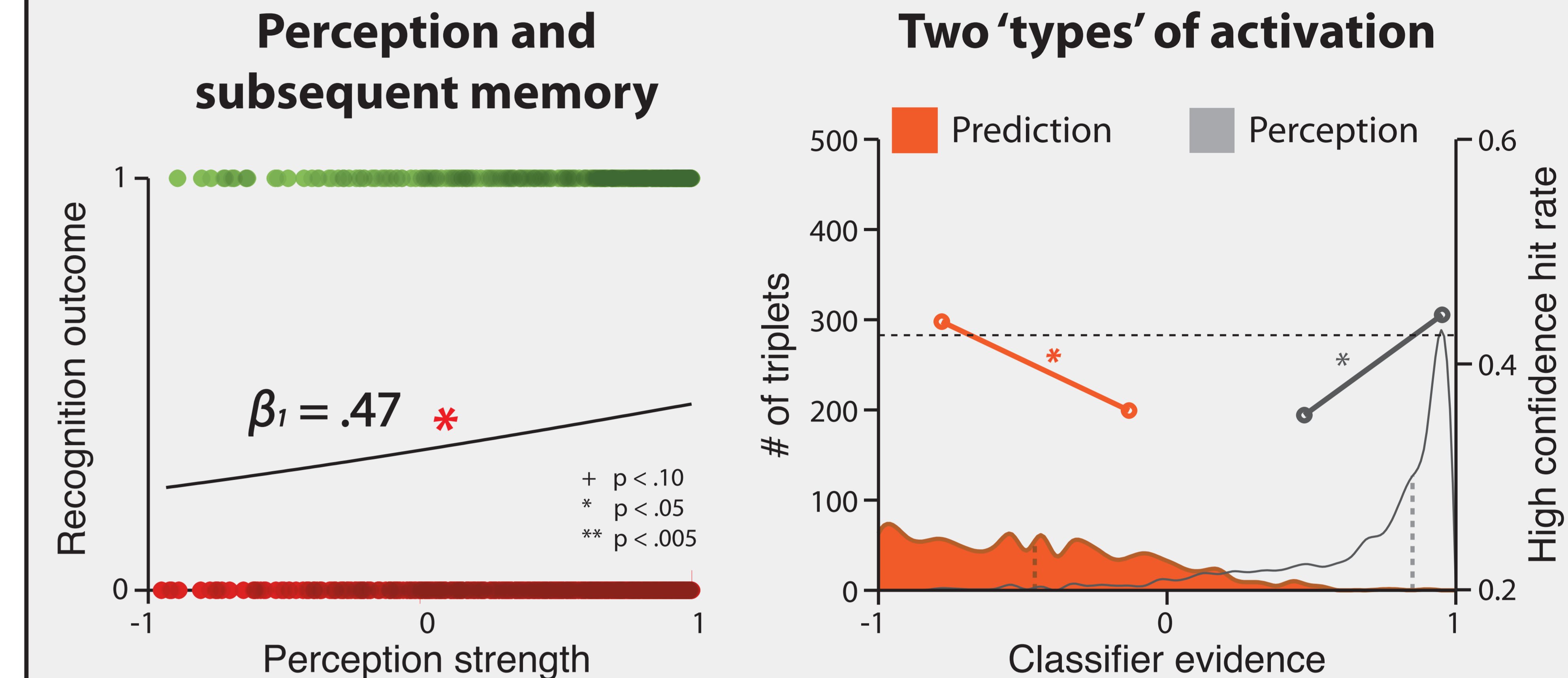
Evidence of **C** category
Evidence of **A/B/D** category

Classifier evidence
Time (s)

A B C   A B D

Sample data

Triplet 1   Scene - face: -0.36   **Hit**
Triplet 2   Scene - face: 0.12   **Miss**
Triplet 3   Face - scene: -0.04   **Miss**
Triplet 4   Face - scene: 0.21   **Hit**

Triplet 1   Triplet 4
Triplet 3   Triplet 2

Recognition outcome
Prediction strength

48 Triplets x 24 subjects = 1152 data points

Prediction and Subsequent Memory

Overall effect

Recognition outcome
Prediction strength

$\beta_1 = -.83$ *

+ p < .10
* p < .05
** p < .005

Change over time

β_1

0-4.5   4.5-9   9-13.5   13.5-18
Time bins (s)

