

# tDCS reduces depression and state anxiety symptoms in older adults from the augmenting cognitive training in older adults study (ACT)

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## ABSTRACT

**Background:** Pharmacological interventions for depression and anxiety in older adults often have significant side effects, presenting the need for more tolerable alternatives. Transcranial direct current stimulation (tDCS) is a promising non-pharmacological intervention for depression in clinical populations. However, its effects on depression and anxiety symptoms, particularly in older adults from the general public, are understudied.

**Objective:** We conducted a secondary analysis of the Augmenting Cognitive Training in Older Adults (ACT) trial to assess tDCS efficacy in reducing psychological symptoms in older adults. We hypothesized that active stimulation would yield greater reductions in depression and state anxiety compared to sham post-intervention and at the one-year follow-up. We also explored tDCS effects in subgroups characterized by baseline symptom severity.

**Methods:** A sample of 378 older adults recruited from the community completed a 12-week tDCS intervention with cognitive or education training. Electrodes were placed at F3/F4, and participants received active or sham tDCS during training sessions. We assessed the association between tDCS group and changes in depression, state anxiety, and trait anxiety from baseline to post-intervention and one-year controlling for covariates.

**Results:** The active tDCS group demonstrated greater reductions in depression and state anxiety compared to sham post-intervention, particularly in individuals with mild depression and moderate/severe state anxiety at baseline. Furthermore, the active tDCS group with moderate/severe state anxiety maintained greater symptom reductions at one-year.

**Conclusions:** tDCS effectively reduced depression and state anxiety symptoms in a large sample of older adults. These findings highlight the importance of considering symptom severity when identifying those who may benefit most from this intervention.

The Augmenting Cognitive Training in Older Adults study (i.e., ACT; [clinicaltrials.gov](https://clinicaltrials.gov) NCT02851511 [1]) is the largest sham-controlled randomized clinical trial for transcranial direct current stimulation (tDCS) completed to date. The ACT trial was ultimately designed to determine if a 12-week intervention, combining active stimulation with multi-domain cognitive training, would enhance performance on untrained cognitive tasks in a large sample of healthy, cognitively intact

older adults. Initial findings did not identify a significant tDCS effect; the entire sample, regardless of stimulation condition, demonstrated improvements on a composite score of untrained cognitive tasks (i.e., NIH Toolbox Fluid Cognition Composite) from baseline to post-intervention and at the one-year follow-up [2]. Notably, the ACT trial collected a robust set of cognitive, functional, neuroimaging, and self-report measures, providing an opportunity for secondary data analyses to discover

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unanticipated benefits from the intervention.

One avenue of exploration involves the growing evidence supporting tDCS as a non-pharmacological intervention for improving psychological symptoms. Through suspected modulation of cortical excitability in frontal brain regions involved in emotion regulation (i.e., the dorsolateral prefrontal cortex [dlPFC] [3–6]), tDCS has demonstrated efficacy in ameliorating depressive symptoms in clinically depressed populations [7–12]. Combining tDCS with other interventions, such as antidepressants or cognitive training, has resulted in sustained antidepressant effects [13] and further symptom reduction in individuals with depressive disorders [7,14]. However, results of a recent multi-site trial did not indicate an additional benefit of active stimulation with a stable dose of selective serotonin reuptake inhibitors (SSRIs) in adults with major depressive disorder [15], suggesting continued large-scale investigations of combined intervention approaches are warranted.

Fewer studies have examined the impact of tDCS on anxiety symptoms, despite the dlPFC's involvement in threat processing and anxiety regulation [16,17], and have typically assessed a broad range of clinical presentations (e.g., Generalized Anxiety Disorder, Social Anxiety Disorder, Anorexia Nervosa, mathematics anxiety, etc. [18]). In the context of Generalized Anxiety Disorder, some studies have demonstrated improvements in anxiety symptoms following stimulation [19,20], while others have shown no significant changes [21]. The heterogeneity of tDCS effects in clinical depression and anxiety populations identified across studies and in meta-analyses may be attributed to small sample sizes and differences in intervention implementation [10,18].

Given the comprehensive data collected, the ACT trial provides a unique opportunity to investigate whether previously identified stimulation effects on mental health extend to a broader sampling of older adults from the general population. Even in the absence of diagnosed psychiatric disorders, older adults often experience subclinical depression and anxiety symptoms, which are associated with adverse outcomes, including reduced quality of life, poorer physical health, increased functional disability, and increased healthcare utilization [22–26]. Subclinical psychological symptoms have also been linked to structural brain changes, such as reduced brain volumes and increased white matter hyperintensities [27–30], as well as an increased risk of cognitive decline in unimpaired older adults [26,31]. Therefore, it is crucial to identify effective intervention strategies to reduce psychological symptoms and potentially improve cognitive and functional outcomes in older adults.

To our knowledge, only two studies have specifically evaluated the effects of tDCS (combined with cognitive training) on psychological symptoms in older adults without psychiatric disorders [32,33]. Freidle and colleagues (2020) demonstrated no effect of tDCS on a scale measuring total mood disturbance or on a daily mood question [32]; however, Szymkowicz and colleagues (2022) revealed active stimulation was associated with reduced depression symptoms post-intervention [33]. Neither of these studies examined anxiety-specific measures. Leveraging data from ACT, the present study is a secondary data analysis that aims to assess the effects of a 12-week tDCS intervention on depression, state anxiety, and trait anxiety symptoms in 378 older adults recruited from the community. While *trait* anxiety refers to a relatively stable predisposition to interpret situations as threatening, *state* anxiety is the transient emotional reaction to a specific adverse circumstance [34]. The duration and intensity of state anxiety can vary depending on the perceived stressor. However, the acute nature of symptoms makes state anxiety more amenable to short-term interventions [35]. Hence, we hypothesized that compared to sham, participants receiving active stimulation would demonstrate a greater reduction in depression and state anxiety symptoms immediately following intervention and at a one-year follow-up. We do not expect an effect of stimulation on trait anxiety yet included this variable in analyses to confirm differential effects on transient versus more stable anxiety presentations. While individuals with diagnosed psychiatric disorders or self-reported moderate to severe depression symptoms were

excluded from the ACT parent trial, we further explored the effects of tDCS on symptoms within subgroups of participants divided by “symptom severity” based on their baseline mental health questionnaires. Specifically, we examined the magnitude of tDCS effects in individuals with minimal versus mild baseline depression symptoms and those with mild versus moderate/severe baseline state and trait anxiety symptoms. Collectively, the present findings contribute to our understanding of the potential efficacy of tDCS as an intervention for psychological symptoms in the general older adult population. Furthermore, results provide insight into who benefits most from this intervention, informing future efforts for personalized treatment approaches.

## 1. Methods

The following provides a summary of the methods from prior publications [1,2].

### 1.1. Inclusion and exclusion criteria

Briefly, older adults were recruited from the general community by the University of Florida and the University of Arizona. Participants were between 65 and 89, right-handed, fluent in English, and performed below the 80th percentile on the Brain HQ Cognitive Training composite to avoid potential training ceiling effects. Participants were excluded if they had a formal diagnosis or evidence of mild cognitive impairment (1.5 standard deviations below normative data in a single cognitive domain on the National Alzheimer's Coordinating Center Uniform Data Set battery [NACC UDS]) [36], dementia, past opportunistic brain infection, neurological disorders, major psychiatric illness (see screening details below), unstable and chronic medical conditions, cancer in the past three years, history of head injury resulting in loss of consciousness greater than 20 min, colorblindness, uncorrected vision worse than 20/80, hearing loss greater than 20 dB, MRI contraindications, and if they were on medications that interfere with tDCS (GABA-ergic, glutamatergic, or sodium channel blockers) [37]. Participants were not excluded if they reported using a medication that could be prescribed for depression or anxiety. All participants signed a consent form approved by the Institutional Review Boards at the University of Florida and at the University of Arizona [1].

### 1.2. Participants' depression and anxiety history

The screening for major psychiatric history was based on patient self-report, and the specific procedures were as follows. First, at telephone screening, participants were excluded if they answered “yes” to the question “Do you **have** any major psychiatric illness, such as schizophrenia, major depression and/or suicidality, bi-polar disorder, etc.?” At the in-person screening visit, participants were then asked to respond “yes” or “no” if they have “**ever had** any of the following conditions” including anxiety, depression, schizophrenia, or “other psychiatric illness.” If they responded “yes” to ever having any of the conditions, they were asked to specify the year of onset and report whether they had undergone treatment. Individuals who responded “yes” to ever having schizophrenia or specified another major psychiatric illness were excluded from trial participation. Individuals who responded “yes” to ever having anxiety or depression could be included in the trial as long as they did not describe currently experiencing significant symptoms negatively interfering with daily function upon further query by study staff. Furthermore, participants were excluded if they had a total Beck Depression Inventory – Second Edition (BDI-II) score  $\geq 20$  (indicative of at least moderate depression symptoms) and were encouraged to seek further evaluation for depression. As such, the present sample is inherently limited to individuals who reported minimal to mild depression symptoms at baseline. There was no exclusionary cut-off on the State-Trait Anxiety Inventory (STAI) for study entry; therefore, the sample includes individuals with a wide range of self-reported anxiety

symptoms.

At the in-person screening, 87 participants reported having a history of depression. Notably, 84 of these participants reported depression onset occurring years prior to the study (i.e., 1950–2015). One participant indicated experiencing depression in the year prior to their screening visit, while another participant reported depression in the same year as their screening visit. Despite this, both participants scored in the minimal symptoms range on the BDI-II at baseline. Finally, there was one participant who did not indicate a year of onset. Of the 87 participants reporting depression history, 73 had undergone treatment.

At the in-person screening, 74 participants reported having a history of anxiety. 65 of these participants reported anxiety onset occurring at least 2 years prior to the study (i.e., 1948–2018). Two participants reported anxiety onset in the year prior to their screening visit. One participant reported anxiety onset in the same year as their screening visit, and three participants reported a new instance of anxiety between their screening and baseline visit due to acute events. All four of these participants still scored within the mild symptoms range on the STAI state at the time. Finally, three participants did not indicate a year of onset. Of the 74 participants reporting a history of anxiety, 54 had undergone treatment. Taken together, this sample recruited from the community reported various depression and anxiety histories and were largely experiencing subclinical symptoms at baseline with 95.8% reporting minimal depression, 84.4% reporting mild state anxiety, and 88.4% reporting mild trait anxiety (Table 1).

1.3. Intervention

1.3.1. Education training and cognitive training

ACT was an adaptive, two-phase clinical trial design. In phase 1, 87 participants were randomized to one of four conditions for a 12-week intervention: cognitive training with active tDCS, cognitive training with sham tDCS, education training with active tDCS, or education training with sham tDCS. Analyses conducted at the end of phase 1 revealed that participants who received cognitive training demonstrated greater improvements on proximal tasks compared to the education training control group regardless of stimulation condition [38,39]. Therefore, education training conditions were eliminated for phase 2 of the study, and the remaining 292 participants were randomized to only the cognitive training conditions of the 12-week intervention (i.e., cognitive training with active tDCS or cognitive training with sham tDCS) [1,2]. 378 participants across phase 1 and 2 were included in present analyses (cognitive training n = 333, education training n = 45), controlling for training type to focus on the effects of tDCS on mental health outcomes (Fig. 1).

