Attention Compensates for Reduced Conjunctive Learning in Older Adults

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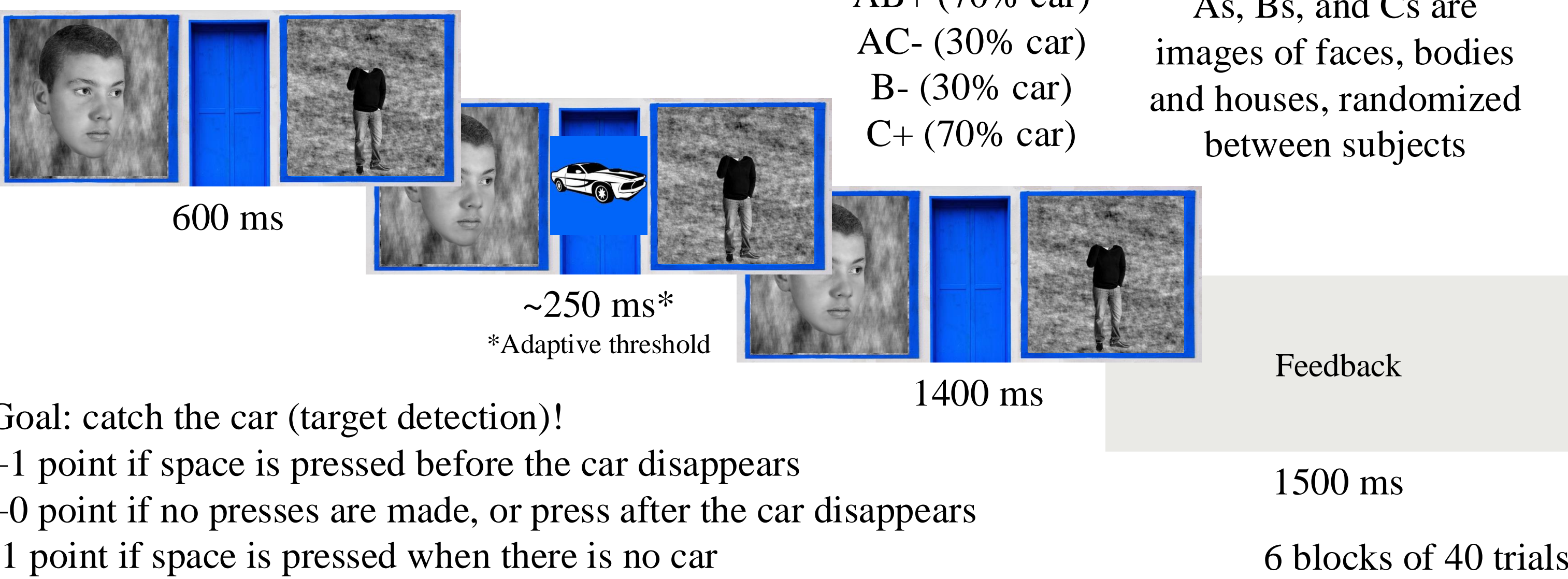Computational and Cognitive Neural Sciences

Introduction

The hippocampus forms conjunctions of features through pattern separation, a process that supports the computation of values of multi-feature stimuli in the striatum[1].

