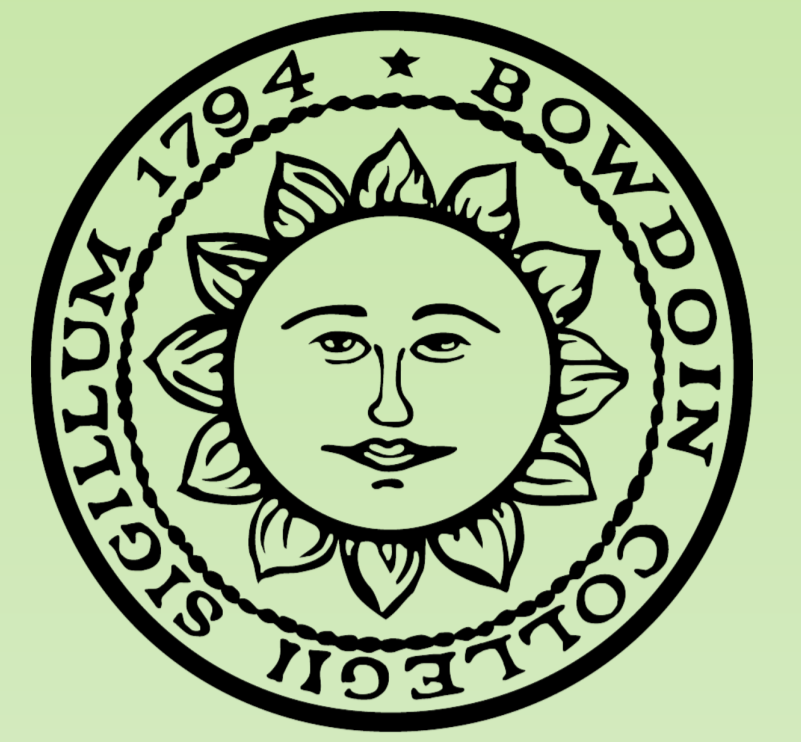# How to Use tACS to Change Your Memory Confidence

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INTRODUCTION

o The importance of theta (3-7 Hz) oscillations in memory is well established.[1] Specifically, frontal theta is associated with retrieving source information and parietal theta with memory confidence.[2,3]

o Most previous studies have only explored correlations between memory and theta oscillations.

o **We utilized transcranial alternating current stimulation (tACS) to explore the direct contribution of theta oscillations in memory.**

o Experiment one[4] is a recently published study and experiment two is currently ongoing.
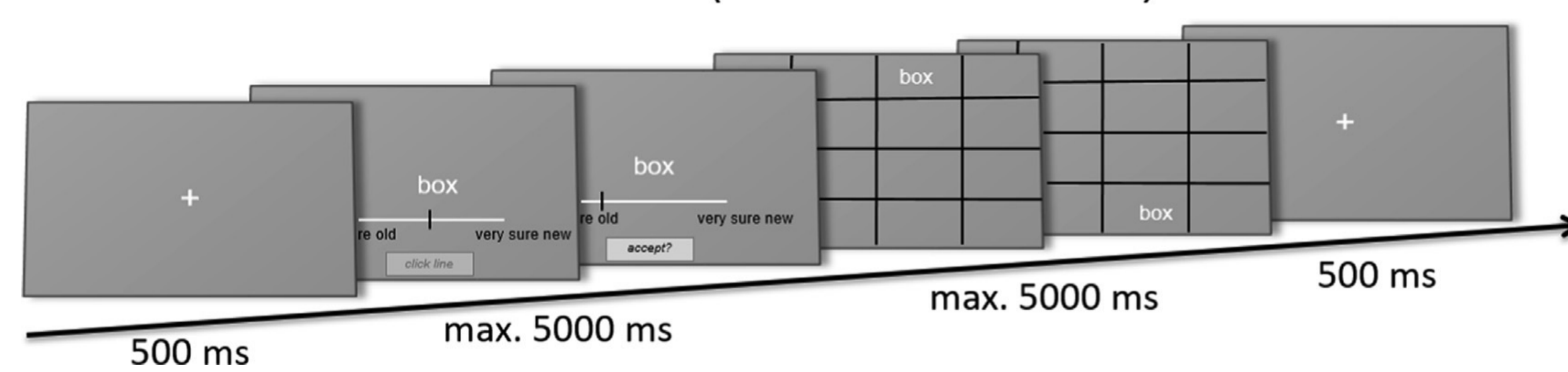
EXP 1: DESIGN