Over the 12-week intervention, participants were to complete sixty 40-min sessions (40 h total) of their respective training intervention (cognitive or education). Twenty of the sessions were combined with stimulation conducted in the lab by study staff, while the remaining training sessions were completed at home without stimulation on laptops provided by the study. Education training sessions involved watching 40 min of National Geographic Channel videos on history, nature, and wildlife. Participants were provided with a binder filled with questions related to each video and were asked to answer 4–6 content questions after each onsite and at-home session. Answers were collected from participants at their onsite stimulation sessions to provide feedback on training engagement. Cognitive training sessions involved completing 40 min of adaptive and computerized attention, processing speed, and working memory tasks from Posit Science’s Brain HQ program ([www.positscience.com](http://www.positscience.com); described in Woods et al., 2018 [1]). Metrics collected through the cognitive training platform were monitored (i.e., number of levels completed) and reviewed with participants at their onsite stimulation sessions to optimize adherence. Participants were considered adherent to cognitive training by completing greater than or equal to 80% of the intervention (i.e., ≥720 levels). Overall, for both training arms, contact with intervention staff was consistent,

Table 1  
Demographics and Baseline Characteristics by tDCS Group.

| Variable                                                                                                  |                                      | Overall<br>(n =<br>378) | Sham (n<br>= 188) | Active<br>(n =<br>190) | p <sup>+</sup> |
|-----------------------------------------------------------------------------------------------------------|--------------------------------------|-------------------------|-------------------|------------------------|----------------|
| Age                                                                                                       | Mean ± SD                            | 71.5 ± 5.1              | 71.7 ± 4.8        | 71.4 ± 5.4             | 0.25           |
| Sex                                                                                                       | Male                                 | 143<br>(37.8%)          | 66<br>(35.1%)     | 77<br>(40.5%)          | 0.28           |
|                                                                                                           | Female                               | 235<br>(62.2%)          | 122<br>(64.9%)    | 113<br>(59.5%)         |                |
| Race                                                                                                      | American Indian/<br>Alaskan Native   | 9 (2.4%)                | 5 (2.7%)          | 4 (2.1%)               | 0.51           |
|                                                                                                           | Asian                                | 4 (1.1%)                | 3 (1.6%)          | 1 (0.5%)               |                |
|                                                                                                           | African American/Black               | 21 (5.6%)               | 10 (5.3%)         | 11 (5.8%)              |                |
|                                                                                                           | Native Hawaiian/<br>Pacific Islander | 1 (0.3%)                | 0 (0.0%)          | 1 (0.5%)               |                |
|                                                                                                           | White                                | 331<br>(87.6%)          | 166<br>(88.3%)    | 165<br>(86.8%)         |                |
|                                                                                                           | Multiracial                          | 9 (2.4%)                | 4 (2.1%)          | 5 (2.6%)               |                |
|                                                                                                           | Unknown/Not reported                 | 3 (0.8%)                | 0 (0.0%)          | 3 (1.6%)               |                |
| Ethnicity                                                                                                 | Hispanic or Latinx                   | 25 (6.6%)               | 10 (5.3%)         | 15 (7.9%)              | 0.31           |
|                                                                                                           | Non-Hispanic or Latinx               | 353 (93.4%)             | 178 (94.7%)       | 175 (92.1%)            |                |
|                                                                                                           | Years of Education                   | Mean ± SD               | 16.3 ± 2.4        | 16.3 ± 2.5             | 0.85           |
| Highest Academic Degree                                                                                   | GED or equivalent                    | 4 (1.1%)                | 1 (0.5%)          | 3 (1.6%)               | 0.50           |
|                                                                                                           | High school graduate                 | 30 (7.9%)               | 18 (9.6%)         | 12 (6.3%)              |                |
|                                                                                                           | Some college/associate degree        | 83 (22.0%)              | 44 (23.4%)        | 39 (20.5%)             |                |
|                                                                                                           | Bachelor’s degree                    | 118 (31.2%)             | 54 (28.7%)        | 64 (33.7%)             |                |
|                                                                                                           | Professional/graduate degree         | 143 (37.8%)             | 71 (37.8%)        | 72 (37.9%)             |                |
| # of medical problems                                                                                     | Mean ± SD                            | 3.4 ± 1.9               | 3.5 ± 2.0         | 3.4 ± 1.9              | 0.34           |
| # of neurological problems                                                                                | Mean ± SD                            | 0.3 ± 0.7               | 0.3 ± 0.7         | 0.3 ± 0.7              | 0.67           |
| # of psychiatric problems                                                                                 | Mean ± SD                            | 0.4 ± 0.7               | 0.5 ± 0.7         | 0.4 ± 0.7              | 0.88           |
| # of prescription drugs used                                                                              | Mean ± SD                            | 3.2 ± 2.7               | 3.2 ± 2.6         | 3.2 ± 2.7              | 0.85           |
| # of participants at screening and baseline taking a prescription drug that can be for anxiety/depression | Yes                                  | 80 (21.2%)              | 44 (23.4%)        | 36 (18.9%)             | 0.29           |
|                                                                                                           | No                                   | 298 (78.8%)             | 144 (76.6%)       | 154 (81.1%)            |                |
| Brain HQ CT Composite z-score                                                                             | Mean ± SD                            | −0.20 ± 0.46            | −0.23 ± 0.48      | −0.17 ± 0.45           | 0.50           |
| Site                                                                                                      | UF                                   | 261 (69.0%)             | 129 (68.6%)       | 132 (69.5%)            | 0.86           |
|                                                                                                           | UA                                   | 117 (31.0%)             | 59 (31.4%)        | 58 (30.5%)             |                |
| Stimulation Adherence                                                                                     | Yes                                  | 298 (78.8%)             | 146 (77.7%)       | 152 (80.0%)            | 0.58           |
|                                                                                                           | No                                   | 80 (21.2%)              | 42 (22.3%)        | 38 (20.0%)             |                |
| Cognitive Training Adherence                                                                              | Yes                                  | 241 (63.8%)             | 118 (62.8%)       | 123 (64.7%)            | 0.69           |
|                                                                                                           | No                                   | 137 (36.2%)             | 70 (37.2%)        | 67 (35.3%)             |                |

(continued on next page)

Table 1 (continued)

| Variable                              |                     | Overall<br>(n =<br>378) | Sham (n<br>= 188) | Active<br>(n =<br>190) | p <sup>+</sup> |
|---------------------------------------|---------------------|-------------------------|-------------------|------------------------|----------------|
| Education or<br>Cognitive<br>Training | ET                  | 45<br>(11.9%)           | 22<br>(11.7%)     | 23<br>(12.1%)          | 0.90           |
|                                       | CT                  | 333<br>(88.1%)          | 166<br>(88.3%)    | 167<br>(87.9%)         |                |
| BDI-II Severity                       | Minimal             | 362<br>(95.8%)          | 183<br>(97.3%)    | 179<br>(94.2%)         | 0.13           |
|                                       | Mild                | 16<br>(4.2%)            | 5 (2.7%)          | 11<br>(5.8%)           |                |
| STAI-State<br>Severity                | Mild                | 319<br>(84.4%)          | 157<br>(83.5%)    | 162<br>(85.3%)         | 0.64           |
|                                       | Moderate/<br>Severe | 59<br>(15.6%)           | 31<br>(16.5%)     | 28<br>(14.7%)          |                |
|                                       | Mild                | 334<br>(88.4%)          | 166<br>(88.3%)    | 168<br>(88.4%)         |                |
| STAI-Trait<br>Severity                | Moderate/<br>Severe | 44<br>(11.6%)           | 22<br>(11.7%)     | 22<br>(11.6%)          | 0.97           |

Notes: The cognitive training adherence rows include those in the education training group, who were counted as “non-adherent”. CT = Cognitive Training, ET = Education Training, UF = University of Florida, UA = University of Arizona, BDI-II = Beck Depression Inventory – Second edition, STAI = State-Trait Anxiety Inventory.

<sup>+</sup>p-values resulted from either Wilcoxon rank-sum or chi-squared tests.

occurring during onsite intervention visits or occasional phone calls to address scheduling or technical concerns.

1.3.2. Transcranial direct current stimulation

The tDCS intervention involved completing 20 stimulation sessions in the lab combined with their cognitive or education training – 10 daily sessions for the first two weeks (i.e., Monday through Friday) and 1 weekly for the remaining ten weeks. It is important to note that the frequency of tDCS sessions (transitioning from daily to weekly) is an unconventional approach. However, weekly tDCS “booster” sessions were intentionally included to potentially facilitate longer-lasting effects on outcomes. Participants were considered adherent to the tDCS intervention by completing greater than or equal to 80% of stimulation sessions (i.e., ≥16). A schematic example of a participant’s training and stimulation intervention timeline is provided in Hausman et al., 2023 [2].

Intervention staff were provided with a unique 6-digit code to enter into the Soterix Clinical Trials Direct Current Stimulator. The codes were pre-programmed into the stimulators to initiate delivery of either active or sham tDCS and were assigned to participants by the trial statistician to maintain blinding of all study staff and participants. The active stimulation group received 20 min of 2 mA direct current through two biocarbon rubber electrodes encased in saline-soaked 5 × 7 cm sponges (10 cc of 0.9% saline solution per sponge; 2 cc pre-saturated at point of manufacturing, 8 cc added by study team) located at F3 (cathode) and F4 (anode) using the International 10–20 measurement system. Sham procedures were identical except for stimulation duration, which was 30 s of 2 mA direct current (ramp up and back down) at the start of the stimulation session and then no current for the remaining 20 min. Participants completed sensation questionnaires to rate the intensity of a perceived sensation on a scale of 0–10 (e.g., itching, tingling, burning) before, during, and after each stimulation session. Following the completion of the 12-week intervention, participants and experimenters completed a tDCS blinding questionnaire and rated their confidence level for predicting stimulation condition [1,2].

1.4. Mental health outcomes

Present analyses focused on mental health measures of depression and anxiety symptoms collected before intervention, within ~48 h of completing the 12-week intervention, and one year from

randomization/baseline assessment. Depression symptoms were measured using the BDI-II, a 21-item self-report questionnaire that involves rating symptoms such as experiencing low mood, worthlessness, and irritability over the last two weeks. The symptom severity cutoffs for BDI-II total scores are 0–13 for minimal, 14–19 for mild, 20–28 for moderate, and 29–63 for severe symptoms [40].

Anxiety symptoms were measured using the STAI, a 40-item self-report questionnaire that involves rating statements indicating how someone currently feels (i.e., state anxiety) and how they feel generally (i.e., trait anxiety). Higher STAI state and STAI trait anxiety scores reflect greater anxiety, with cutoff scores of 39–40 used to indicate significant anxiety scores [41–44]. For present analyses, STAI scores less than 39 represented mild symptoms, while scores greater than or equal to 39 represented moderate/severe symptoms. As previously mentioned, in the ACT trial, participants were excluded if they had a total BDI-II score ≥20; however, participants were not excluded for their baseline STAI scores.

1.5. Statistical analyses

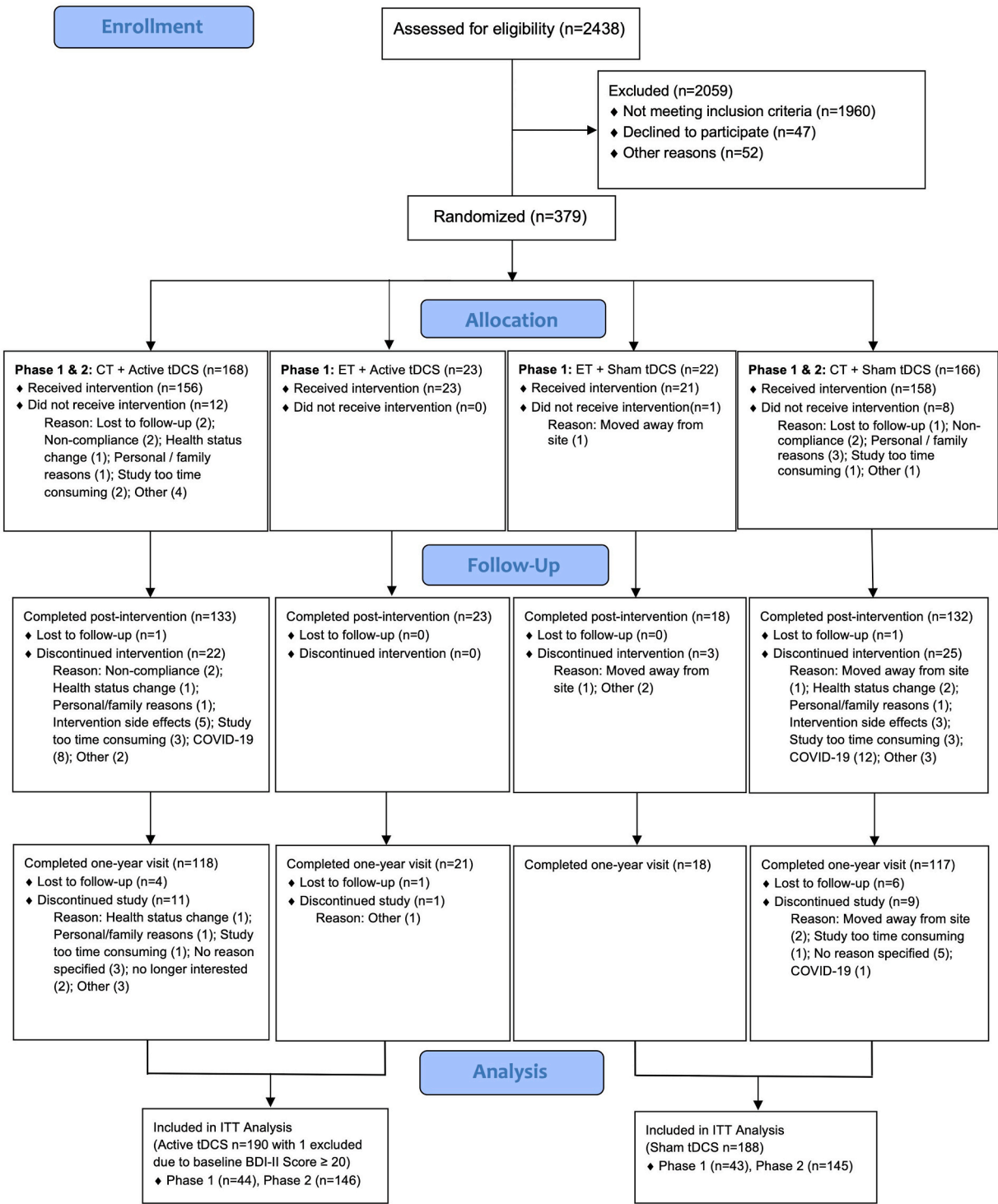
All statistical analyses were completed in SAS version 9.4 with a significance level of  $\alpha = 0.05$ . Chi-squared and Wilcoxon rank-sum tests were conducted to determine if there were significant differences between active and sham stimulation groups in demographics, relevant clinical variables (i.e., cognitive functioning, medical and psychiatric history, prescription medication use), baseline symptom severity subgroup classifications, and model covariates (i.e., study site, intervention adherence, training type). Additionally, univariate analyses with Wilcoxon rank-sum tests were conducted to present differences between the active and sham group in BDI-II, STAI state anxiety, and STAI trait anxiety scores at each timepoint as well as changes in these measures from baseline to post-intervention and baseline to one-year for the total sample and the symptom severity subgroups. However, to appropriately account for factors that may impact intervention effects, the primary analyses of interest were multiple linear regressions conducted on the overall sample (n = 378) with changes in mental health outcome (BDI-II, STAI state anxiety, and STAI trait anxiety scores) from baseline to post-intervention and baseline to one-year as the dependent variables and tDCS group as the independent variable, controlling for age, sex, educational level, study site, training type (cognitive training versus education training), stimulation adherence, cognitive training adherence, and the baseline respective mental health measure. Controlling for participants’ baseline measures is considered an effective approach to ensure that intervention effects on changes scores exist beyond a regression to the mean phenomenon [45,46]. Participants were then divided based on baseline symptom severity (i.e., minimal depression, mild depression, mild state anxiety, moderate/severe state anxiety, mild trait anxiety, and moderate/severe trait anxiety symptoms), and the same regression models were conducted on these subgroups. All participants were included in these intent-to-treat statistical models, whether or not they had data at all follow-up timepoints. Therefore, missing depression and anxiety outcomes were imputed from regression models that included participant demographic and baseline characteristics.

