Weakening memories through closed-loop modulation of perceptual distraction

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Introduction

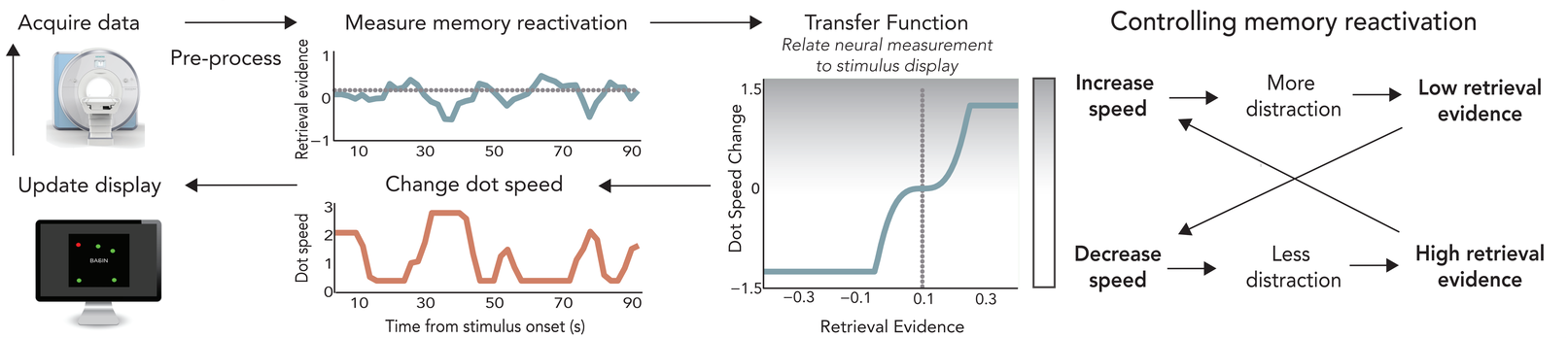
Moderately reactivating memories leads to weakening of those memories (Newman & Norman, 2010; Detre et al., 2013; Kim et al., 2014; Lewis-Peacock & Norman, 2014)

Perceptual distraction (via Multiple Object Tracking, MOT) can control memory reactivation (Poppenk & Norman, 2014, SfN)

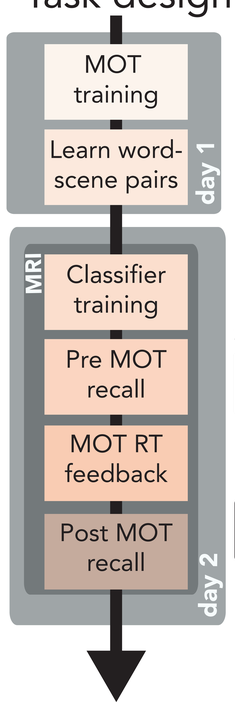
Closed-loop fMRI neurofeedback can be used to adjust task difficulty in real time (deBettencourt et al., 2015)

Goal: Adjust perceptual distraction in real time to promote moderate memory reactivation, thereby enhancing memory weakening effects

Closed-loop neurofeedback



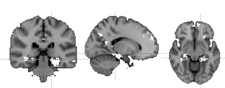
Task design



Subject groups

Real-time (n = 7)
controls dot speed changes
Yoked-control (n = 7)
dot speed controlled by previous subject

Retrieval mask



Neurosynth.org

Classification training

4 trial types to decode scene retrieval

Retrieval | Control

Fast dots

Slow dots

MOT trials: 10 trials/block, 3 blocks

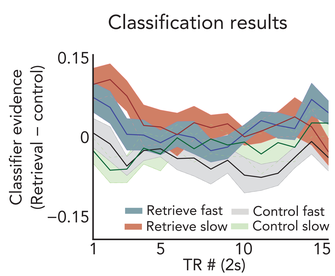
Recall trials: 20 trials/block

Stimulus types

1. MOT (10 scenes): shown during MOT
2. Omit (10 scenes): not shown during MOT

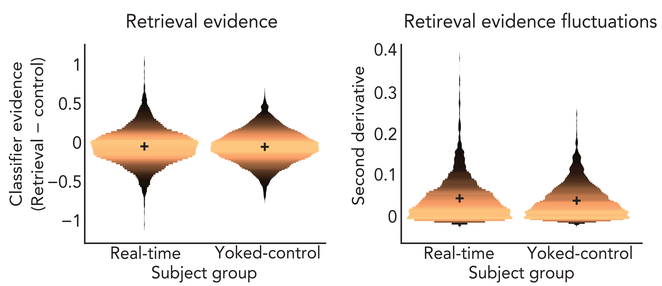
Neural decoding

1. Can we decode memory retrieval?



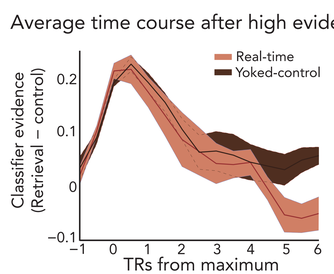
Yes: retrieval trials show more retrieval evidence

2. Did we stabilize retrieval in the "optimal" range during MOT?



No: RT groups show higher classifier evidence variance and larger temporal fluctuations

3. Why isn't retrieval evidence stable?

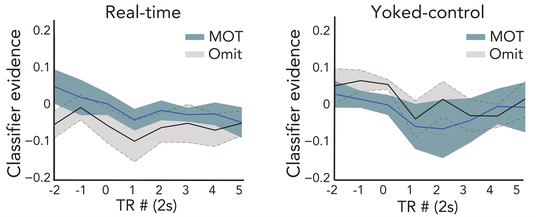


Rt-feedback overcompensates

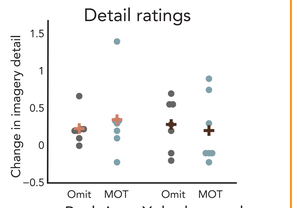
Memory results

How does dot tracking affect memory for that scene (post-pre MOT)?

1. How is retrieval classifier evidence affected?



2. How are detail ratings affected?



Real-time subjects show less evidence of forgetting compared to yoked-control subjects

Discussion

Our current neurofeedback system may be too reactive to subtle changes in memory reactivation.

This can be further refined with the following improvements:
- Decreasing the gain on the transfer function
- Testing the success of different machine learning algorithms to detect retrieval evidence
- Applying control systems theory to optimize feedback

In the future, we seek to adapt this paradigm for clinical populations using negatively-valenced stimuli.

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