Activation of posterior parietal cortex when viewing trained symbols compared to untrained symbols after drawing experience

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Introduction

Background

- Drawing facilitates visual recognition. [1]
- Drawing leads to changes in brain function during visual perception. [1]
- BOLD signals can be used to measure brain activation during visual perception using functional Magnetic Resonance Imaging (fMRI).[2]

Hypothesis/ Experimental Questions

We hypothesized that changes in brain function after drawing would be related to changes in visual recognition after drawing, because drawing leads to both changes. To test this hypothesis, we asked:

- Are the symbols recognized by the participants?
- What regions of the brain are more active when viewing trained compared to untrained symbols?
- Is there a correlation between brain activity and recognition?

Methods

Participants

27 adults consented to participate in this IRB approved study

Stimuli

Over 200 symbols were used in this study, but only 40 of them were used for training (Figure 1). The others were used as distractor symbols.

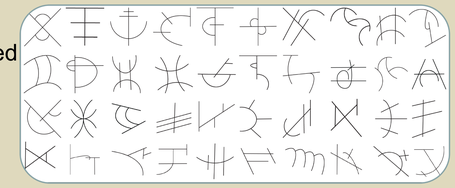


Figure 1. 40 trained symbols in training sessions

Design

Subjects learned to draw novel symbols and were tested on their ability to visually recognize them for 4 days before undergoing fMRI (Figure 2). During fMRI, participants viewed trained and untrained symbols.

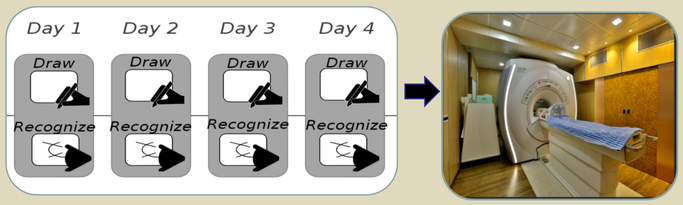


Figure 2. The overall experimental design

Methods

Procedure

Training—Subjects were tasked with drawing symbols in training sessions that lasted for 30 minutes. Symbols were drawn 10 times at each session.

Testing—After training, subjects were presented with trained and distractor symbols and were tested on their ability to recognize the symbols they had learned to draw during training.

MRI Scans—An MRI scan was taken after the training sessions, each scan containing tasks of identify distractor symbols from trained symbols.

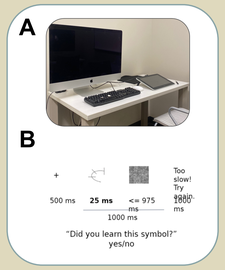


Figure 3. Training and Testing Procedure. **A.** Wacom tablet for drawing training and computer for recognition testing. **B.** Example trial of visual recognition test.

Data Analysis

FSL was used for fMRI data analysis, including a whole brain contrast followed by functional and anatomical region of interest (ROI) analyses. Correlation analyses determined the relationship between brain activity and recognition.

Results

Behavioral (Recognition) Testing

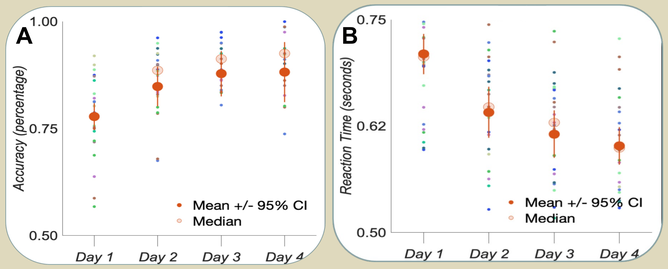


Figure 4. Visual Recognition Performance at Test. Participants became more accurate (**A**) and faster (**B**) with each day of training. By day 4 of training, participants recognized symbols with above chance accuracy, t(26)=16.46, p<0.001, chance = 50%. Each dot represents one subject.

Brain Activation During Symbol Viewing

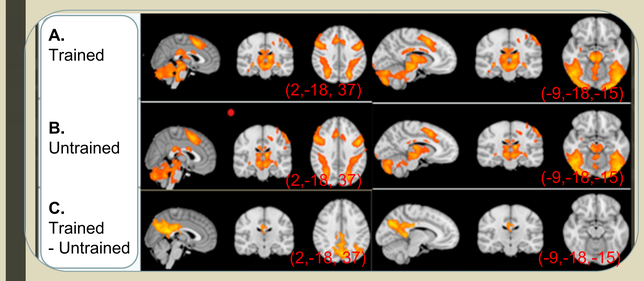
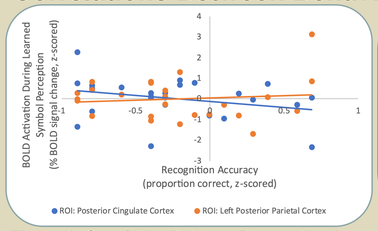


Figure 5. Brain activity when viewing trained and untrained symbols. **A.** Brain activation when viewing trained symbols. **B** Brain activation when viewing untrained symbols. **C** Brain activation after subtracting the activation of trained symbols from the activation of untrained symbols.

Results

Correlations Between Behavior and Brain Activity



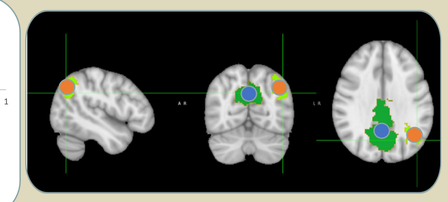
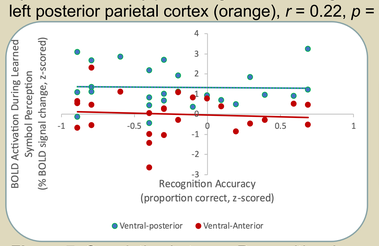


Figure 6. Correlation Between Recognition Accuracy and Functional ROIs During Perception of Trained Symbols. Accuracy plotted against BOLD signal for posterior cingulate cortex (blue), r = -0.09, p = 0.66, and left posterior parietal cortex (orange), r = 0.22, p = 0.26, during Trained Symbol blocks.



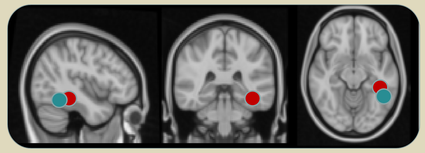


Figure 7. Correlation between Recognition Accuracy and Anatomical ROIs During Perception of Trained Symbols. Recognition Accuracy plotted against BOLD signal in 2 ROIs: 10 mm spherical ROIs [3] centered on Talairach coordinates [37, 38, 7] (green) , r = -0.027, p = 0.9, and [44, 49, 9] (red) , r = -0.091, p = 0.67.

Discussion

- Recognition testing indicated that subjects learned to visually recognize symbols after drawing—an increase in accuracy and a decrease in reaction time per day.
- Whole brain contrasts demonstrated that subjects' brain activity during visual perception was changed after drawing—greater activation in bilateral posterior cingulate cortex and posterior parietal cortex when viewing trained compared to untrained symbols.
- Visual recognition and brain activity after drawing were not related—no correlation between recognition and BOLD signal in either functional or anatomical ROIs.
- **Conclusion:** Learning experiences, like drawing, may lead to changes in the way that the brain supports visual perception that may not be related to recognition.

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References

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