2. Results

2.1. Sample characteristics

The sample included 378 of the 379 randomized healthy older adults (mean age = 71.5 ± 5.1), excluding one participant due to having a baseline BDI-II score of 20.87.6% identified as White, and 93.4% of the sample identified as Non-Hispanic or Latinx. The sample was considered to be cognitively intact based on performance on a cognitive screener – the Montreal Cognitive Assessment (mean total score = 26.73 ± 1.95) and within normal limits performance across cognitive domains on the





**Fig. 1.** Flow Diagram for the ACT Trial Mental Health Secondary Analyses  
Notes: A CONSORT flow diagram adapted from Hausman and colleagues (2023) [2] depicting the phases of enrollment, intervention allocation, follow-up, and secondary data analyses for the ACT trial. CT = cognitive training, ET = education training, tDCS = transcranial direct current stimulation, ITT = intent-to-treat.

NACC UDS (i.e., average z-scores ranging from  $-0.14$  to  $0.17$ ). There were 12 individuals (3.17% of the entire sample) who reported they currently smoke cigarettes, and they were evenly distributed between active and sham stimulation groups (i.e., 6 in each group,  $p = 0.99$ ).  
Chi-squared and Wilcoxon rank-sum tests revealed there were no significant differences between active and sham stimulation groups in demographics and baseline characteristics (Table 1), scores on baseline mental health measures (Table A.1), and cognitive functioning (i.e.,

MoCA and NACC UDS scores;  $p$ -values  $>0.05$ ) except that the active group had slightly lower NACC UDS memory scores (active mean  $z$ -score =  $-0.09 \pm 0.70$ , sham mean  $z$ -score =  $0.08 \pm 0.68$ ,  $p = 0.03$ ). Review of self-reported medications also revealed no group differences in the number of prescription medications overall and in the number of individuals taking a medication that can be prescribed for depression or anxiety (Table 1). The percentage of individuals taking a prescription medication that can be used for depression or anxiety (i.e., 21.2% of the

total sample), and the frequency of these medications reported can be found in Table 1 and Table A.2, respectively.

2.2. Blinding Efficacy and stimulation sensations

There were no significant differences in predicting stimulation condition or confidence in predictions between active and sham groups for participants and experimenters (Table A.3 and A.4). Specifically, for the participants, 57.5% of the active group and 60% of the sham group believed they received the active treatment condition ( $p = 0.66$ ). Ratings of any sensation during stimulation for both conditions were largely between 0 and 1 on a 10-point scale. The active tDCS group had lower ratings of pain prior to stimulation ( $p = 0.03$ ) and greater ratings of tingling and burning during stimulation ( $p = 0.01$ ,  $p < 0.01$ ) compared to sham (Table A.5).

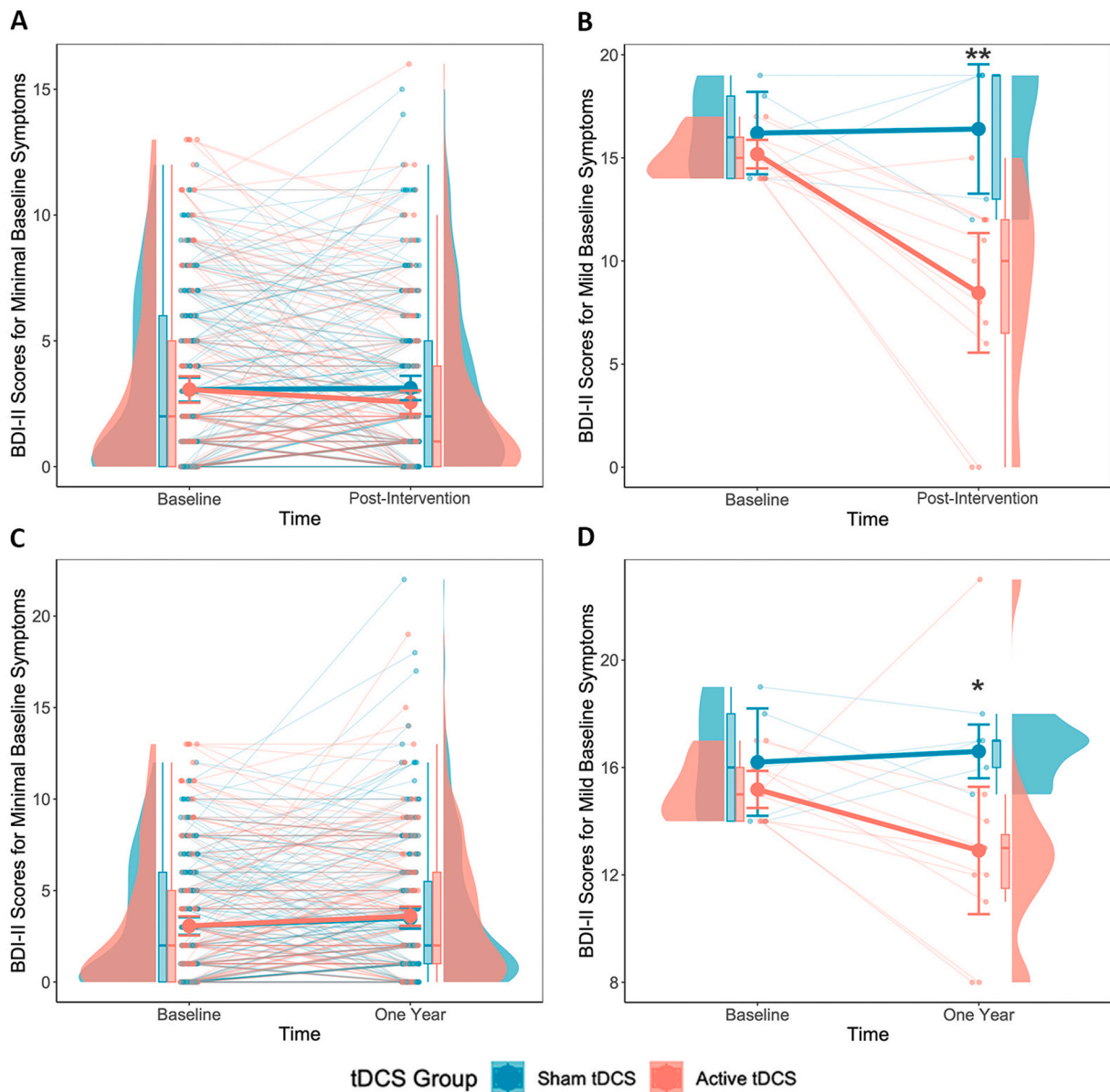
2.3. tDCS effects on mental health measures

2.3.1. Comparison of sample raw scores

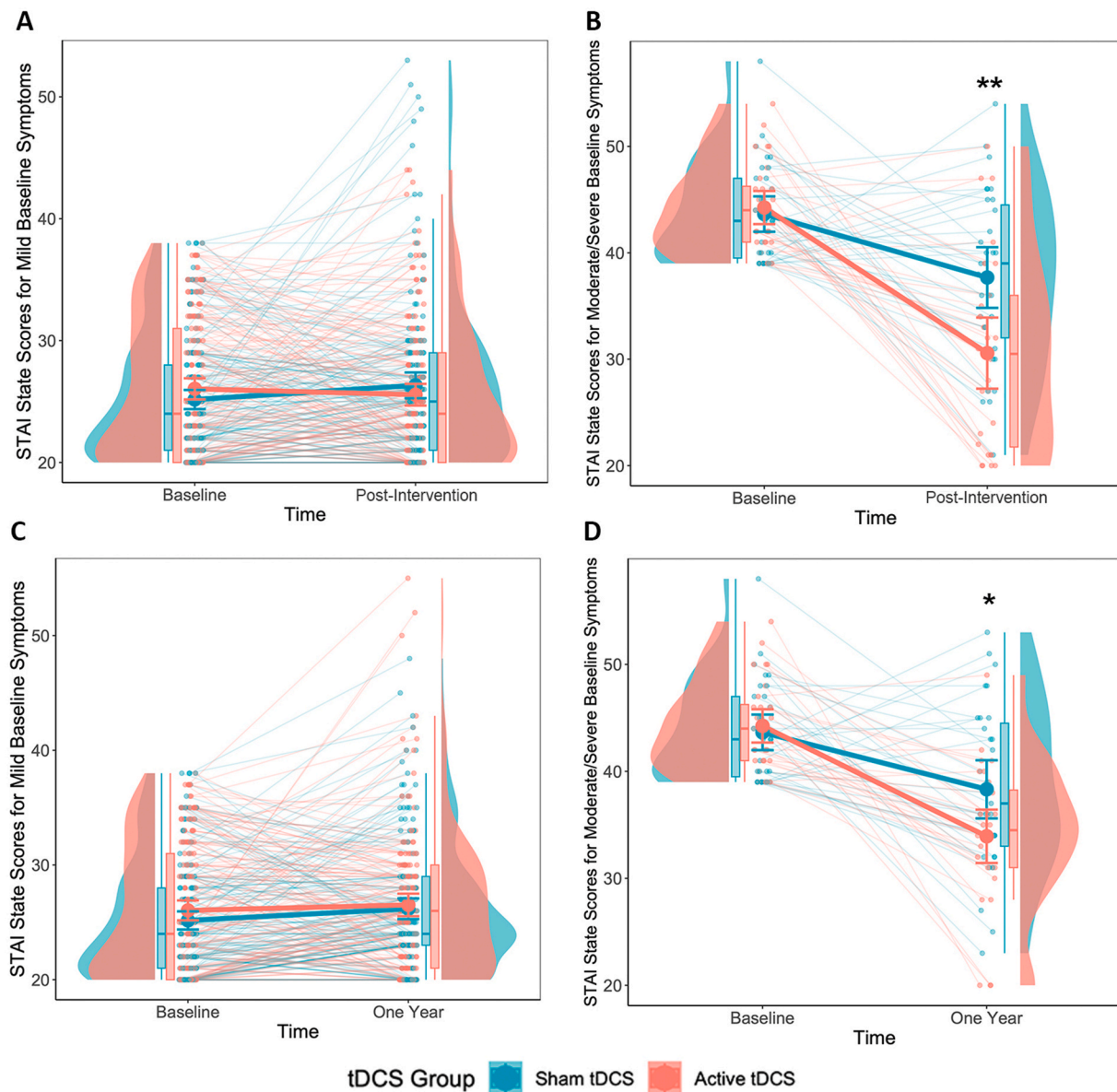
Wilcoxon rank-sum tests comparing BDI-II, STAI state, and STAI trait anxiety scores at each timepoint and change scores between the active and sham stimulation groups for the total sample and symptom severity subgroups are presented in Table A.1. Furthermore, Figs. 2–4 depict score differences between the active and sham stimulation groups at each timepoint within the symptom severity subgroups. Together, these data present tDCS effects on the raw scores of the mental health measures without controlling for covariates.

2.3.2. Total sample regression results

The primary analyses of interest were the multiple linear regressions fitted with change in mental health outcomes as the dependent variable and tDCS group as the independent variable, controlling for covariates



**Fig. 2.** Depression Distributions by tDCS Group and Baseline Symptom Severity. Notes: Plots depict distributions of Beck Depression Inventory – Second Edition total scores by active and sham stimulation groups for the minimal depression symptom sample and the mild depression symptom sample from baseline to post-intervention (A–B) and from baseline to one-year (C–D). Wilcoxon rank-sum tests for assessing score differences can be found in Table A.1. \* $p < 0.05$ , \*\* $p < 0.01$ .



