Decoding and Training Sustained Attention with Real-Time fMRI

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Introduction

Selective attention fluctuates when sustained over time, and behavioral errors can occur when attention lapses

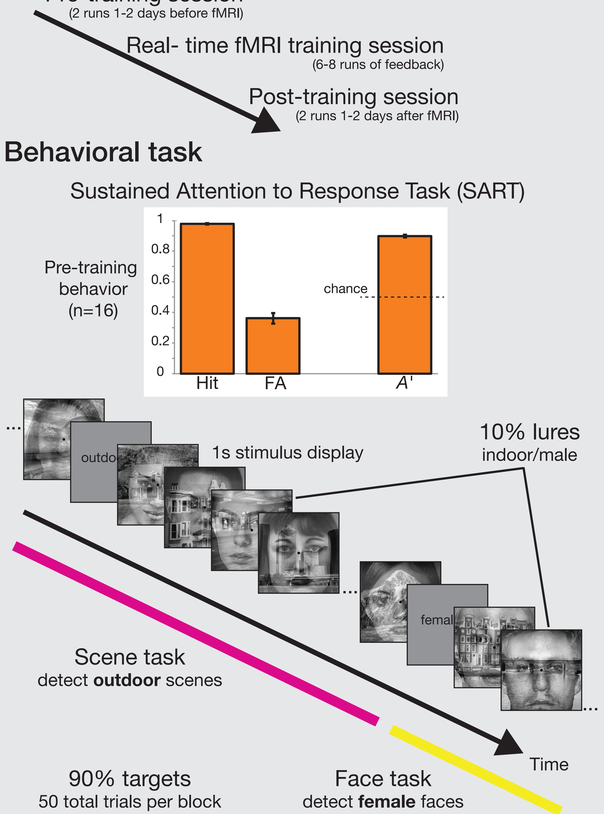
Detecting attentional fluctuations could allow for the delivery of timely feedback when lapses occur

How can attentional fluctuations be measured?

What is the training benefit of real-time feedback?

Design

Experimental procedure

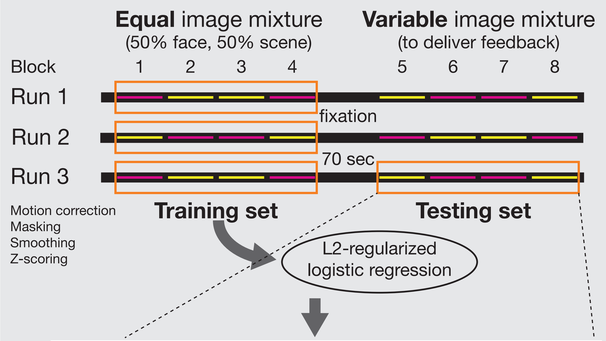


Behavioral task

Sustained Attention to Response Task (SART)

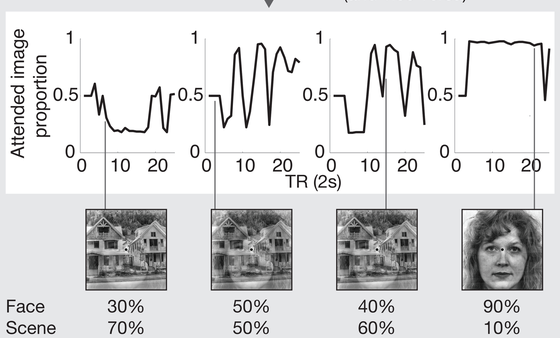
Real-Time Decoding

Strategy: Decode attentional state and give feedback about classifier success



Classifier activation determines image mixture

Better neural representations lead to clearer images (and vice versa)



Subject groups

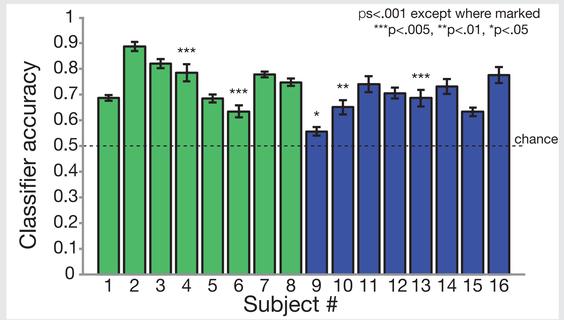
Feedback group — Classifier output → Next stimulus

Yoked-Control group — Classifier output → Next stimulus

fMRI Results

Classifier cross-validation

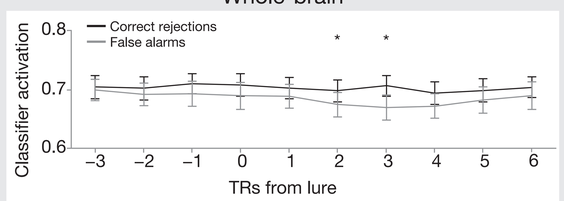
Test real-time models on equal image mixture portions of runs that were not in training set



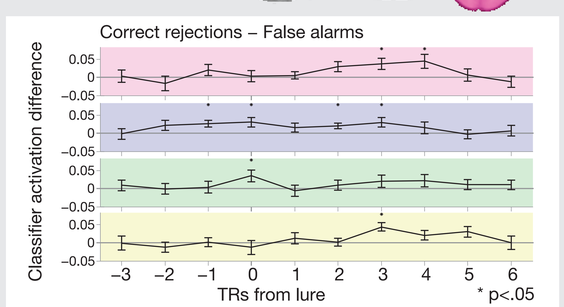
Robust whole-brain decoding of attentional state

Relating behavior to classifier

Whole-brain



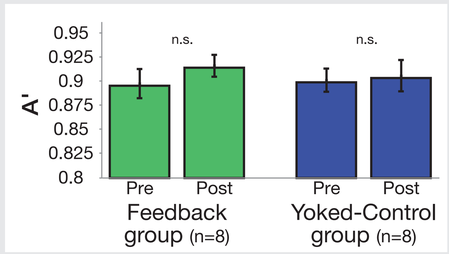
Anatomical masks



Greater evidence of attended category before (temporal and parietal) and after avoiding lure

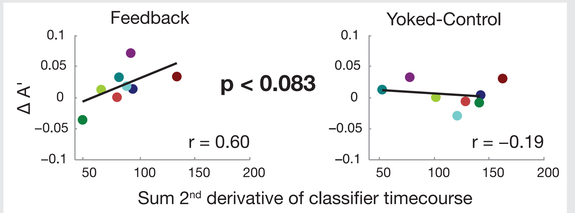
Initial Training Results

Overall change in behavior



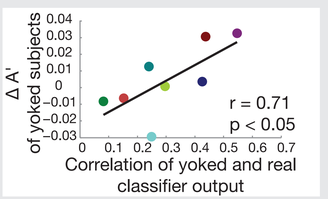
Training experience

What provides the best opportunity to learn?



Yoked-Control improvement

What happened when yoked feedback was accidentally accurate?



Discussion

Real-time MVPA over whole brain can measure fluctuations in sustained attention and predict behavior

Preliminary evidence that real-time neurofeedback can be used to train selective attention

In particular, rapid fluctuations in attentional state provide an opportunity to learn from (accurate) feedback

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