o *Objective.* In experiment one, we applied theta tACS bilaterally over the parietal cortex during retrieval. **The aim of this study was to explore the role of parietal theta oscillations in memory performance and confidence.**

o *Participants.* Fifty-four (38 females) participants with a mean age of 21 were included in this within-subject study.

o *Memory task.* During encoding, 200 words were presented to the participant at random locations on the screen. During retrieval, 200 'old' words and 200 'new' words were presented. Participants rated their memory on a confidence scale and thereafter recollected the location of the remembered words.
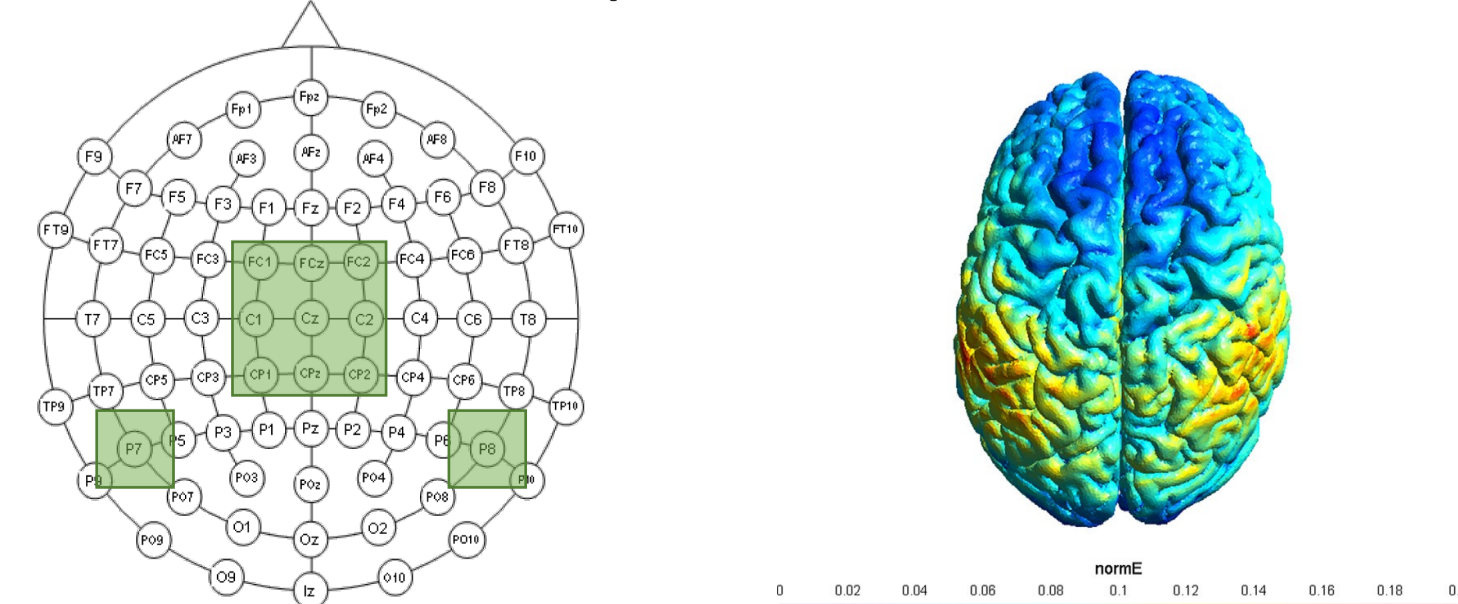
Encoding Trials (*natural or manmade?*)
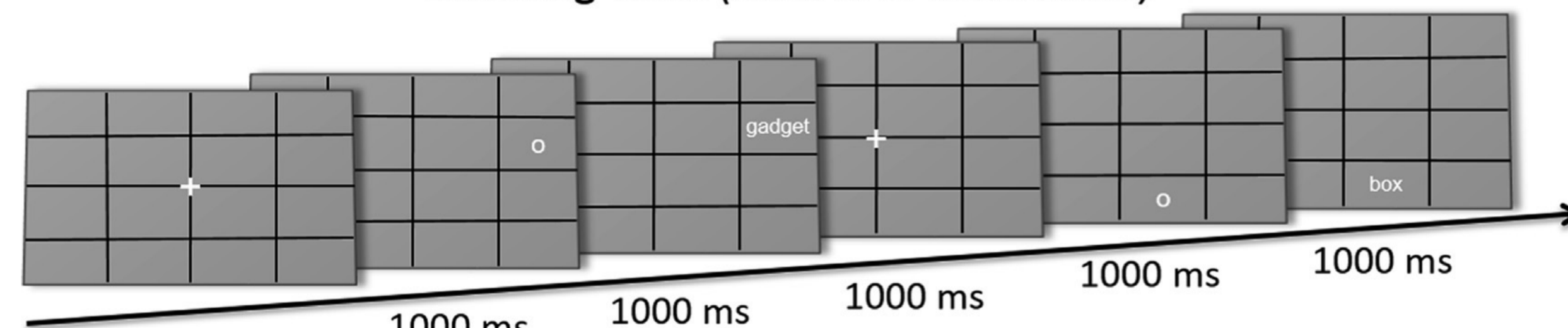
Retrieval Trials (*Old or New? Location?*)