**Fig. 3.** State Anxiety Distributions by tDCS Group and Baseline Symptom Severity.

Notes: Plots depict distributions of STAI state total scores by active and sham stimulation groups for the mild state anxiety sample and the moderate/severe state anxiety sample from baseline to post-intervention (A–B) and from baseline to one-year (C–D). Wilcoxon rank-sum tests for assessing score differences can be found in [Table A.1](#).

\* $p < 0.05$ , \*\* $p < 0.01$ .

and respective baseline measures. Notably, decreases in BDI-II and STAI scores indicate reporting fewer symptoms, while increases in scores indicate reporting more symptoms over time. Regression results revealed that in the entire sample ( $n = 378$ ), compared to the sham group, the active group demonstrated a 0.75-point greater decrease in BDI-II scores ( $p < 0.01$ ) and a 1.93-point greater decrease in STAI state anxiety scores ( $p < 0.01$ ) from baseline to post-intervention. There were no significant tDCS effects on change in STAI trait anxiety scores from baseline to post-intervention or on change in BDI-II, STAI state anxiety, and STAI trait anxiety from baseline to one-year in the overall sample ([Table 2](#), [3](#), [4](#), [A.6](#), [A.7](#), [A.8](#), [A.9](#), [A.10](#) and [A.11](#)).

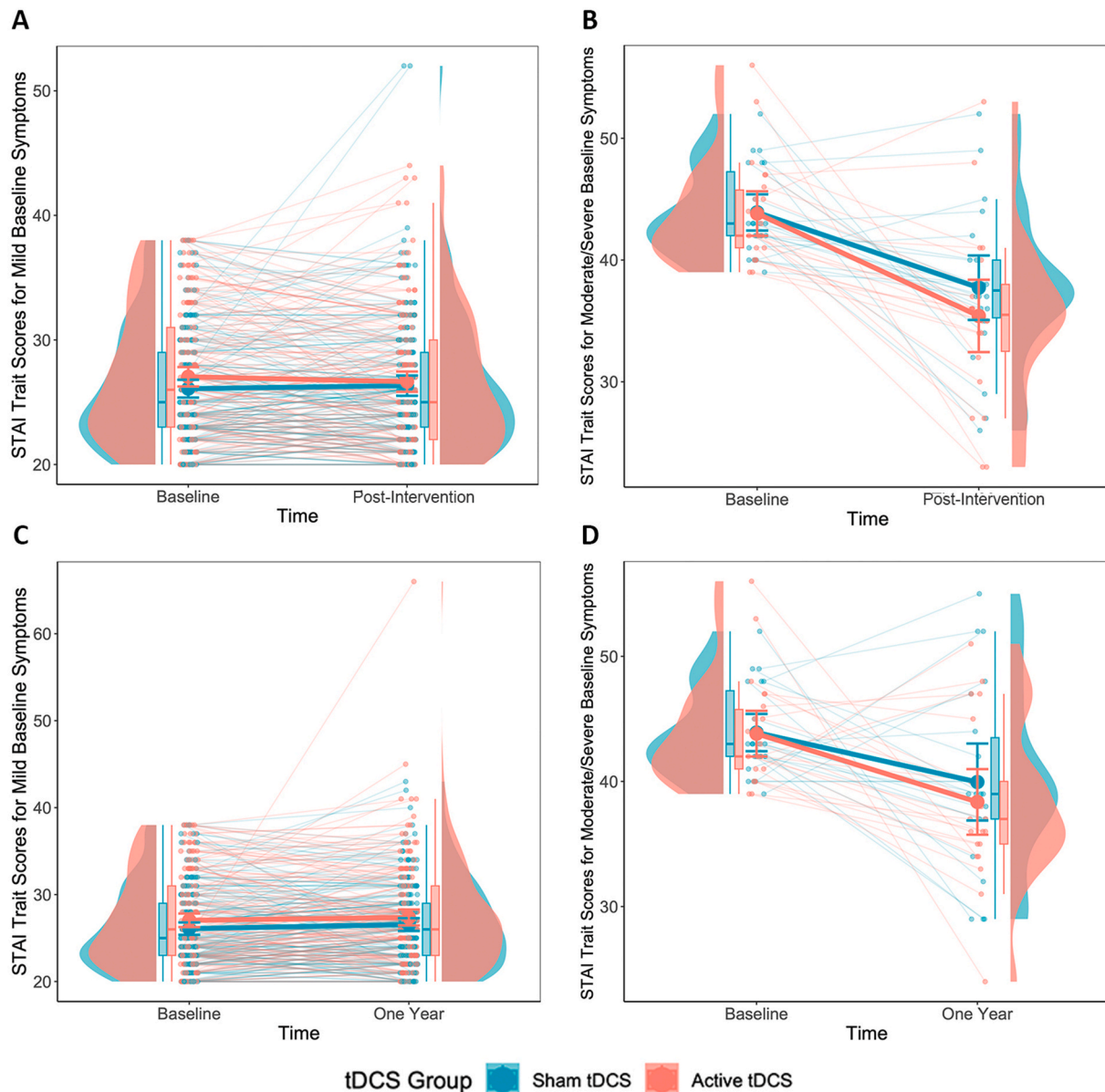
### 2.3.3. Symptom severity subgroup regression results

The same regression models were conducted within the symptom severity subgroups reporting minimal depression, mild depression, mild state anxiety, moderate/severe state anxiety, mild trait anxiety, and

moderate/severe trait anxiety symptoms at baseline. Regression results revealed that compared to the sham group, the active group demonstrated a 0.52-point ( $p = 0.0498$ ) and a 9.67-point ( $p = 0.03$ ) greater decrease in BDI-II scores from baseline to post-intervention in participants reporting minimal (BDI-II scores = 0–13,  $n = 362$ ) and mild (BDI-II scores = 14–19,  $n = 16$ ) depression symptoms at baseline, respectively. In the minimal depression sample, there were no significant tDCS effects on change in BDI-II scores from baseline to one-year. In the mild depression sample, the active group demonstrated a 3.85-point greater decrease in BDI-II scores from baseline to one-year. However, this association was also not statistically significant ( $p = 0.16$ ).

There were no significant tDCS effects on change in STAI state anxiety scores from baseline to post-intervention or from baseline to one-year in participants reporting mild state anxiety symptoms at baseline (i.e., STAI state scores  $< 39$ ,  $n = 319$ ). In the moderate/severe state anxiety sample (i.e., STAI state scores  $\geq 39$ ,  $n = 59$ ), compared to the





**Fig. 4.** Trait Anxiety Distributions by tDCS Group and Baseline Symptom Severity.

Notes: Plots depict distributions of STAI trait total scores by active and sham stimulation groups for the mild trait anxiety sample and the moderate/severe trait anxiety sample from baseline to post-intervention (A–B) and from baseline to one-year (C–D). Wilcoxon rank-sum tests for assessing score differences can be found in Table A.1.

sham group, the active group demonstrated a 5.92-point ( $p = 0.01$ ) and a 4.03-point greater decrease ( $p = 0.048$ ) in STAI state scores from baseline to post-intervention and baseline to one-year, respectively.

Finally, there were no significant tDCS effects on change in STAI trait anxiety scores from baseline to post-intervention and baseline to one-year for either the mild ( $n = 334$ ) or the moderate/severe trait anxiety samples ( $n = 44$ ) (Table 2, 3, 4, A.6, A.7, A.8, A.9, A.10 and A.11, Figs. 2–4).

#### 2.3.4. Covariate results

Tables 2–4 present the estimates for significant covariate main effects in regression models. Female sex was associated with a greater increase in BDI-II scores from baseline to post-intervention in the overall (0.64-point,  $p = 0.03$ ) and minimal depression samples (0.71-point,  $p = 0.01$ ) and from baseline to one-year in the minimal depression sample (0.70-point,  $p = 0.03$ ). Female sex was also associated with a greater increase in STAI state anxiety scores from baseline to post-intervention

(1.46-point,  $p = 0.03$ ) and from baseline to one-year (1.34-point,  $p = 0.04$ ) in the overall sample. Older age was associated with a greater increase in STAI state anxiety scores from baseline to post-intervention in the overall (0.24-point,  $p < 0.01$ ) and mild state anxiety samples (0.21-point,  $p < 0.01$ ). Having a bachelor's degree or above was associated with a greater decrease in STAI trait anxiety scores from baseline to post-intervention and from baseline to one-year in the overall (−1.15-point,  $p = 0.02$ ; −1.90-point,  $p < 0.01$ ) and mild trait anxiety samples (−0.98-point,  $p = 0.04$ ; −1.85-point,  $p < 0.01$ ). Additionally, having a bachelor's degree or above was associated with a greater decrease in STAI state anxiety scores from baseline to one-year in the overall (−1.37-point,  $p = 0.04$ ) and mild state anxiety samples (−1.70-point,  $p = 0.01$ ). Adherence to cognitive training was associated with a greater decrease in STAI state anxiety scores from baseline to post-intervention in the moderate/severe state anxiety sample (−7.69-point,  $p = 0.01$ ). Finally, higher baseline BDI-II, STAI state, and STAI trait anxiety scores were associated with greater decreases in their respective measures



**Table 2**  
Depression results from baseline to post-intervention and baseline to one-year.

| Model & Variables                                   | Variable Category | Imputed Estimate | p      |
|-----------------------------------------------------|-------------------|------------------|--------|
| <i>Total Sample (n = 378)</i>                       |                   |                  |        |
| <b>T2 – T1 BDI-II Model</b>                         |                   |                  |        |
| tDCS                                                | Active            | −0.75            | <0.01  |
| Sex                                                 | Female            | 0.64             | 0.03   |
| Baseline BDI-II Score                               |                   | −0.38            | <0.01  |
| <b>T3 – T1 BDI-II Model</b>                         |                   |                  |        |
| tDCS                                                | Active            | 0.09             | 0.78   |
| Baseline BDI-II Score                               |                   | −0.27            | <0.01  |
| <i>Minimal Depression Symptoms Sample (n = 362)</i> |                   |                  |        |
| <b>T2 – T1 BDI-II Model</b>                         |                   |                  |        |
| tDCS                                                | Active            | −0.52            | 0.0498 |
| Sex                                                 | Female            | 0.71             | 0.01   |
| Baseline BDI-II Score                               |                   | −0.41            | <0.01  |
| <b>T3 – T1 BDI-II Model</b>                         |                   |                  |        |
| tDCS                                                | Active            | 0.17             | 0.58   |
| Sex                                                 | Female            | 0.70             | 0.03   |
| Baseline BDI-II                                     |                   | −0.32            | <0.01  |
| <i>Mild Depression Symptoms Sample (n = 16)</i>     |                   |                  |        |
| <b>T2 – T1 BDI-II Model</b>                         |                   |                  |        |
| tDCS                                                | Active            | −9.67            | 0.03   |
| <b>T3 – T1 BDI-II Model</b>                         |                   |                  |        |
| tDCS                                                | Active            | −3.85            | 0.16   |

Notes: This table only presents the tDCS group effect and significant covariates for depression statistical models. Full statistical models can be found in [Table A.6 and A.7](#). T2 – T1 BDI-II Model = models with post-intervention minus baseline depression change scores as dependent variables. T3 – T1 BDI-II Model = models with one-year minus baseline depression change scores as dependent variables.

across all models except for those with mild depression. The remaining covariates were not significant and are presented in [Table A.6, A.7, A.8, A.9, A.10 and A.11](#).

2.4. Exploratory analyses

To characterize the potential effects of medications on mental health findings, the same multiple linear regressions were conducted for the total sample and symptom severity subgroups additionally controlling for participants who reported taking a prescription drug that can be used for depression or anxiety. Taking a prescription drug that can be used for depression and anxiety was associated with greater increases in BDI-II scores in the mild depression sample (6.55-point,  $p = 0.046$ ), in STAI state scores in the total and mild state anxiety samples (2.37-point,  $p < 0.01$ ; 1.89-point,  $p = 0.02$ ), and in STAI trait scores in the total sample (1.24-point,  $p = 0.03$ ) from baseline to post-intervention. There were no significant medication effects in baseline to one-year models. Overall, tDCS effects largely remained significant and consistent with original models with the exception of slightly reduced tDCS effects in the minimal depression sample from baseline to post-intervention (0.49-point greater reduction in the active group,  $p = 0.06$ ) and in the moderate/severe state anxiety sample from baseline to one-year (4-point greater reduction in the active group,  $p = 0.05$ ) ([Table A.12, A.13, A.14, A.15, A.16 and A.17](#)).

