# Causal manipulation of activity in the ventral visual stream changes visual long-term memory storage

Chong Zhao & Geoffrey F. Woodman

Vanderbilt University, Department of Psychology, Vanderbilt Vision Research Center

## Abstract

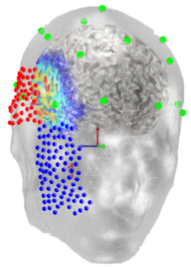
Modern theories of memory propose that the temporal cortex is critical for storing detailed visual long-term memory representations. Here we tested this idea by causally manipulating activity in the temporal lobe of human subjects performing a visual recognition memory task. Subjects were required to remember 500 pictures of common visual objects following 20 minutes of transcranial direct current stimulation (tDCS) applied to the temporal lobe (10/20 electrode T3 or T4) or following a sham procedure to which subjects were blind. First, we applied anodal tDCS and found that subjects' recognition memory performance was better than their sham baseline. Second, we applied cathodal stimulation and found that subjects' recognition memory performance was worse than their sham baseline. Third, to determine whether the memory enhancement effect was due to enhanced encoding or retrieval, we applied stimulation immediately prior to the visual memory test phase. This experiment showed no benefit of stimulation when applied prior to retrieval. Fourth, to understand the neural dynamics underlying the enhanced recognition memory performance, we recorded the subjects' electroencephalogram (EEG) and their averaged event-related potentials (ERPs) after anodal tDCS. We found that the stimulation-induced memory enhancement was accompanied by significant inhibition of alpha-band power as the pictures were encoded into visual long-term memory. Our findings provide causal support for the view that activity in the temporal lobe (i.e., the ventral visual stream) is essential for accurate storage of representations in visual long-term memory.

## Acknowledgement

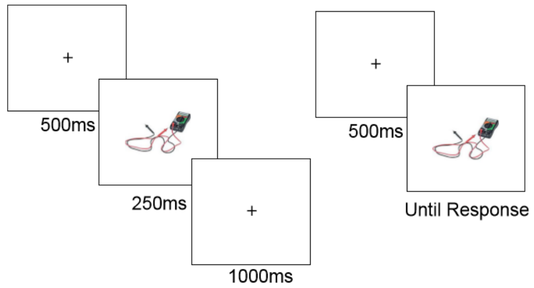
Grants were provided by the National Institutes of Health to GFW (R01-EY019882, R01-MH110378, and P30-EY08126).

## Stimulation Model and Recognition Memory Task

***20 min of tDCS over T3/T4***

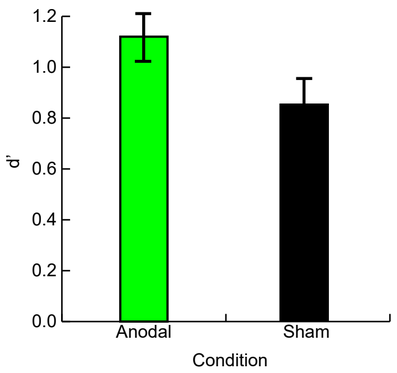


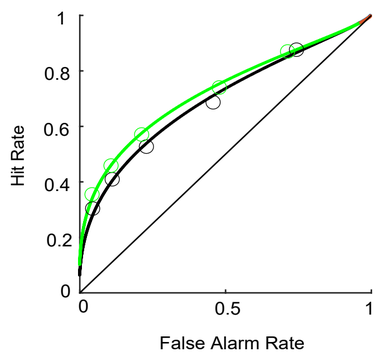

***Recognition Memory Task***



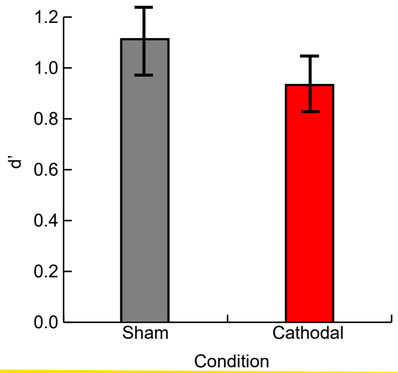

## Behavioral Results

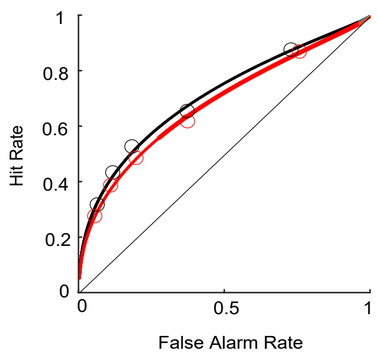
***20 min of pre-encoding anodal tDCS improves recognition memory***



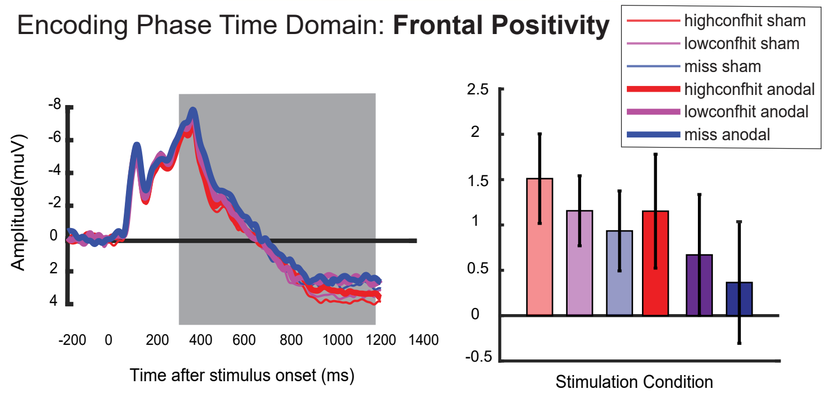

***20 min of pre-encoding cathodal tDCS impairs recognition memory***



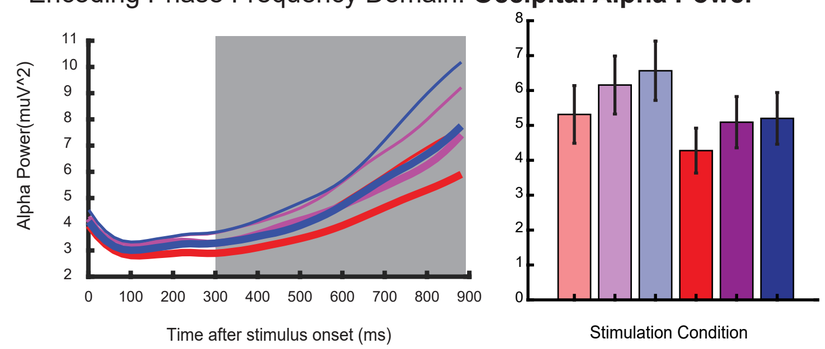




## EEG Results

Encoding Phase Time Domain: **Frontal Positivity**




Encoding Phase Frequency Domain: **Occipital Alpha Power**




Retrieval Phase Frequency Domain: **Occipital Alpha Power**