

Dissociable neural reinstatement of emotional memories in the human PFC

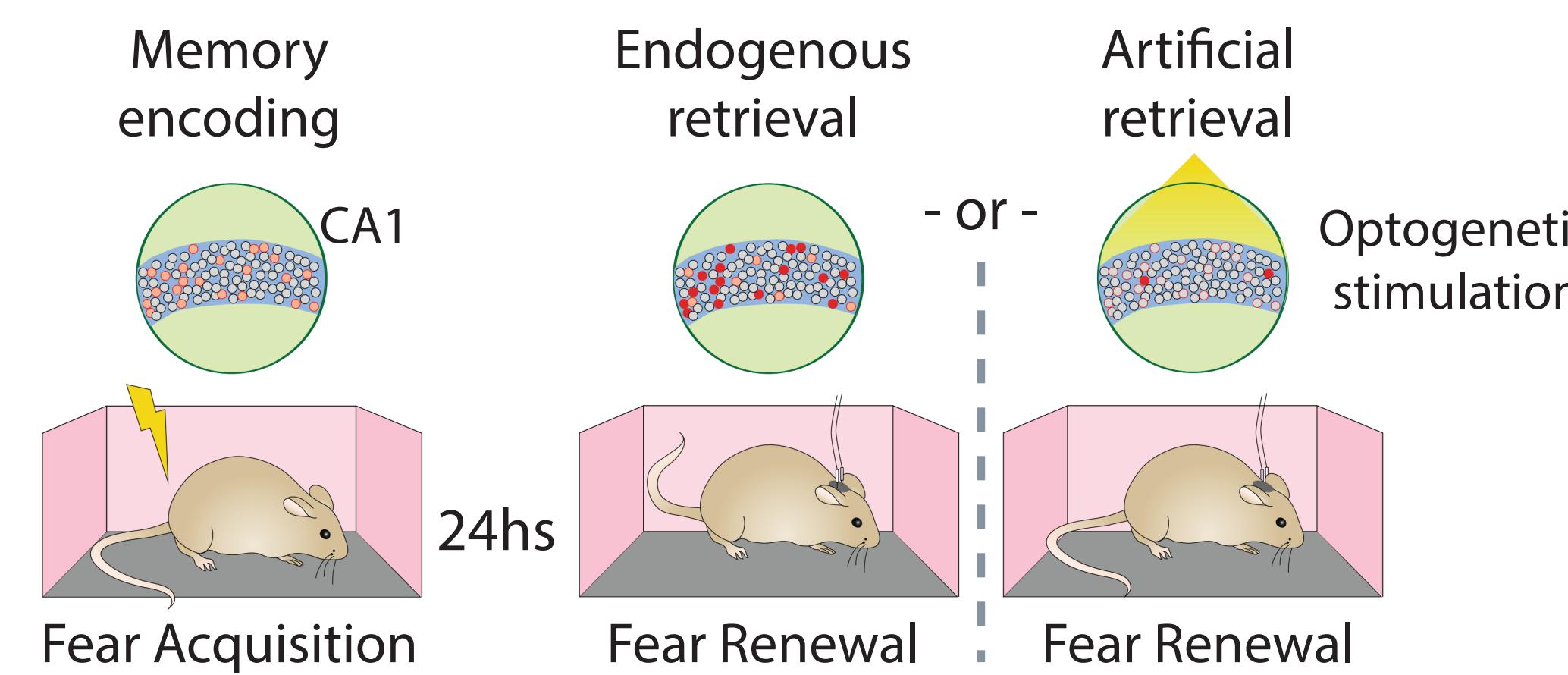
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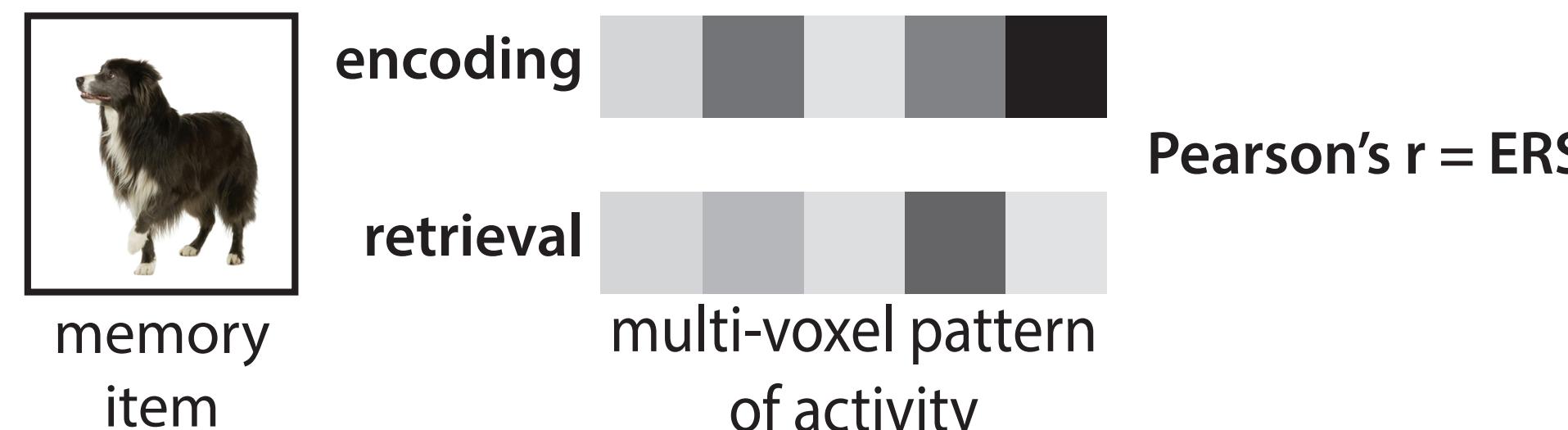
1. INTRODUCTION