Additionally, we explored differences in STAI scores by BDI-II symptom severity subgroups and BDI-II scores by STAI symptom severity subgroups using Wilcoxon rank-sum tests. Compared to the minimal depression sample, the mild depression sample had higher STAI state and STAI trait anxiety scores at baseline, post-intervention, and one-year ([Table A.18](#)). Compared to the mild state anxiety sample, the moderate/severe state anxiety sample had higher BDI-II and STAI trait anxiety scores at baseline, post-intervention, and one-year, greater reductions in BDI-II from baseline to post-intervention, and greater

**Table 3**  
State anxiety results from baseline to post-intervention and baseline to one-year.

| Model & Variables                                             | Variable Category          | Imputed Estimate | p     |
|---------------------------------------------------------------|----------------------------|------------------|-------|
| <i>Total Sample (n = 378)</i>                                 |                            |                  |       |
| <b>T2 – T1 STAI State Model</b>                               |                            |                  |       |
| tDCS                                                          | Active                     | −1.93            | <0.01 |
| Sex                                                           | Female                     | 1.46             | 0.03  |
| Age                                                           |                            | 0.24             | <0.01 |
| Baseline STAI State Score                                     |                            | −0.59            | <0.01 |
| <b>T3 – T1 STAI State Model</b>                               |                            |                  |       |
| tDCS                                                          | Active                     | −0.67            | 0.27  |
| Sex                                                           | Female                     | 1.34             | 0.04  |
| Educational Level                                             | Bachelor's degree or above | −1.37            | 0.04  |
| Baseline STAI State Score                                     |                            | −0.51            | <0.01 |
| <i>Mild State Anxiety Symptoms Sample (n = 319)</i>           |                            |                  |       |
| <b>T2 – T1 STAI State Model</b>                               |                            |                  |       |
| tDCS                                                          | Active                     | −1.04            | 0.10  |
| Age                                                           |                            | 0.21             | <0.01 |
| Baseline STAI State Score                                     |                            | −0.50            | <0.01 |
| <b>T3 – T1 STAI State Model</b>                               |                            |                  |       |
| tDCS                                                          | Active                     | 0.00             | 1.00  |
| Educational Level                                             | Bachelor's degree or above | −1.70            | 0.01  |
| Baseline STAI State Score                                     |                            | −0.48            | <0.01 |
| <i>Moderate/Severe State Anxiety Symptoms Sample (n = 59)</i> |                            |                  |       |
| <b>T2 – T1 STAI State Model</b>                               |                            |                  |       |
| tDCS                                                          | Active                     | −5.92            | 0.01  |
| Cognitive Training Adherence                                  | Yes                        | −7.69            | 0.01  |
| Baseline STAI State Score                                     |                            | −1.36            | <0.01 |
| <b>T3 – T1 STAI State Model</b>                               |                            |                  |       |
| tDCS                                                          | Active                     | −4.03            | 0.048 |
| Baseline STAI State Score                                     |                            | −1.04            | <0.01 |

Notes: This table only presents the tDCS group effect and significant covariates for STAI State statistical models. Full statistical models can be found in [Table A.8 and A.9](#). T2 – T1 STAI State Model = models with post-intervention minus baseline state anxiety change scores as dependent variables. T3 – T1 STAI State Model = models with one-year minus baseline state anxiety change scores as dependent variables.

reductions in STAI trait scores from baseline to post-intervention and baseline to one-year ([Table A.19](#)). Similarly, compared to the mild trait anxiety sample, the moderate/severe trait anxiety sample had higher BDI-II and STAI state anxiety scores at baseline, post-intervention, and one-year, greater reductions in BDI-II from baseline to post-intervention, and greater reductions in STAI state scores from baseline to post-intervention and baseline to one-year ([Table A.20](#)).

3. Discussion

The present findings offer promising support for the clinical efficacy of tDCS in improving psychological symptoms among older adults from the community. Following the 12-week intervention, individuals who received active tDCS showed reductions in self-reported depression and state anxiety symptoms, which were particularly pronounced in individuals with mild depression and moderate/severe state anxiety. Notably, individuals with moderate/severe state anxiety showed the greatest long-term benefit from active stimulation, with significantly greater reductions of state anxiety symptoms at the one-year follow-up compared to sham. Examining raw scores, this group showed an average decrease of ~14 points in STAI state scores from baseline to post-intervention and ~10 points from baseline to one-year. These changes were approximately twice as large as those seen in the sham group and shift participants on average from the moderate/severe category to the mild category, indicating clinically meaningful improvement. As

**Table 4**  
Trait anxiety results from baseline to post-intervention and baseline to one-year.

| Model & Variables                                             | Variable Category          | Imputed Estimate | p     |
|---------------------------------------------------------------|----------------------------|------------------|-------|
| <i>Total Sample (n = 378)</i>                                 |                            |                  |       |
| <b>T2 – T1 STAI Trait Model</b>                               |                            |                  |       |
| tDCS                                                          | Active                     | –0.45            | 0.33  |
| Educational Level                                             | Bachelor’s degree or above | –1.15            | 0.02  |
| Baseline STAI Trait Score                                     |                            | –0.38            | <0.01 |
| <b>T3 – T1 STAI Trait Model</b>                               |                            |                  |       |
| tDCS                                                          | Active                     | 0.11             | 0.83  |
| Educational Level                                             | Bachelor’s degree or above | –1.90            | <0.01 |
| Baseline STAI Trait Score                                     |                            | –0.34            | <0.01 |
| <i>Mild Trait Anxiety Symptoms Sample (n = 334)</i>           |                            |                  |       |
| <b>T2 – T1 STAI Trait Model</b>                               |                            |                  |       |
| tDCS                                                          | Active                     | –0.32            | 0.46  |
| Educational Level                                             | Bachelor’s degree or above | –0.98            | 0.04  |
| Baseline STAI Trait Score                                     |                            | –0.26            | <0.01 |
| <b>T3 – T1 STAI State Model</b>                               |                            |                  |       |
| tDCS                                                          | Active                     | 0.37             | 0.43  |
| Educational Level                                             | Bachelor’s degree or above | –1.85            | <0.01 |
| Baseline STAI Trait Score                                     |                            | –0.31            | <0.01 |
| <i>Moderate/Severe Trait Anxiety Symptoms Sample (n = 44)</i> |                            |                  |       |
| <b>T2 – T1 STAI Trait Model</b>                               |                            |                  |       |
| tDCS                                                          | Active                     | –2.59            | 0.25  |
| Baseline STAI Trait Score                                     |                            | –0.95            | <0.01 |
| <b>T3 – T1 STAI Trait Model</b>                               |                            |                  |       |
| tDCS                                                          | Active                     | –1.46            | 0.51  |
| Baseline STAI Trait Score                                     |                            | –1.25            | <0.01 |

Notes: This table only presents the tDCS group effect and significant covariates for STAI Trait statistical models. Full statistical models can be found in [Table A.10 and A.11](#). T2 – T1 STAI Trait Model = models with post-intervention minus baseline trait anxiety change scores as dependent variables. T3 – T1 STAI Trait Model = models with one-year minus baseline trait anxiety change scores as dependent variables.

expected, there was no significant tDCS effect on trait anxiety, potentially due to the inherent stability of the metric hindering the short-term intervention’s ability to reduce symptoms. A longer-term intervention (e.g., psychotherapy) may be more effective in addressing elevated trait anxiety, perhaps in combination with tDCS to have a possibly faster and more robust response. Furthermore, exploratory analyses revealed that tDCS effects on mental health outcomes largely remained when controlling for participants reported use of medications that can be prescribed for depression or anxiety. Overall, the present findings fill gaps in the literature by demonstrating significant tDCS effects in reducing both depression and anxiety symptoms in a large sample of older adults from the general population. Moreover, identifying differential tDCS effects based on symptom severity holds significant implications for both research and clinical practice.

Compared to prior tDCS studies in older adults without psychiatric disorders, the present findings align with Szymkowicz and colleagues (2022), who reported a reduction in subclinical depression symptoms following active tDCS and cognitive training using similar intervention parameters as ACT (i.e., F3/F4 montage, 2 mA for 20 min, paired with cognitive training) [33]. The present study extended this work by evaluating a much larger sample (378 vs. 15 participants), including

measures of anxiety, analyzing symptom severity subgroups, and identifying a larger reduction of subclinical depression symptoms particularly with examining those reporting mild symptoms at baseline. The differences in the magnitude of the tDCS effect may be related to this greater variability in baseline depression scores with our larger sample and the intervention duration, as ACT participants completed ten additional weeks of tDCS (one session per week) and cognitive training (daily). In contrast to present findings, Freidle and colleagues (2020) did not discover a tDCS effect on mood outcomes in 123 older adults [32], which may be due to differences in intervention parameters (i.e., F3/contralateral supraorbital area, 2 mA for 25 min, 1-month intervention) and outcome measures (i.e., total mood disturbance and a daily mood question vs. specific anxiety and depression measures).

The ACT trial employed an electrode montage and dosing parameters that are thought to broadly target the prefrontal cortex, including the dlPFC, in older adults [47,48]. The dlPFC, involved in emotion regulation through top-down control processes, such as suppressing negative affect and executing cognitive reappraisal strategies [6,49–51], is hypoactive in individuals with clinical depression and anxiety [4,6,52,53]. This makes it an ideal target for neuromodulation interventions, aiming to increase cortical excitability in this region.

Studies exploring the application of tDCS in conjunction with other interventions to further optimize treatment effects in clinical depression have shown varied therapeutic benefits [11,54]. For example, while some studies demonstrated benefits of combining tDCS with antidepressant medications [7,54,55], others failed to show additional antidepressant effects with stimulation [15,56,57]. Since tDCS targets functionally relevant brain regions activated during task execution [58,59], combining tDCS with an intervention that specifically enhances dlPFC engagement, such as cognitive training, has emerged as a promising strategy for depression symptom reduction in clinical populations. For example, both active and sham stimulation combined with an attention and working memory cognitive training paradigm resulted in reduced depression symptoms post-intervention in adults with major depressive disorder; however, receiving active stimulation during training led to further reductions three weeks following the intervention [13]. In contrast, a more recent study failed to demonstrate a synergistic effect of active stimulation combined with an adaptive working memory task (i.e., the Paced Auditory Serial Addition Task [PASAT]) on depression symptoms post-intervention and at the longer interval follow-up (i.e., three months). However, effects may have been negatively impacted by the intermittent scheduling of stimulation (i.e., on Monday, Wednesday, and Friday [60]). Notably, Brunoni and colleagues (2014) previously demonstrated that 10 consecutive days of active stimulation combined with this PASAT task demonstrated superior reduction of depression symptoms specifically in older adults (i.e., >50 years old) who experienced greater improvements on the trained working memory task. This interaction was not observed in younger adults [14]. Thus, a combined tDCS and cognitive training approach may be particularly beneficial for targeting psychological symptoms in older adults, given that structural and functional changes in the prefrontal cortex are also observed with aging [61,62].

While the ACT parent trial investigated a combined tDCS intervention in older adults (i.e., active or sham tDCS with education or cognitive training), the primary aim of the trial was to determine if active stimulation with cognitive training would result in enhanced cognitive performance on untrained tasks. Mental health outcomes were a secondary focus; therefore, intervention parameters were modeled after a pilot study demonstrating stimulation effects on cognitive performance in older adults [63] and not after tDCS and cognitive training studies in clinical depression populations. Primary trial findings revealed no additional benefit of combining stimulation with cognitive training for the cognitive outcome, as all participants, irrespective of tDCS condition, improved performance [2]. However, as discussed, the present study did demonstrate significant tDCS effects on secondary mental health outcomes using these intervention parameters.

Similar to the aforementioned Brunoni and colleagues (2014) tDCS and cognitive training study in clinical depression, the active stimulation group in the present study also received 2 mA of direct current. However, the length of stimulation (20 min vs. 30 min), frequency of sessions (10 daily then 10 weekly vs. 10 daily), electrode placement (cathode = F3 and anode = F4 vs. anode = F3 and cathode = F4), cognitive training intervention (multi-domain vs. working memory only), and length of long-term follow-up (one year from baseline vs. one month from baseline) varied between the two studies. Our unconventional approach, adding 10 weekly tDCS booster sessions, may have allowed for the maintenance of state anxiety effects at the one-year follow-up. However, the present study did not collect data immediately following the 10 daily tDCS sessions, limiting our ability to evaluate the specific benefits of additional booster sessions. An ongoing clinical trial, investigating the effects of a combined tDCS and cognitive behavioral therapy intervention on depression, will play a crucial role in determining the necessary dosage for clinically significant effects [64]. This trial will assess depression outcomes following both two weeks of consecutive tDCS sessions and biweekly booster sessions, which will provide valuable insights for the ongoing pursuit of dose optimization and harmonization. Additionally, it is important to highlight that the present study controlled for training (education or cognitive) and adherence to the training intervention in analyses for mental health outcomes. Thus, it is difficult to compare the therapeutic benefit of this combined intervention approach to prior studies in clinical populations, as we were not specifically investigating differences between cognitive training alone versus cognitive training with stimulation. Instead, our focus was on isolating the effects of tDCS on depression and anxiety symptoms in this healthy older adult population.

However, cognitive training *adherence* emerged as a significant predictor for individuals with moderate/severe state anxiety. In this subgroup, individuals who adhered to cognitive training experienced a greater reduction in state anxiety than non-adherent individuals. This suggests that perhaps this multi-domain cognitive training intervention (i.e., attention, working memory, and processing speed) better engages and restores dlPFC functioning in older adults with greater state anxiety, potentially facilitating better use of coping strategies to manage symptoms in the moment. Notably, this was also the only subgroup that sustained significantly greater reductions of symptoms with active stimulation at both the post-intervention and one-year timepoints, suggesting this is a population that particularly benefitted from each component of the intervention. Future ACT analyses will be able to examine neuroimaging data to model interaction effects between cognitive training adherence and tDCS condition on neural circuitry involved in emotion regulation for this specific symptom severity subgroup.