Declines in hippocampal function and pattern separation are associated with healthy aging[2].
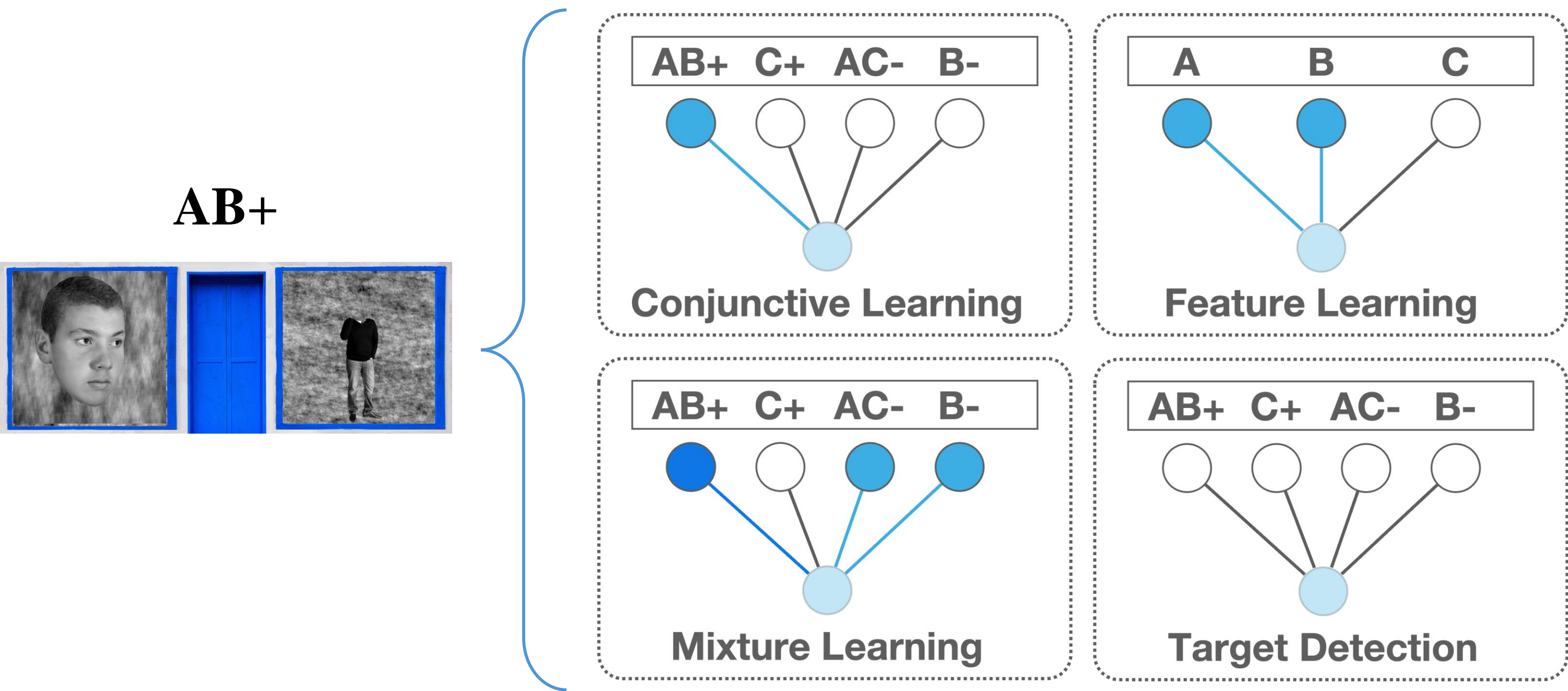
Do older adults exhibit reduced conjunctive reward learning?

Task

Four stimuli configurations:
AB+ (70% car)
AC- (30% car)
B- (30% car)
C+ (70% car)

As, Bs, and Cs are images of faces, bodies and houses, randomized between subjects