o *tACS.* Participants received target (3.5 Hz), control (8 Hz), or sham tACS during retrieval in three sessions (counterbalanced and randomized). Electrodes were placed over P7, P8 and Cz.


EXP 1: RESULTS

o The three tACS conditions were compared, and results showed **no effect of tACS on memory performance, but theta tACS reduced memory confidence** as compared to sham.


EXP 2: DESIGN

o *Objective.* In experiment two, we applied theta tACS over the left parietal cortex and right prefrontal cortex during retrieval. **The aim of this study was to explore frontoparietal theta in memory performance and confidence.**

o *Participants.* Currently, 25 (17 females, mean age 20) out of 54 participants are included in this within-subject study.

o *Memory task.* During encoding, 200 words were presented to the participant. They either imagined a word-related place or rated the pleasantness of the word. During retrieval, 200 'old' words and 200 'new' words were presented. Participants indicated whether they remembered the word and in which condition (place/pleasantness), and rated their memory confidence.
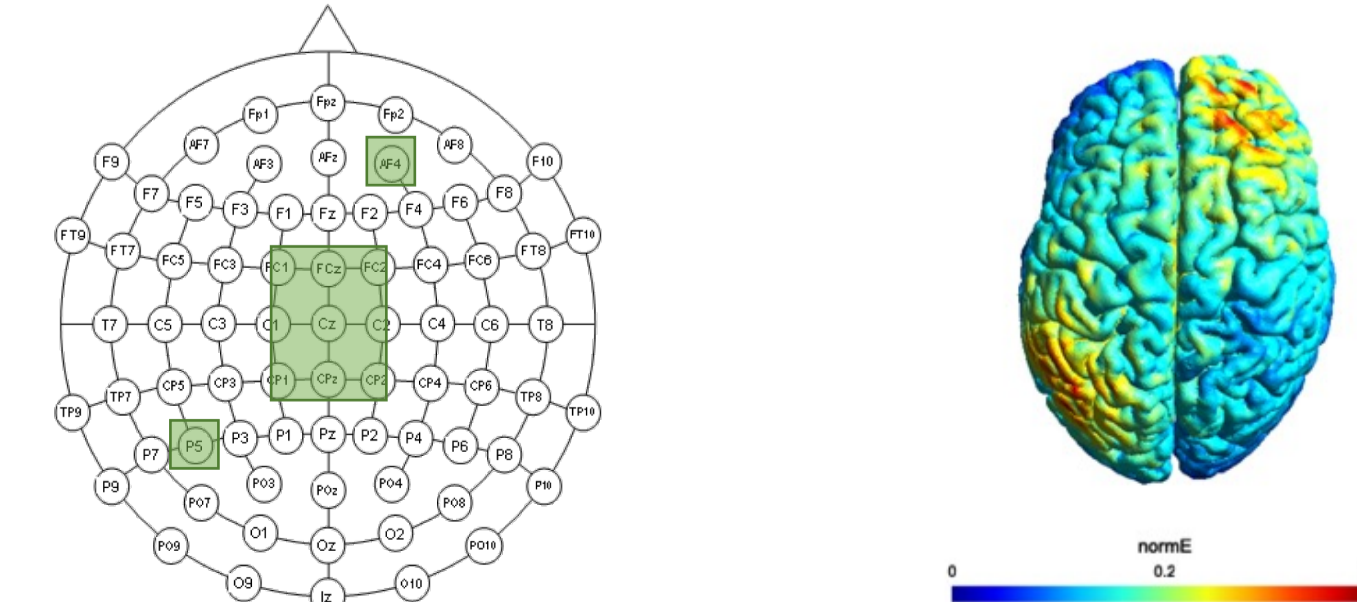
Encoding Trials (*place/pleasantness?*)
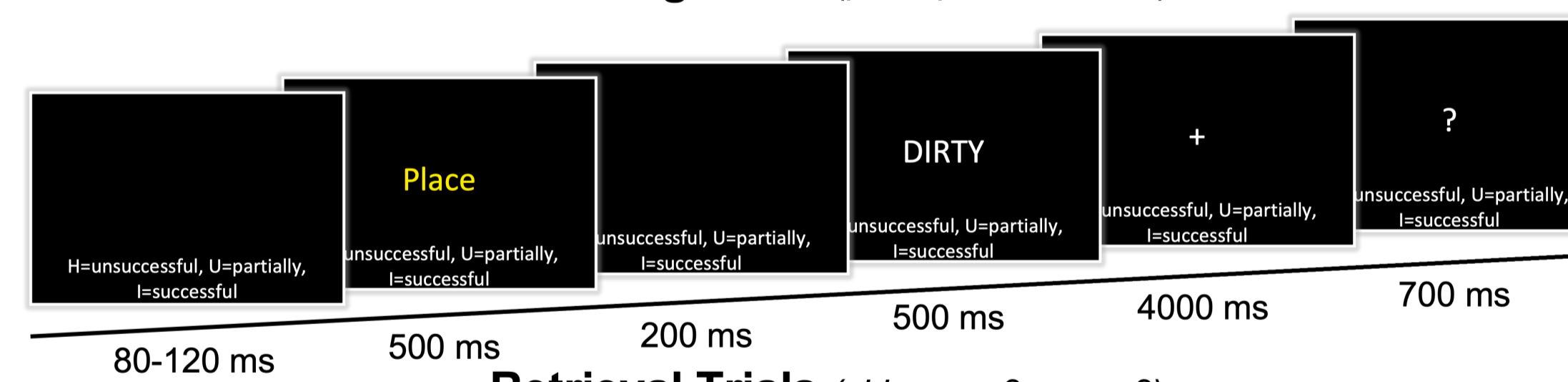
Retrieval Trials (*old or new? source?*)
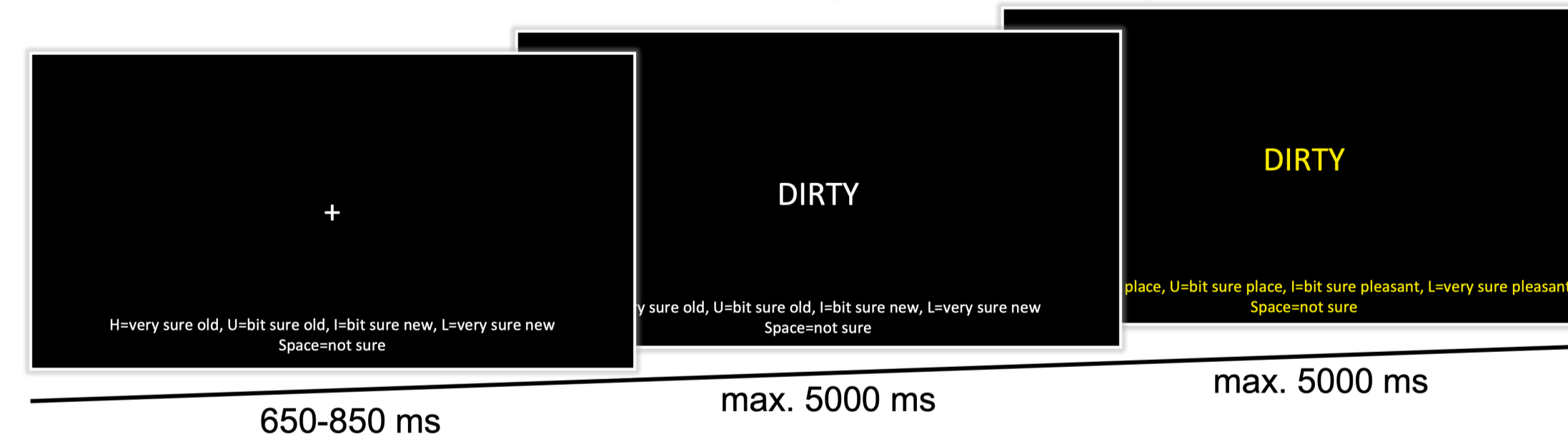
o *tACS.* Participants received target (4 Hz), control (50 Hz), or sham tACS during retrieval in three sessions (counterbalanced and randomized). Electrodes were placed over AF4, P5 and Cz.