Background

Specificity of neural coding



Reinstatement in the human brain



Dual role of PFC in emotional memory

- Engram studies mainly focus on the hippocampus, but the encoding and retrieval of emotional memories involves the amygdala, hippocampus, and PFC
- dACC and vmPFC code for associative memories of opposite valence

Fear acquisition
Extinction
QUESTION:
Are associative emotional memories organized the same way in humans as in rodents?

Hypotheses

- Emotional memories of similar valence will elicit similar patterns of activity across the PFC
- There will be a double dissociation of emotional memory reinstatement in the PFC

 - We predict that fear acquisition memories are preferentially reinstated in the dACC, while extinction memories are preferentially reinstated in the vmPFC

- Individuals with PTSD will display dysregulated reinstatement of emotional memories across these regions

 - Specifically, individuals with PTSD should show less reinstatement of extinction memories in the vmPFC compared to healthy adults

2. METHODS

N=24 Healthy adults, N=24 Individuals with PTSD

2-day fMRI study, TR = 2s, 3mm³ resolution. Imaging data preprocessed with fMRIPrep, anatomical ROIs defined via freesurfer automatic grey matter segmentation

Episodic-associative hybrid task

Day 1: Emotional memory encoding

Baseline
Fear acquisition
Extinction
Stimulus = 4, 4.5, 5s, ITI = 5, 6, 7s
24 unique CS+ and CS- per phase
144 images total
CS+ CS- = Animals, Tools
50% CS-US reinforcement
Do you expect a shock?
Unique episodic memory items approximate a neural "engram tag"

Day 2: Emotional memory retrieval

Surprise Recognition Memory Test

Definitely Old
Maybe Old
Maybe New
Definitely New

Stimulus = 3s, ITI = 4s
144 probes + 96 novel foils
3 memory runs

Memories are retrieved in a neutral emotional context, with no threat of shock

Regions of interest
dACC
vmPFC

Quantifying representational similarity

A RSM with 288 trial unique LS-S β images (144 encoding, 144 retrieval) is built for each ROI

Extinction learning is gradual, we will consider early extinction (4 CS+- trials) and late extinction separately

Baseline
Fear acquisition
Extinction

QUESTION:
Are associative emotional memories organized the same way in humans as in rodents?

Representational Similarity Matrix
Healthy adults - dACC
within phase similarity
encoding: CS+ fear acquisition
Emotional representational quality is operationized as the difference between CS+ and CS- items
Δ fisher z(r) = CS+ - CS-
within phase similarity
retrieval: CS- extinction
encoding-retrieval similarity
item level: CS+ fear acquisition
set level: CS- baseline
CS+ CS- CS+ CS-

3. RESULTS

Within-phase similarity

Healthy group
dACC
vmPFC
Regions of interest
dACC
vmPFC
Baseline Acq Early Ext. Late Ext. Ext.
Main effect of encoding phase* and memory phase*, and an interaction of encoding phase X memory phase*

Encoding-retrieval similarity

Healthy group
dACC
vmPFC
Regions of interest
dACC
vmPFC
Baseline Acq Early Ext. Late Ext. Ext.
Main effect of encoding phase*, and an interaction of encoding phase X ROI*

Group comparisons

Control - PTSD
dACC
vmPFC
Regions of interest
dACC
vmPFC
Baseline Acq Early Ext. Late Ext. Ext.
No significant main effect or interaction of group

References

Frankland, Quirk & Mueller, Dunsmoor, etc

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PTSD group
dACC
vmPFC
Regions of interest
dACC
vmPFC
Baseline Acq Early Ext. Late Ext. Ext.
No significant main effect or interaction of group

Encoding-retrieval
dACC
vmPFC
item level
set level
Baseline Acq Early Ext. Late Ext. Ext.
No significant main effect or interaction of group

Encoding-retrieval
dACC
vmPFC
item level
set level
Baseline Acq Early Ext. Late Ext. Ext.
No significant main effect or interaction of group