600 ms

~250 ms*
*Adaptive threshold

1400 ms

Feedback

1500 ms

6 blocks of 40 trials

Goal: catch the car (target detection)!
+1 point if space is pressed before the car disappears
+0 point if no presses are made, or press after the car disappears
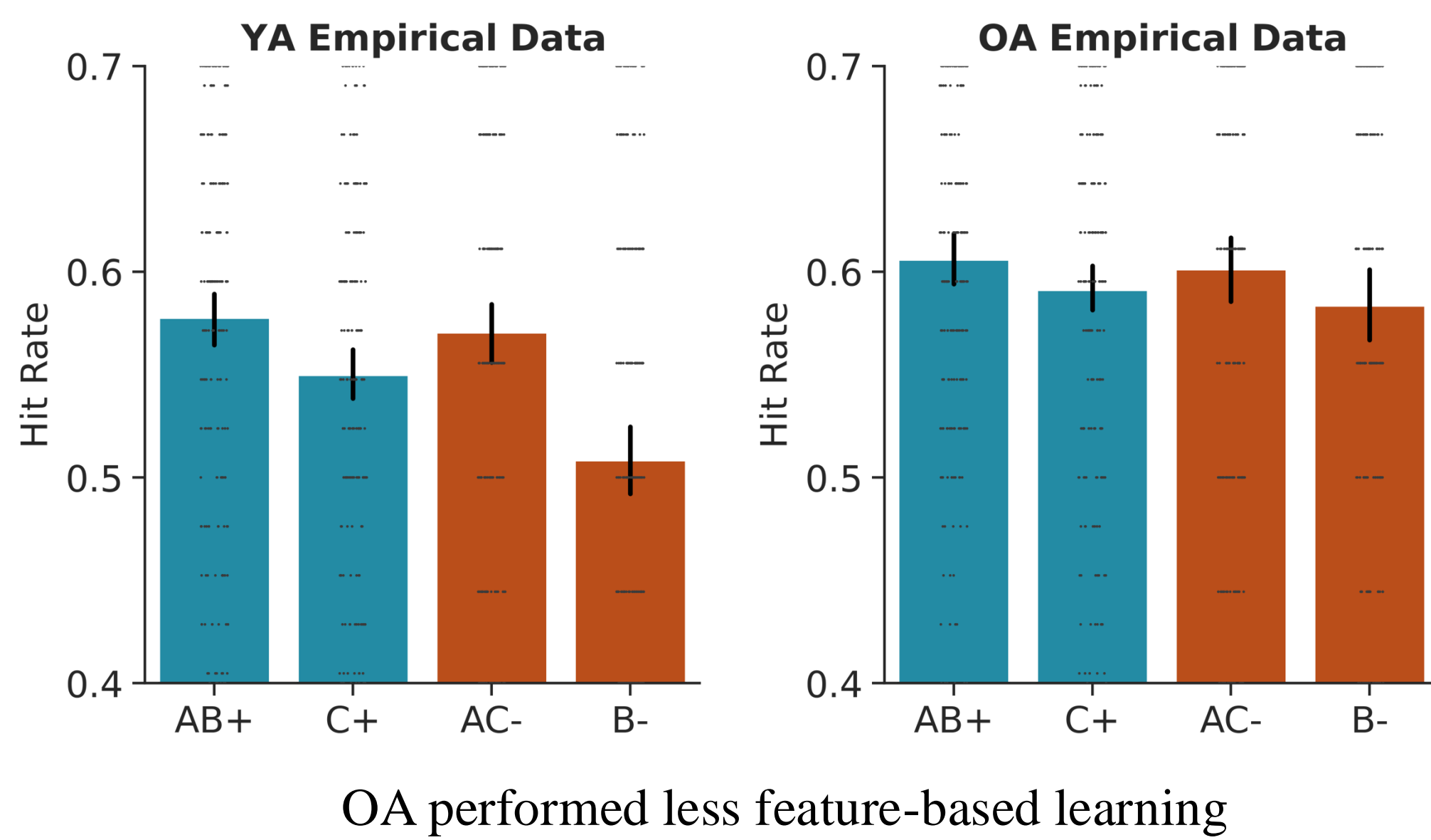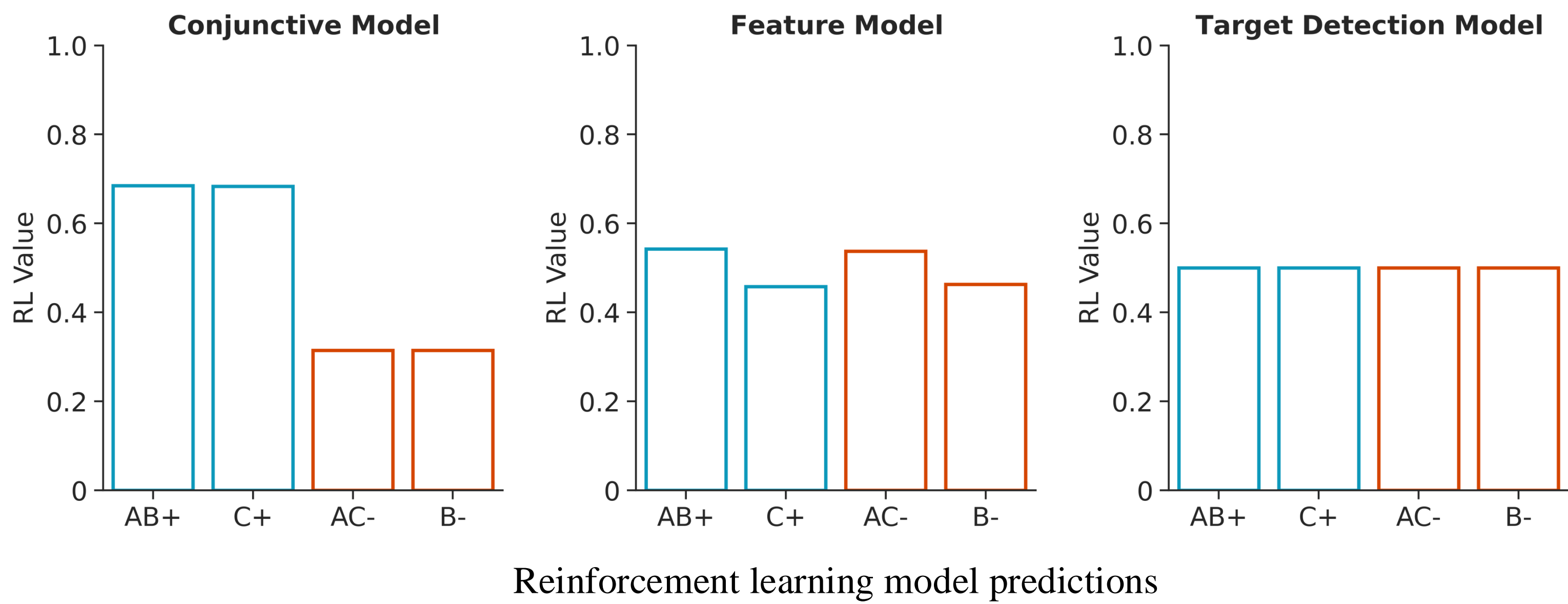-1 point if space is pressed when there is no car

