Transcranial Electrical Stimulation as a Potential Intervention for Internalizing Psychopathologies: Does Current Type or Sham Ordering Matter?

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Background

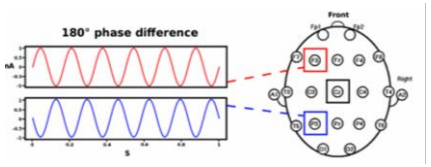
Internalizing psychopathologies involving depression and anxiety are characterized by negative bias and a disruption in the ability to successfully regulate emotions. Potential biomarkers to target this disruption include the dorsolateral prefrontal cortex (DLPFC), an integral region to successful emotion regulation shown to be disturbed in internalizing psychopathologies, and the theta frequency band which becomes more synchronized during conflict and anxiety.

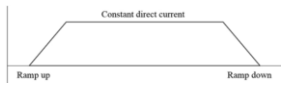
Objectives

We hypothesized that by targeting these potential biomarkers, we might be able to relieve anxiety or depressive symptoms. For this purpose we applied either transcranial alternating current stimulation (tACS) or transcranial direct current stimulation (tDCS) during or before participants completed a set of emotional response tasks (ERTs). We were interested in determining which methodology would yield the more promising results and took a deeper look into potential effects of using both sham and verum stimulation in the same day.

Methods

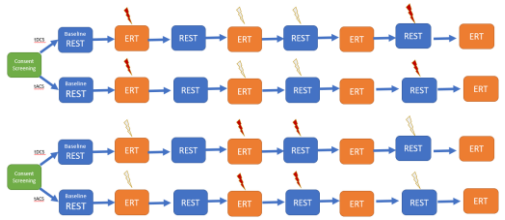
Transcranial Stimulation





ACS Participants:
*Stimulating electrodes were placed where theta synchrony was determined to be the highest in each participant.
*Alternating current was applied at 6HZ with a 180 degree phase difference.

DCS Participants:
*Anodes were placed over the left DLPFC, and cathodes were placed over the contralateral supra-orbital area.
*A constant 6Hz current was applied during the full duration of stimulation time windows.

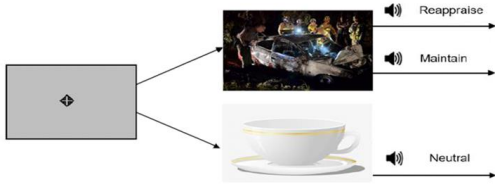


Full Session Design

*Participants were randomly assigned to receive either ACS or DCS and underwent a series of ERT tasks and rests, such that they received verum/sham stimulation during the first two ERT tasks and the last two rests.
*Approximately 50% of participants received sham stimulation for their first session and 50% received verum stimulation for their first session.

ERT Task Design

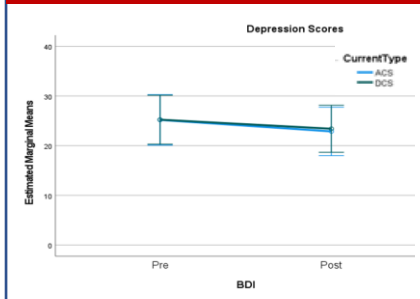
*Participants completed 4 ERT tasks where they had to look at neutral stimuli, maintain a negative affect while viewing negative images, and reappraise negative images.

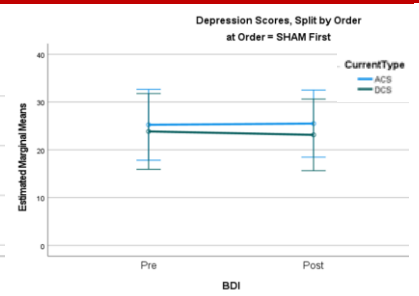


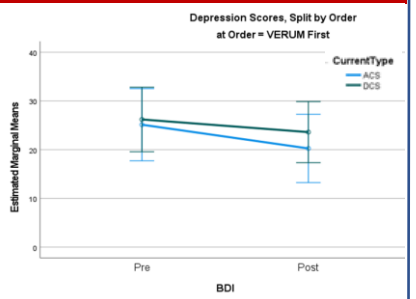
Clinical Analyses

Depression Scores: Participants completed the Beck Depression Index (BDI) both before and after the study.
Anxiety Scores: Participants completed the Spielberger State and Trait Anxiety Index (STAI) before the study and following each block of ERT and rest, resulting in 5 total scores. Only state anxiety items were included in the questionnaire.
*Analyses were performed in SPSS, both on all ACS and all DCS participants as well as stratified by their order of stimulation.

Results

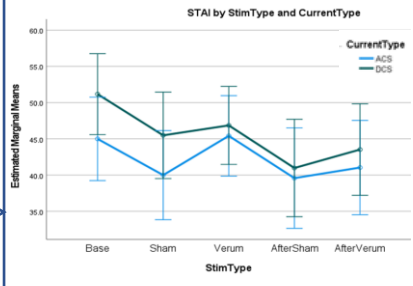


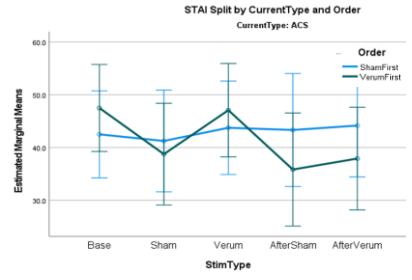


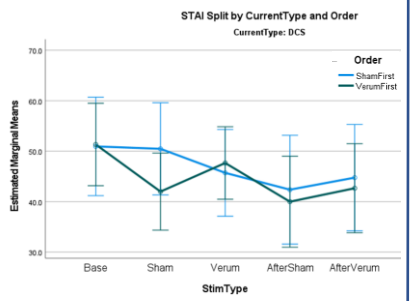


Initial analysis of ACS participants and DCS participants yielded a significant decrease in depression scores in ACS participants ($F(1,14)=8.914$, $p=.010$), but a non-significant decrease in DCS participants ($F(1,15)=1.067$, *ns*).

When the data was stratified by the order in which participants received stimulation, however, DCS participants showed a slight but significant decrease in BDI scores ($F(1,9)=6.183$, $p=.035$) and ACS participants showed a stronger decrease in depression scores ($F(1,7)=21.862$, $p=.002$). Neither group showed significant changes in BDI scores when they received sham stimulation first.







Initial STAI analyses yielded no significant main effect in the ACS participants ($F(1,15)=.983$, *ns*) and a non significant decrease in scores from the start to the end of the study ($t(15)=1.179$, *ns*), but a significant main effect of STAI in DCS participants ($F(1,16)=7.128$, $p=.017$), as well as a significant decrease from start to finish ($t(16)=2.945$, $p=.010$).

Sham-first ACS participants showed no significant change over the course of the study, but those receiving verum first showed a significant main effect of STAI ($F(1,7)=7.589$, $p=.028$), as well as a strong significant decrease from start to finish ($t(7)=2.592$, $p=.036$). DCS participants receiving either stimulation type first displayed a significant decrease from before to after the study.

Future Directions

Theta-targeted offset tACS appears to be a promising method for modulating symptoms of internalizing psychopathologies, more so than using tDCS to target DLPFC. More work is required, however, to better understand potential effects of the standard “sham” methodology and to determine if it is truly a placebo condition.