o *EEG.* EEG was recorded during the experiment from 32 electrodes.

EXP 2: ANALYSES

Planned behavioral analyses

o The main behavioral outcomes are: recognition (old/new) accuracy, source (place/pleasantness) accuracy, and memory confidence.

o We will compare the three tACS conditions across these variables.

o **We mainly expect a theta tACS effect on source accuracy and memory confidence**, given the involvement of the frontoparietal network in both source memory and memory confidence.[5]

o The direction of this effect is hard to predict, since tACS could optimize theta entrainment or disrupt ideal endogenous theta oscillations.

Planned electrophysiological analyses

o We will investigate electrophysiology that can predict behavioral tACS effects and electrophysiology directly related to tACS effects.

o Prior to the stimulation sessions, all participants will complete a baseline session, where memory and task-related electrophysiology will be established.

o **We will investigate whether task-related baseline behavioral performance and theta power are able to predict tACS-induced effects.**

o The biggest challenge of experiment two is the removal of the tACS artifact in order to look at direct effects of tACS on brain oscillations. By minimizing the artifact and comparing conditions within a session, we hope to subtract most of the common tACS artifact.

o **We aim to get information regarding the electrophysiological mechanisms behind the behavioral tACS effects.**

SUMMARY

o **Here we presented two experiments where we used tACS to explore the role of theta oscillations in memory retrieval.**

o **In experiment one, we showed that theta tACS can be used to alter memory confidence, indicating a direct involvement of parietal theta oscillations in the subjective aspect of memory.**

o **We presented our plans for experiment two, where we will investigate the direct role of frontoparietal theta in memory.**

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