Neural mechanisms underlying reactivation-induced perceptual learning

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Introduction

• Perceptual learning leads to increase in visual sensitivity and is enabled by repeated practice.
• However, visual perceptual learning was recently shown to be achieved by brief reactivations of the encoded task [1].

What are the neural mechanisms underlying reactivation-induced learning?

Hypothesis

In contrast to the standard practice-dependent plasticity dominant in early visual areas [2], a more significant engagement of high-level regions mediates rapid reactivation-induced perceptual learning.

Methodology

Procedure

252 trials Full practice

5 trials Reactivations

Pre-training scan

Day 1 Day 2 Day 3 Day 4 Day 5

Post-training scan

Participants: Naive healthy adults, ages 18-40 years, with normal or corrected-to-normal vision.

Texture Discrimination Task (TDT) [3]

Vertical or Horizontal?

Threshold (ms)

Lab session

fMRI session

Control task

N=18

TDT>Control task, Post>Pre

0

Control task

N=18

Reactivation

Full practice

Reactivation

Post

Reactivation

Pre

0

Before learning

Following learning

Control IPS

DMN IPS/ERFC

VIFC

Attention

Control

Precuneus

Control task

N=18

Reactivation

Full practice

Reactivation

Post

Reactivation

Pre

0

Performing the perceptual task pre-training produced stronger activations in attention, control, and DMN regions compared to the control task.

Following learning, the reactivation group showed stronger activations in attention and control regions and weaker activations in DMN regions relative to the Full-practice group.

Behavioral results

Threshold (ms)

Performance measured in % correct

Reactivation-induced learning (t=-5.63, p<.001) and Full-practice (t=-5.12, p<.001) were both highly significant and comparable (t=-0.99, 92, BF=1.16).

Correlation between lab session and fMRI session

The task performed during fMRI yielded a significant improvement in both Reactivation (t=4.70, p<.001) and Full-practice (t=0.01, p>0.05) groups, with no significant interaction (t=-1.8, p=.08, BF=1.22).

Conclusions

• Brief memory reactivations induced significant learning, comparable to full-practice.
• Reactivation-induced learning involves stronger activity in higher-order attention related regions relative to full-practice.
• Reactivations are beneficial for minimizing practice, and may also enhance learning generalization via engagement of higher-order brain regions [4].

References


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