Data was asynchronously collected though Prolific [older adults (OA), 65+, n=196] and UC Riverside's SONA Pool [younger adults (YA), n=194].
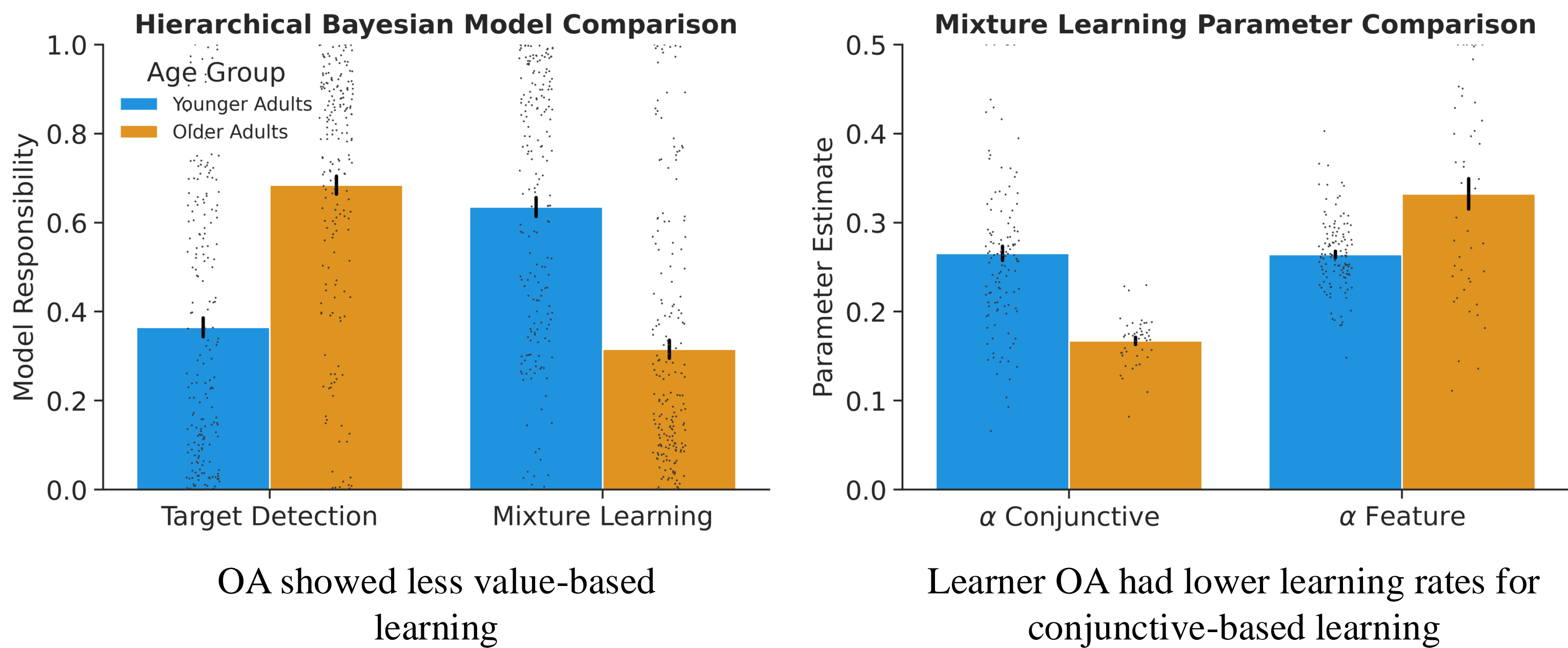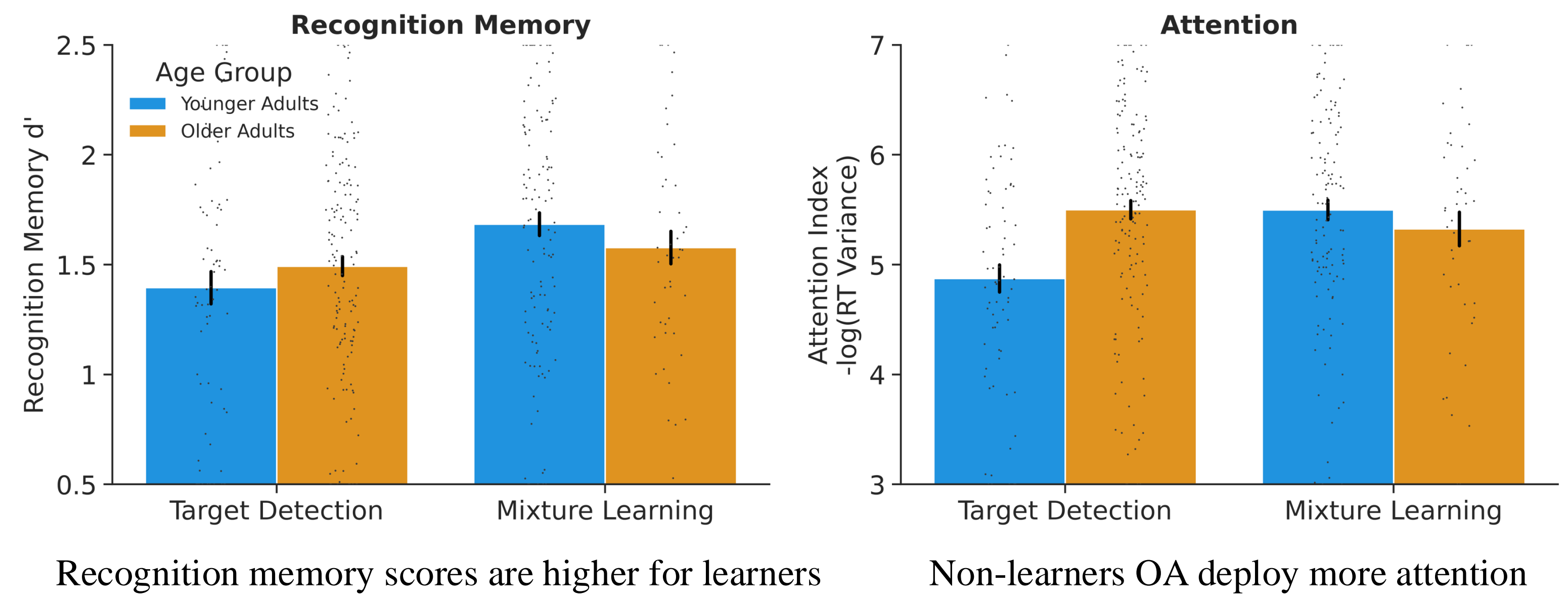
Reinforcement Learning Modeling