Furthermore, considering the established association between psychological symptoms and cognitive functioning in older adults [26,31, 65,66], it is possible that individuals with moderate/severe state anxiety may have also experienced greater improvements in cognitive performance following active stimulation, especially in conjunction with the reduction of their anxiety symptoms. While these potential effects might not have been detectable in the overall group-level cognitive analyses [2], identifying this pattern in future subgroup analyses would shed light on the potential interplay between tDCS intervention, psychological symptom relief, and cognitive outcomes in older adults. This nuanced exploration could contribute to our understanding of how tDCS might uniquely benefit individuals with specific symptom profiles, enhancing the precision and effectiveness of future mental health and cognitive interventions for older adults.

### 3.1. Future research and clinical implications

These findings have important implications for future research and implementation of tDCS as an intervention for psychological symptoms. First of all, older adults experience a higher prevalence of subclinical

depression and anxiety symptoms than diagnosed psychiatric disorders [25,67,68]. Not only are subclinical symptoms associated with a variety of adverse outcomes [22–31] and significant economic costs [69], there is insufficient evidence for effective intervention strategies in this population, leaving practitioners without appropriate treatment recommendations [70–72]. The present study fills a significant gap in the literature as the largest study to date to investigate and identify the promising efficacy of a tDCS intervention in ameliorating subclinical depression and anxiety symptoms in older adults. Thus, we present a potential treatment option for these individuals, who may not benefit or qualify for psychotherapy or pharmacological intervention. Moreover, tDCS effects on mental health outcomes existed above and beyond potential medication use for depression and anxiety. Compared to medications, tDCS has a more favorable side effect profile [73–76], which may influence older adults with subclinical symptoms to first seek an intervention like tDCS and promote better adherence to the intervention overall [77].

Second, findings suggest there is a need for increased tDCS research focusing on anxiety, as individuals with moderate to severe state anxiety symptoms demonstrated the largest and most persistent tDCS effects. Exploratory analyses also revealed there appears to be a general co-occurrence of symptoms, such that participants who reported greater anxiety symptoms also reported greater depression symptoms and vice versa. This finding aligns with a population-based study ( $n = 14,200$ ), which demonstrated the prevalence of anxiety symptoms increases across older adults without depression symptoms (32%), those with subclinical depression symptoms (67%), and those with clinically elevated depression (87%) [78]. tDCS may be able to concurrently target both depression and anxiety symptoms within the same individual, which is clinically notable as even mild co-occurring symptoms are associated with increased risk for disability onset in older adults [79]. Future large-scale tDCS studies should include anxiety and depression measures in a sample of older adults to further investigate the utility of tDCS in reducing co-occurring symptoms.

Moreover, tDCS parameters are customizable, which allows for potential tailoring of the intervention. In the present study, age, sex, and educational level all affected changes in symptoms over time irrespective of tDCS condition. For instance, older participants reported greater increases in state anxiety, females reported greater increases in depression and state anxiety, yet having a bachelor's degree or beyond was associated with greater reductions in state and trait anxiety. As such, future studies should consider individualizing tDCS dosing parameters based on a combination of relevant demographic factors as well as interindividual anatomical differences that may impact response to intervention [47]. tDCS is also non-invasive, low-cost, and portable, with studies beginning to demonstrate the feasibility of at-home treatments [9,80]. For instance, combining self-administered tDCS with a behavioral therapy smartphone app has shown promise in improving depression and anxiety symptoms for patients with distinct psychiatric disorders [80]. Future research should investigate the feasibility of at-home tDCS in improving subclinical psychological symptoms in older adults. Establishing tDCS as an approved intervention for at-home use would expand accessibility to a cost-effective mental health intervention, promote individual autonomy, and reduce the need for additional personnel to implement the intervention.

### 3.2. Limitations

There are limitations to consider. Although the present study was conducted in a large community sample ( $n = 378$ ), the subgroups reporting greater symptoms at baseline were relatively small (i.e., mild depression  $n = 16$ , moderate/severe state anxiety  $n = 59$ , moderate/severe trait anxiety  $n = 44$ ) and potentially indicative of intentional efforts to recruit a “healthy” older adult population. While we still demonstrated significant tDCS effects in these subgroups, larger samples would likely increase the power to detect effects, particularly regarding

one-year changes in those with mild depression. Furthermore, due to exclusionary trial criteria, the present study only included individuals with minimal and mild depression symptoms. Future tDCS studies should include older adults reporting moderate depression symptoms to assess differential effects across a broader range of symptom severity subgroups within a community sample.

Moreover, since the primary objective of the parent trial was to evaluate an intervention targeting healthy older adults rather than a clinical population, participants were not required to keep their medications constant throughout the intervention. Consequently, some participants might have initiated antidepressants or anxiolytics prior to their post-intervention or one-year assessment, potentially influencing our findings. For instance, in participants with major depressive disorder, combining active stimulation with a common selective serotonin reuptake inhibitor for depression (i.e., sertraline) yields a more robust clinical response than either intervention alone [7]. In our exploratory analyses, we found that tDCS effects largely persisted beyond a participant’s reported use of current medications at baseline that can be prescribed for depression or anxiety. However, it is noteworthy that use of these medications was associated with significantly greater *increases* in reported symptoms from baseline to post-intervention in the mild depression, total and mild state anxiety, and total trait anxiety samples. Thus, future research is warranted to further evaluate the interactions between tDCS and psychiatric medication use in healthy older adult samples recruited from the community with largely subclinical reports of depression and anxiety symptoms.

The study also did not evaluate other non-pharmacological interventions for psychological symptoms. Comparing tDCS alone, tDCS with cognitive training, and tDCS combined with another behavioral intervention would help determine the most effective and feasible approaches for addressing psychological symptoms in older adults. Furthermore, increased social interaction and support due to regular contact with the study team may have contributed to improvements in psychological symptoms for the entire sample. However, these factors alone are unlikely to account for observed differences between active and sham stimulation groups in reducing depression and anxiety symptoms. This is because study contact was designed to be consistent across both intervention arms, and there was evidence of sustained group differences even after several months without any contact with study staff.

Finally, our sample predominately consisted of Non-Hispanic White individuals; thus, we were unable to evaluate the effects of this intervention on psychological symptoms in individuals from marginalized racial and ethnic groups. An individual’s experience and expression of psychological symptoms and interactions with the healthcare system are influenced greatly by sociocultural and environmental factors. For instance, African American, Hispanic or Latinx, and other underserved racial/ethnic groups face significant mental health disparities in accessing services, receiving accurate diagnoses and quality care, and in involuntary hospitalization rates [81,82]. Conducting studies on tDCS and psychological symptoms in more diverse older adult populations would shed light on how sociocultural factors impact response to intervention and create a foundation for developing an effective and

equitable mental health intervention.

4. Conclusions

This study provides a foundation for future research and clinical implementation of tDCS as a promising intervention for targeting psychological symptoms in older adults. The significant reductions in depression and state anxiety symptoms following 12 weeks of active stimulation support the efficacy of tDCS, particularly for individuals with mild depression and moderate/severe state anxiety symptoms. Furthermore, those with moderate/severe state anxiety who received active stimulation continued to demonstrate significantly larger reductions in state anxiety symptoms at one-year. Adhering to cognitive training was also associated with symptom reduction for the moderate/severe state anxiety sample, supporting mechanistic theories suggesting that enhanced prefrontal cortical functioning underlies these effects. Future research should further investigate tDCS effects on anxiety, optimize stimulation dosing based on individual-level factors, examine racially and ethnically diverse older adults, and work towards establishing tDCS as an at-home mental health intervention.

CRediT authorship contribution statement

**Hanna K. Hausman:** Writing – review & editing, Writing – original draft, Formal analysis, Data curation, Conceptualization. **Gene E. Alexander:** Writing – review & editing, Investigation. **Ronald Cohen:** Writing – review & editing, Investigation, Conceptualization. **Michael Marsiske:** Writing – review & editing, Methodology, Investigation, Conceptualization. **Steven T. DeKosky:** Writing – review & editing, Investigation, Conceptualization. **Georg A. Hishaw:** Writing – review & editing, Methodology, Investigation. **Andrew O’Shea:** Writing – review & editing, Supervision, Methodology, Investigation, Formal analysis, Data curation. **Jessica N. Kraft:** Writing – review & editing, Investigation, Data curation. **Yunfeng Dai:** Writing – review & editing, Methodology, Formal analysis, Data curation. **Samuel Wu:** Writing – review & editing, Formal analysis, Data curation, Conceptualization. **Adam J. Woods:** Writing – review & editing, Writing – original draft, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A

Table A.1  
Summary of Mental Health Measures by tDCS Group and Assessment.

| Outcome | Time | Statistic         | Total Sample (n = 378) |           |      | Minimal (n = 362) |           |      | Mild (n = 16) |             |      |
|---------|------|-------------------|------------------------|-----------|------|-------------------|-----------|------|---------------|-------------|------|
|         |      |                   | Sham                   | Active    | p    | Sham              | Active    | p    | Sham          | Active      | p    |
|         |      |                   | (n = 188)              | (n = 190) |      | (n = 183)         | (n = 179) |      | (n = 5)       | (n = 11)    |      |
| BDI-II  | T1   | Mean ± SD         | 3.4 ± 3.9              | 3.8 ± 4.5 | 0.61 | 3.1 ± 3.3         | 3.1 ± 3.6 | 0.98 | 16.2 ± 2.3    | 15.2 ± 1.2  | 0.48 |
|         |      | Median (Min, Max) | 2 (0, 19)              | 2 (0, 17) |      | 2 (0, 12)         | 2 (0, 13) |      | 16 (14, 19)   | 15 (14, 17) |      |

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Table A.1 (continued)