Strong (violated) predictions lead to forgetting

Perception and Prediction

Perception and subsequent memory

Recognition outcome
Perception strength

$\beta_1 = .47$ *

+ p < .10
* p < .05
** p < .005

Two 'types' of activation

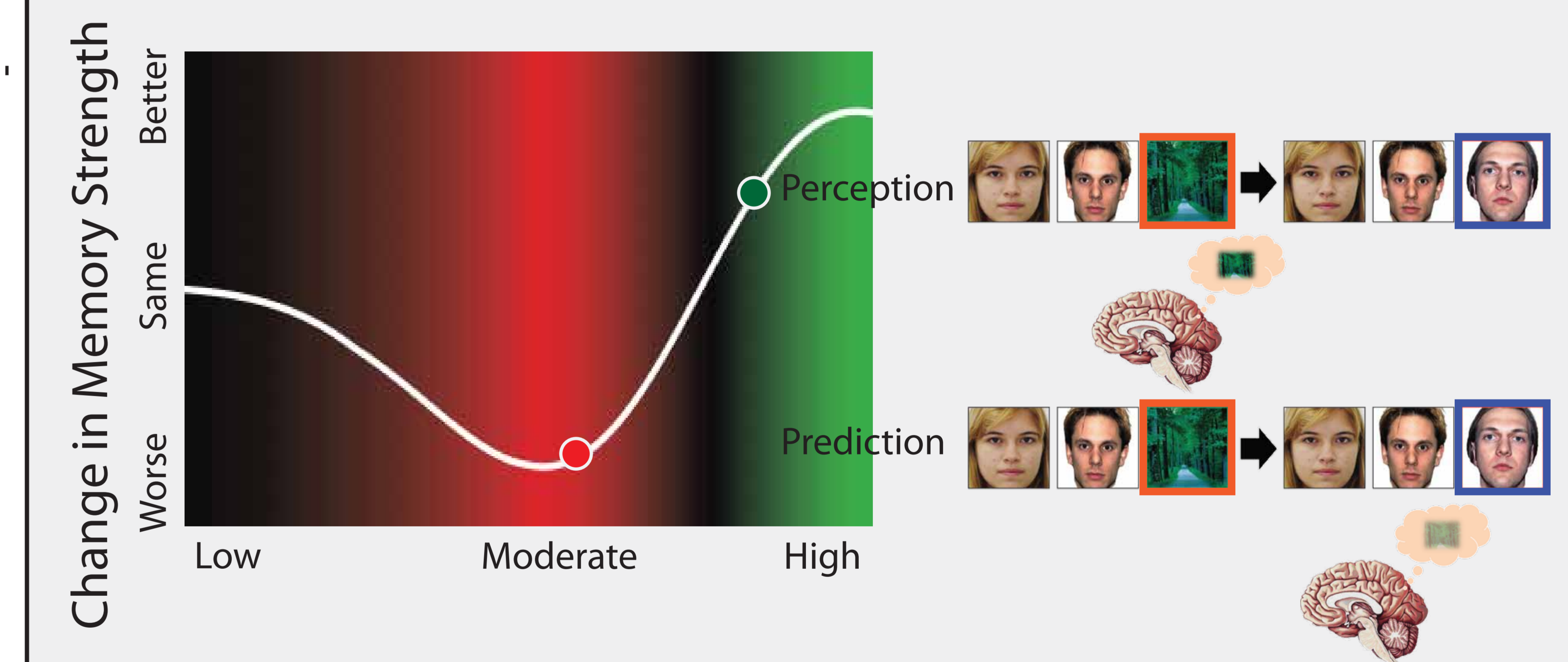Prediction   Perception

# of triplets
High confidence hit rate
Classifier evidence

Moderate levels of activation — prediction or perception — were associated with worse memory

Nonmonotonic plasticity hypothesis

Newman & Norman, 2010, Cereb Cortex; Detre et al., submitted; Lewis-Peacock & Norman, submitted

Change in Memory Strength
Better Same Worse
Low   Moderate   High

Perception
Prediction

Conclusions

Contextual relationships are learned rapidly and used to make predictions about subsequent events

When violated, mnemonic representations of (incorrectly) predicted items are weakened

Effects of perception and prediction on memory can be explained by the nonmonotonic plasticity hypothesis

Memory for an event is partly determined by the history of its context