AB+

AB+ C+ AC- B-
A B C
Conjunctive Learning
Feature Learning

AB+ C+ AC- B-
AB+ C+ AC- B-
Mixture Learning
Target Detection

Older Adults Displayed Impairments in Reinforcement Learning

Conjunctive Model

Feature Model

Target Detection Model

Reinforcement learning model predictions

YA Empirical Data

OA Empirical Data

OA performed less feature-based learning

Older Adults Showed Reduced Conjunctive Learning

Hierarchical Bayesian Model Comparison

Age Group
Younger Adults
Older Adults

Mixture Learning Parameter Comparison

OA showed less value-based learning

Learner OA had lower learning rates for conjunctive-based learning

Recognition Memory and Attention Were Associated with Value-Based Learning

Recognition Memory

Age Group
Younger Adults
Older Adults

Attention

Recognition memory scores are higher for learners

Non-learners OA deploy more attention

Cognitive Reserve Index Scores in Older Adults Were Linked to Task Performance and Learning
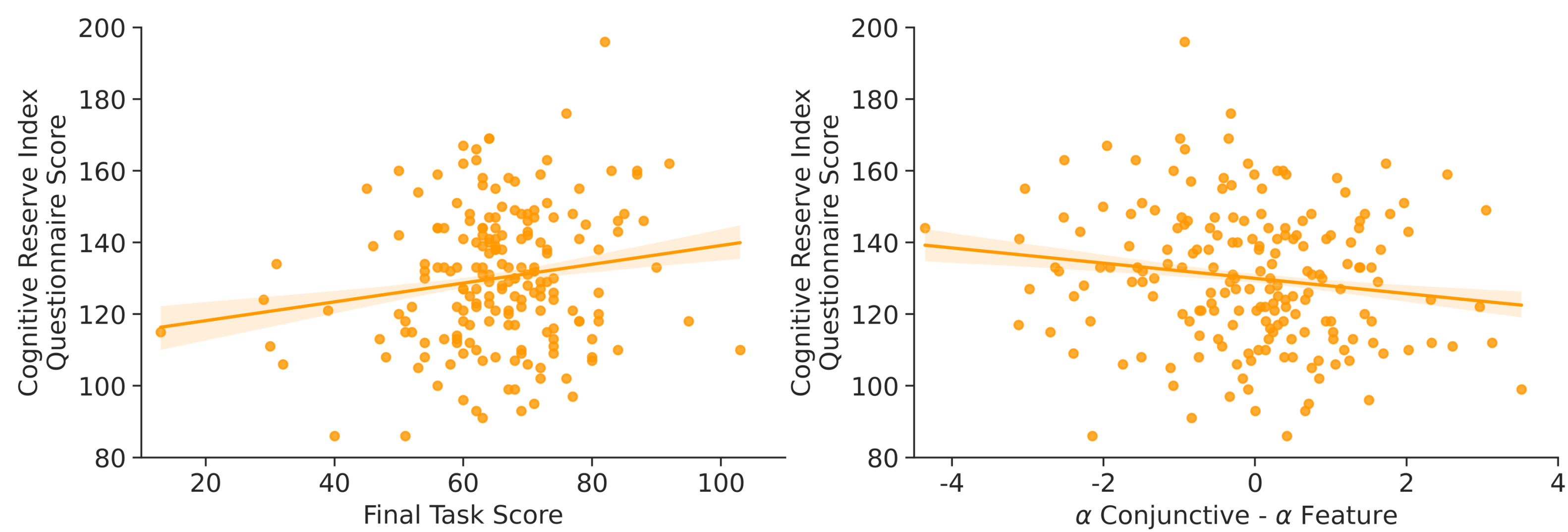
Conclusions

- As hypothesized, older adults (OA) exhibited deficits for conjunctive-based reward learning

- OA relied less on value-based reward learning, adopting a more "target detection", attention-dependent strategy

- OA with higher cognitive reserve index scores performed better in the task, however, they learned more through a feature-, rather than through a conjunctive-based reinforcement learning model

1. Ballard IC, Wagner AD, McClure SM. Hippocampal pattern separation supports reinforcement learning. Nat Commun. 2019.
2. Yassa MA, Lacy JW, Stark SM, Albert MS, Gallagher M, Stark CE. Pattern separation deficits associated with increased hippocampal CA3 and dentate gyrus activity in nondemented older adults. Hippocampus. 2011.