| Outcome    | Time              | Statistic         | Total Sample (n = 378) |              |            | Minimal (n = 362) |             |           | Mild (n = 16)            |                |       |
|------------|-------------------|-------------------|------------------------|--------------|------------|-------------------|-------------|-----------|--------------------------|----------------|-------|
|            |                   |                   | Sham                   | Active       | p          | Sham              | Active      | p         | Sham                     | Active         | p     |
|            |                   |                   | (n = 188)              | (n = 190)    |            | (n = 183)         | (n = 179)   |           | (n = 5)                  | (n = 11)       |       |
| T2         |                   | Mean ± SD         | 3.5 ± 4.0              | 2.9 ± 3.5    | 0.12       | 3.1 ± 3.4         | 2.6 ± 3.1   | 0.07      | 16.4 ± 3.6*              | 8.5 ± 4.9*     | <0.01 |
|            |                   | Median (Min, Max) | 2 (0, 19)              | 1 (0, 16)    |            | 2 (0, 15)         | 1 (0, 16)   |           | 19 (12, 19)              | 10 (0, 15)     |       |
|            | T2-T1             | Mean ± SD         | 0.1 ± 2.9*             | −0.9 ± 3.3*  | 0.02       | 0.1 ± 2.8         | −0.5 ± 2.9  | 0.10      | 0.2 ± 4.2*               | −6.7 ± 4.5*    | 0.03  |
|            |                   | Median (Min, Max) | 0 (−8, 14)             | 0 (−14, 11)  |            | 0 (−8, 14)        | 0 (−11, 11) |           | 0 (−6, 5)                | −5 (−14, 1)    |       |
|            | T3                | Mean ± SD         | 3.8 ± 4.5              | 4.1 ± 4.2    | 0.29       | 3.5 ± 4.0         | 3.6 ± 3.6   | 0.50      | 16.6 ± 1.1*              | 12.9 ± 4.0*    | 0.01  |
|            |                   | Median (Min, Max) | 2 (0, 22)              | 3 (0, 23)    |            | 2 (0, 22)         | 2 (0, 19)   |           | 17 (15, 18)              | 13 (8, 23)     |       |
| T3-T1      | Mean ± SD         | 0.4 ± 3.3         | 0.4 ± 3.1              | 0.52         | 0.4 ± 3.3  | 0.5 ± 3.0         | 0.97        | 0.4 ± 2.4 | −2.3 ± 3.8               | 0.07           |       |
|            | Median (Min, Max) | 0 (−8, 14)        | 0 (−8, 18)             |              | 0 (−8, 14) | 0 (−8, 18)        |             | 1 (−3, 3) | −3 (−6, 8)               |                |       |
| Outcome    | Time              | Statistic         | Total Sample (n = 378) |              |            | Mild (n = 319)    |             |           | Moderate/Severe (n = 59) |                |       |
|            |                   |                   | Sham                   | Active       | p          | Sham              | Active      | p         | Sham                     | Active         | p     |
|            |                   |                   | (n = 188)              | (n = 190)    |            | (n = 157)         | (n = 162)   |           | (n = 31)                 | (n = 28)       |       |
| STAI State | T1                | Mean ± SD         | 28.2 ± 8.5             | 28.7 ± 8.5   | 0.60       | 25.2 ± 5.0        | 26.0 ± 5.6  | 0.32      | 43.6 ± 4.7               | 44.3 ± 4.2     | 0.44  |
|            |                   | Median (Min, Max) | 25 (20, 58)            | 27 (20, 54)  |            | 24 (20, 38)       | 24 (20, 38) |           | 43 (39, 58)              | 44 (39, 54)    |       |
|            | T2                | Mean ± SD         | 28.2 ± 8.1*            | 26.3 ± 6.6*  | 0.02       | 26.3 ± 6.7        | 25.6 ± 5.8  | 0.29      | 37.7 ± 8.1*              | 30.6 ± 9.0*    | <0.01 |
|            |                   | Median (Min, Max) | 26 (20, 54)            | 24 (20, 50)  |            | 25 (20, 53)       | 24 (20, 44) |           | 39 (21, 54)              | 30.5 (20, 50)  |       |
|            | T2-T1             | Mean ± SD         | −0.0 ± 7.6*            | −2.4 ± 8.2*  | 0.01       | 1.2 ± 6.5*        | −0.5 ± 5.8* | 0.02      | −6.0 ± 9.9*              | −13.6 ± 10.9*  | 0.01  |
|            |                   | Median (Min, Max) | 0 (−24, 27)            | −1 (−31, 24) |            | 0 (−16, 27)       | 0 (−15, 24) |           | −6 (−24, 15)             | −12.5 (−31, 6) |       |
|            | T3                | Mean ± SD         | 28.2 ± 7.6             | 27.6 ± 6.9   | 0.73       | 26.2 ± 5.8        | 26.5 ± 6.4  | 0.64      | 38.3 ± 7.7*              | 33.9 ± 6.7*    | 0.04  |
|            |                   | Median (Min, Max) | 25.5 (20, 53)          | 26 (20, 55)  |            | 24 (20, 48)       | 26 (20, 55) |           | 37 (23, 53)              | 34.5 (20, 49)  |       |
|            | T3-T1             | Mean ± SD         | −0.0 ± 6.7             | −1.1 ± 7.7   | 0.07       | 1.0 ± 5.6         | 0.5 ± 6.3   | 0.18      | −5.3 ± 9.0               | −10.3 ± 8.7    | 0.06  |
|            |                   | Median (Min, Max) | 0 (−22, 16)            | 0 (−34, 29)  |            | 1 (−16, 16)       | 0 (−13, 29) |           | −5 (−22, 10)             | −8.5 (−34, 2)  |       |
| Outcome    | Time              | Statistic         | Total Sample (n = 378) |              |            | Mild (n = 334)    |             |           | Moderate/Severe (n = 44) |                |       |
|            |                   |                   | Sham                   | Active       | p          | Sham              | Active      | p         | Sham                     | Active         | p     |
|            |                   |                   | (n = 188)              | (n = 190)    |            | (n = 166)         | (n = 168)   |           | (n = 22)                 | (n = 22)       |       |
| STAI Trait | T1                | Mean ± SD         | 28.2 ± 7.3             | 29.0 ± 7.4   | 0.20       | 26.1 ± 4.7        | 27.0 ± 5.2  | 0.11      | 43.9 ± 3.6               | 43.8 ± 4.4     | 0.60  |
|            |                   | Median (Min, Max) | 26 (20, 52)            | 27 (20, 56)  |            | 25 (20, 38)       | 26 (20, 38) |           | 43 (39, 52)              | 42 (39, 56)    |       |
|            | T2                | Mean ± SD         | 27.7 ± 6.6             | 27.7 ± 6.3   | 0.89       | 26.3 ± 5.3        | 26.7 ± 5.4  | 0.64      | 37.7 ± 6.3               | 35.4 ± 7.1     | 0.19  |
|            |                   | Median (Min, Max) | 26 (20, 52)            | 26 (20, 53)  |            | 25 (20, 52)       | 25 (20, 44) |           | 37.5 (26, 52)            | 35.5 (23, 53)  |       |
|            | T2-T1             | Mean ± SD         | −0.5 ± 5.0             | −1.3 ± 5.4   | 0.13       | 0.2 ± 4.0         | −0.4 ± 4.1  | 0.24      | −6.2 ± 7.4               | −8.4 ± 8.3     | 0.30  |
|            |                   | Median (Min, Max) | 0 (−22, 25)            | −1 (−30, 16) |            | 0 (−12, 25)       | 0 (−16, 16) |           | −4.5 (−22, 5)            | −6 (−30, 8)    |       |
|            | T3                | Mean ± SD         | 28.1 ± 6.8             | 28.7 ± 7.0   | 0.42       | 26.5 ± 4.9        | 27.4 ± 6.0  | 0.32      | 40.0 ± 7.4               | 38.4 ± 6.3     | 0.41  |
|            |                   | Median (Min, Max) | 27 (20, 55)            | 27 (20, 66)  |            | 26 (20, 43)       | 26 (20, 66) |           | 39 (29, 55)              | 37 (24, 51)    |       |
|            | T3-T1             | Mean ± SD         | −0.1 ± 4.7             | −0.3 ± 6.0   | 0.20       | 0.5 ± 3.7         | 0.3 ± 5.3   | 0.30      | −4.0 ± 8.5               | −5.5 ± 8.1     | 0.73  |
|            |                   | Median (Min, Max) | 0 (−23, 14)            | 0 (−29, 42)  |            | 0.5 (−15, 14)     | 0 (−14, 42) |           | −5 (−23, 12)             | −5 (−29, 10)   |       |

Notes: Summary statistics are reported for the entire sample, including participants with missing follow-up assessments whose data were imputed via regression. All p-values are from Wilcoxon rank-sum tests. BDI-II = Beck Depression Inventory Second Edition, STAI = State-Trait Anxiety Inventory, T1 = baseline assessment, T2 = post-intervention, T3 = one-year assessment.

\*Significant differences between sham and active tDCS groups at  $p < 0.05$ .

Table A.2  
Frequencies of Self-Reported Medications that can be used for Depression or Anxiety.

| Generic Drug Name | Frequency in Medication Review |
|-------------------|--------------------------------|
| Bupropion         | 68                             |
| Trazadone         | 51                             |
| Sertraline        | 49                             |
| Gabapentin        | 37                             |
| Escitalopram      | 35                             |
| Citalopram        | 32                             |
| Venlafaxine       | 22                             |
| Fluoxetine        | 15                             |
| Paroxetine        | 14                             |
| Buspirone         | 10                             |
| Lorazepam         | 9                              |
| Amitriptyline     | 7                              |
| Aripiprazole      | 7                              |
| Mirtazapine       | 5                              |
| Chlordiazepoxide  | 4                              |
| Desvenlafaxine    | 4                              |
| Nortriptyline     | 4                              |
| Vortioxetine      | 3                              |
| Hydroxyzine       | 2                              |
| Alprazolam        | 1                              |
| Clonazepam        | 1                              |
| Duloxetine        | 1                              |

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Table A.2 (continued)

| Generic Drug Name | Frequency in Medication Review |
|-------------------|--------------------------------|
| Imipramine        | 1                              |
| l-Theanine        | 1                              |
| Lamotrigine       | 1                              |
| Psilocybin        | 1                              |
| Temazepam         | 1                              |

Table A.3  
Blinding Efficacy.

| Question                                                                                           | Treatment Condition | Overall (n = 298)* | Those Who Received Active tDCS | Those Who Received Sham tDCS | p    |
|----------------------------------------------------------------------------------------------------|---------------------|--------------------|--------------------------------|------------------------------|------|
| Participant: Which brain stimulation treatment condition do you believe you received?              | Active              | 175 (58.7%)        | 88 (57.5%)                     | 87 (60.0%)                   | 0.66 |
|                                                                                                    | Sham                | 123 (41.3%)        | 65 (42.5%)                     | 58 (40.0%)                   |      |
| Experimenter: Which brain stimulation treatment condition do you believe the participant received? | Active              | 119 (40.3%)        | 62 (41.1%)                     | 57 (39.6%)                   | 0.80 |
|                                                                                                    | Sham                | 176 (59.7%)        | 89 (58.9%)                     | 87 (60.4%)                   |      |

Notes: This table depicts the true allocation of participants to each treatment condition who completed the questionnaire, the total number of responses overall for treatment condition predictions, and then the responses divided between those who actually received active and sham stimulation.

\*Of 306 participants with post-intervention data, 8 participants and 11 experimenters did not provide a response.

Table A.4  
Confidence in Predicting Treatment Condition.

| Confidence                                                                                                    | Statistics        | Overall Ratings | Those Who Received Active tDCS | Those Who Received Sham tDCS | p    |
|---------------------------------------------------------------------------------------------------------------|-------------------|-----------------|--------------------------------|------------------------------|------|
| Participant: One a scale of 0–10, how confident are you that you received your answer selection?              | Mean ± SD         | 6.0 ± 3.0       | 6.3 ± 2.8                      | 5.8 ± 3.2                    | 0.39 |
|                                                                                                               | Median (Min, Max) | 6 (0, 10)       | 6 (0, 10)                      | 6 (0, 10)                    |      |
| Experimenter: One a scale of 0–10, how confident are you that the participant received your answer selection? | Mean ± SD         | 3.2 ± 2.9       | 3.2 ± 2.8                      | 3.1 ± 3.0                    | 0.80 |
|                                                                                                               | Median (Min, Max) | 3 (0, 10)       | 3 (0, 9)                       | 2 (0, 9)                     |      |

Notes: 0 = not at all confident, 10 = completely confident.

Table A.5  
Average Ratings of Sensations Experienced Before, During, and After Stimulation by tDCS Group.

| Ratings                       | Before stimulation |      |      |      |       |             | During stimulation |      |      |      |       |                 | After stimulation |      |      |      |       |      |
|-------------------------------|--------------------|------|------|------|-------|-------------|--------------------|------|------|------|-------|-----------------|-------------------|------|------|------|-------|------|
|                               | tDCS               |      | Sham |      | t     | p           | tDCS               |      | Sham |      | t     | p               | tDCS              |      | Sham |      | t     | p    |
|                               | M                  | SD   | M    | SD   |       |             | M                  | SD   | M    | SD   |       |                 | M                 | SD   | M    | SD   |       |      |
| Tingling                      | 0.08               | 0.35 | 0.18 | 0.78 | 1.59  | 0.11        | 1.14               | 1.55 | 0.76 | 0.99 | −2.75 | <b>0.01</b>     | 0.07              | 0.17 | 0.18 | 0.85 | 1.74  | 0.08 |
| Itching                       | 0.12               | 0.29 | 0.13 | 0.57 | 0.21  | 0.83        | 0.56               | 1.14 | 0.40 | 0.85 | −1.48 | 0.14            | 0.13              | 0.48 | 0.06 | 0.22 | −1.69 | 0.09 |
| Burning                       | 0.04               | 0.13 | 0.06 | 0.36 | 0.63  | 0.53        | 1.19               | 1.61 | 0.76 | 1.06 | −2.93 | <b>&lt;0.01</b> | 0.07              | 0.21 | 0.08 | 0.48 | 0.45  | 0.66 |
| Pain                          | 0.21               | 0.52 | 0.38 | 0.92 | 2.12  | <b>0.03</b> | 0.40               | 1.17 | 0.24 | 0.56 | −1.69 | 0.09            | 0.09              | 0.49 | 0.16 | 0.60 | 1.16  | 0.25 |
| Fatigue                       | 0.31               | 0.73 | 0.39 | 0.98 | 0.97  | 0.33        | 0.38               | 0.74 | 0.34 | 0.94 | −0.48 | 0.63            | 0.35              | 0.67 | 0.37 | 0.94 | 0.24  | 0.81 |
| Nervousness                   | 0.10               | 0.63 | 0.11 | 0.33 | 0.04  | 0.97        | 0.22               | 0.63 | 0.23 | 0.66 | 0.11  | 0.91            | 0.10              | 0.33 | 0.13 | 0.44 | 0.63  | 0.53 |
| Headache                      | 0.13               | 0.32 | 0.16 | 0.50 | 0.75  | 0.45        | 0.11               | 0.69 | 0.09 | 0.28 | −0.28 | 0.78            | 0.07              | 0.27 | 0.11 | 0.32 | 1.10  | 0.27 |
| Difficulty concentrating      | 0.17               | 0.50 | 0.18 | 0.42 | 0.12  | 0.91        | 0.59               | 1.11 | 0.46 | 0.92 | −1.23 | 0.22            | 0.30              | 0.66 | 0.27 | 0.53 | −0.37 | 0.71 |
| Mood change                   | 0.12               | 0.45 | 0.09 | 0.35 | −0.58 | 0.56        | 0.15               | 0.43 | 0.17 | 0.74 | 0.39  | 0.70            | 0.14              | 0.46 | 0.08 | 0.25 | −1.46 | 0.15 |
| Vision change                 | 0.04               | 0.14 | 0.05 | 0.18 | 0.13  | 0.90        | 0.13               | 0.42 | 0.12 | 0.69 | −0.19 | 0.85            | 0.06              | 0.19 | 0.03 | 0.11 | −1.63 | 0.10 |
| Visual sensation (phosphenes) | 0.01               | 0.09 | 0.04 | 0.38 | 1.03  | 0.30        | 0.02               | 0.13 | 0.01 | 0.09 | −0.85 | 0.40            | 0.02              | 0.14 | 0.01 | 0.09 | −0.74 | 0.46 |

Table A.6  
Depression Results from Baseline to Post-Intervention.

| Variable                                    | Category | Imputed  |        |       |       |
|---------------------------------------------|----------|----------|--------|-------|-------|
|                                             |          | Estimate | 95% CI |       | p     |
| Change in BDI-II for Total Sample (n = 378) |          |          |        |       |       |
| Intercept                                   |          | −0.76    | −4.79  | 3.27  | 0.71  |
| tDCS                                        | Active   | −0.75*   | −1.30  | −0.21 | <0.01 |
|                                             | Sham     | 0.00     |        |       |       |
| Education or Cognitive Training             | CT       | −0.36    | −1.50  | 0.78  | 0.54  |
|                                             | ET       | 0.00     |        |       |       |

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**Table A.6** (continued)

| Variable                                                      | Category                               | Imputed  |         |       |       |
|---------------------------------------------------------------|----------------------------------------|----------|---------|-------|-------|
|                                                               |                                        | Estimate | 95% CI  |       | p     |
| Age                                                           |                                        | 0.03     | −0.03   | 0.08  | 0.35  |
| Sex                                                           | Female                                 | 0.64*    | 0.07    | 1.21  | 0.03  |
|                                                               | Male                                   | 0.00     |         |       |       |
| Site                                                          | UF                                     | 0.46     | −0.14   | 1.06  | 0.14  |
|                                                               | UA                                     | 0.00     |         |       |       |
| Education Level                                               | Bachelor's degree or above             | −0.12    | −0.72   | 0.47  | 0.68  |
|                                                               | Some college/associate degree or below | 0.00     |         |       |       |
| Stimulation Adherence                                         | Yes                                    | −0.05    | −0.98   | 0.88  | 0.92  |
|                                                               | No                                     | 0.00     |         |       |       |
| Cognitive Training Adherence                                  | Yes                                    | 0.00     | −0.91   | 0.90  | 0.99  |
|                                                               | No                                     | 0.00     |         |       |       |
| Baseline BDI-II Score                                         |                                        | −0.38*   | −0.45   | −0.32 | <0.01 |
| <i>Change in BDI-II for Minimal Symptoms Sample (n = 362)</i> |                                        |          |         |       |       |
| Intercept                                                     |                                        | −1.15    | −5.04   | 2.73  | 0.56  |
| tDCS                                                          | Active                                 | −0.52*   | −1.04   | 0.00  | 0.05  |
|                                                               | Sham                                   | 0.00     |         |       |       |
| Education or Cognitive Training                               | CT                                     | −0.17    | −1.27   | 0.93  | 0.76  |
|                                                               | ET                                     | 0.00     |         |       |       |
| Age                                                           |                                        | 0.03     | −0.03   | 0.08  | 0.33  |
| Sex                                                           | Female                                 | 0.71*    | 0.16    | 1.25  | 0.01  |
|                                                               | Male                                   | 0.00     |         |       |       |
| Site                                                          | UF                                     | 0.52     | −0.05   | 1.09  | 0.08  |
|                                                               | UA                                     | 0.00     |         |       |       |
| Education Level                                               | Bachelor's degree or above             | −0.15    | −0.72   | 0.42  | 0.61  |
|                                                               | Some college/associate degree or below | 0.00     |         |       |       |
| Stimulation Adherence                                         | Yes                                    | 0.17     | −0.74   | 1.08  | 0.71  |
|                                                               | No                                     | 0.00     |         |       |       |
| Cognitive Training Adherence                                  | Yes                                    | −0.16    | −1.04   | 0.73  | 0.73  |
|                                                               | No                                     | 0        |         |       |       |
| Baseline BDI-II Score                                         |                                        | −0.41*   | −0.49   | −0.33 | <0.01 |
| <i>Change in BDI-II for Mild Symptoms Sample (n = 16)</i>     |                                        |          |         |       |       |
| Intercept                                                     |                                        | −32.31   | −128.24 | 63.62 | 0.44  |
| tDCS                                                          | Active                                 | −9.67*   | −18.35  | −0.98 | 0.03  |
|                                                               | Sham                                   | 0.00     |         |       |       |
| Education or Cognitive Training                               | CT                                     | 3.98     | −14.09  | 22.05 | 0.61  |
|                                                               | ET                                     | 0.00     |         |       |       |
| Age                                                           |                                        | 0.36     | −0.36   | 1.09  | 0.27  |
| Sex                                                           | Female                                 | −5.63    | −14.91  | 3.66  | 0.19  |
|                                                               | Male                                   | 0.00     |         |       |       |
| Site                                                          | UF                                     | −6.44    | −16.91  | 4.02  | 0.18  |
|                                                               | UA                                     | 0.00     |         |       |       |
| Education Level                                               | Bachelor's degree or above             | −1.01    | −8.08   | 6.05  | 0.74  |
|                                                               | Some college/associate degree or below | 0.00     |         |       |       |
| Stimulation Adherence                                         | Yes                                    | 2.38     | −9.17   | 13.92 | 0.63  |
|                                                               | No                                     | 0.00     |         |       |       |
| Cognitive Training Adherence                                  | Yes                                    | −6.34    | −17.64  | 4.96  | 0.22  |
|                                                               | No                                     | 0.00     |         |       |       |
| Baseline BDI-II Score                                         |                                        | 0.91     | −2.61   | 4.44  | 0.55  |

Notes: CI = confidence interval, CT = cognitive training, ET = education training, UF = University of Florida, UA = University of Arizona, BDI-II = Beck Depression Inventory – Second Edition, Minimal Symptoms = BDI-II scores between 0 and 13, Mild Symptoms = BDI-II scores between 14 and 19.

\*Significant at  $p < 0.05$ .

**Table A.7**

Depression Results from Baseline to One-Year.

| Variable                                    | Category                               | Imputed  |        |      |      |
|---------------------------------------------|----------------------------------------|----------|--------|------|------|
|                                             |                                        | Estimate | 95% CI |      | p    |
| Change in BDI-II for Total Sample (n = 378) |                                        |          |        |      |      |
| Intercept                                   |                                        | 2.13     | −2.40  | 6.65 | 0.36 |
| tDCS                                        | Active                                 | 0.09     | −0.52  | 0.69 | 0.78 |
|                                             | Sham                                   | 0.00     |        |      |      |
| Education or Cognitive Training             | CT                                     | 0.91     | −0.38  | 2.19 | 0.17 |
|                                             | ET                                     | 0.00     |        |      |      |
| Age                                         |                                        | −0.02    | −0.08  | 0.04 | 0.58 |
| Sex                                         | Female                                 | 0.60     | −0.04  | 1.25 | 0.06 |
|                                             | Male                                   | 0.00     |        |      |      |
| Site                                        | UF                                     | −0.39    | −1.07  | 0.28 | 0.25 |
|                                             | UA                                     | 0.00     |        |      |      |
| Education Level                             | Bachelor's degree or above             | −0.12    | −0.78  | 0.55 | 0.73 |
|                                             | Some college/associate degree or below | 0.00     |        |      |      |
| Stimulation Adherence                       | Yes                                    | 0.21     | −0.83  | 1.26 | 0.69 |

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**Table A.7** (continued)

| Variable                                                      | Category                               | Imputed  |        |       |       |
|---------------------------------------------------------------|----------------------------------------|----------|--------|-------|-------|
|                                                               |                                        | Estimate | 95% CI |       | p     |
| Cognitive Training Adherence                                  | No                                     | 0.00     |        |       |       |
|                                                               | Yes                                    | −0.89    | −1.91  | 0.12  | 0.08  |
|                                                               | No                                     | 0.00     |        |       |       |
| Baseline BDI-II Score                                         |                                        | −0.27*   | −0.34  | −0.19 | <0.01 |
| <i>Change in BDI-II for Minimal Symptoms Sample (n = 362)</i> |                                        |          |        |       |       |
| Intercept                                                     |                                        | 1.35     | −3.27  | 5.97  | 0.57  |
| tDCS                                                          | Active                                 | 0.17     | −0.44  | 0.79  | 0.58  |
| Education or Cognitive Training                               | Sham                                   | 0.00     |        |       |       |
|                                                               | CT                                     | 0.80     | −0.51  | 2.11  | 0.23  |
|                                                               | ET                                     | 0.00     |        |       |       |
| Age                                                           |                                        | −0.01    | −0.07  | 0.06  | 0.87  |
| Sex                                                           | Female                                 | 0.70*    | 0.06   | 1.35  | 0.03  |
| Site                                                          | Male                                   | 0.00     |        |       |       |
|                                                               | UF                                     | −0.42    | −1.10  | 0.25  | 0.22  |
| Education Level                                               | UA                                     | 0.00     |        |       |       |
|                                                               | Bachelor's degree or above             | −0.03    | −0.70  | 0.65  | 0.93  |
| Stimulation Adherence                                         | Some college/associate degree or below | 0.00     |        |       |       |
|                                                               | Yes                                    | 0.02     | −1.07  | 1.10  | 0.98  |
| Cognitive Training Adherence                                  | No                                     | 0.00     |        |       |       |
|                                                               | Yes                                    | −0.69    | −1.74  | 0.37  | 0.20  |
| Baseline BDI-II Total Score                                   | No                                     | 0.00     |        |       |       |
|                                                               | Yes                                    | −0.32*   | −0.42  | −0.23 | <0.01 |
| <i>Change in BDI-II for Mild Symptoms Sample (n = 16)</i>     |                                        |          |        |       |       |
| Intercept                                                     |                                        | 1.65     | −62.60 | 65.91 | 0.95  |
| tDCS                                                          | Active                                 | −3.85    | −9.67  | 1.96  | 0.16  |
| Education or Cognitive Training                               | Sham                                   | 0.00     |        |       |       |
|                                                               | CT                                     | 0.89     | −11.21 | 12.99 | 0.86  |
|                                                               | ET                                     | 0.00     |        |       |       |
| Age                                                           |                                        | 0.01     | −0.48  | 0.49  | 0.98  |
| Sex                                                           | Female                                 | −4.45    | −10.67 | 1.77  | 0.13  |
| Site                                                          | Male                                   | 0.00     |        |       |       |
|                                                               | UF                                     | −5.27    | −12.28 | 1.74  | 0.12  |
| Education Level                                               | UA                                     | 0.00     |        |       |       |
|                                                               | Bachelor's degree or above             | −1.43    | −6.16  | 3.30  | 0.49  |
| Stimulation Adherent                                          | Some college/associate degree or below | 0.00     |        |       |       |
|                                                               | Yes                                    | 3.87     | −3.86  | 11.61 | 0.27  |
| Cognitive Training Adherence                                  | No                                     | 0.00     |        |       |       |
|                                                               | Yes                                    | −5.83    | −13.40 | 1.74  | 0.11  |
| Baseline BDI-II Total Score                                   | No                                     | 0.00     |        |       |       |
|                                                               | Yes                                    | 0.41     | −1.95  | 2.77  | 0.69  |

Notes: CI = confidence interval, CT = cognitive training, ET = education training, UF = University of Florida, UA = University of Arizona, BDI-II = Beck Depression Inventory – Second Edition, Minimal Symptoms = BDI-II scores between 0 and 13, Mild Symptoms = BDI-II scores between 14 and 19.

\*Significant at  $p < 0.05$ .

**Table A.8**

State Anxiety Results from Baseline to Post-Intervention.

| Variable                                                | Category                               | Imputed  |        |       |       |
|---------------------------------------------------------|----------------------------------------|----------|--------|-------|-------|
|                                                         |                                        | Estimate | 95% CI |       | p     |
| Change in STAI State for Total Sample (n = 378)         |                                        |          |        |       |       |
| Intercept                                               |                                        | −1.73    | −11.09 | 7.64  | 0.72  |
| tDCS                                                    | Active                                 | −1.93*   | −3.20  | −0.66 | <0.01 |
|                                                         | Sham                                   | 0.00     |        |       |       |
| Education or Cognitive Training                         | CT                                     | 0.33     | −2.35  | 3.01  | 0.81  |
|                                                         | ET                                     | 0.00     |        |       |       |
| Age                                                     |                                        | 0.24*    | 0.11   | 0.36  | <0.01 |
| Sex                                                     | Female                                 | 1.46*    | 0.11   | 2.80  | 0.03  |
|                                                         | Male                                   | 0.00     |        |       |       |
| Site                                                    | UF                                     | −0.18    | −1.59  | 1.23  | 0.80  |
|                                                         | UA                                     | 0.00     |        |       |       |
| Education Level                                         | Bachelor's degree or above             | −0.20    | −1.59  | 1.19  | 0.78  |
|                                                         | Some college/associate degree or below | 0.00     |        |       |       |
| Stimulation Adherence                                   | Yes                                    | 0.85     | −1.35  | 3.04  | 0.45  |
|                                                         | No                                     | 0.00     |        |       |       |
| Cognitive Training Adherence                            | Yes                                    | −0.88    | −3.00  | 1.25  | 0.42  |
|                                                         | No                                     | 0.00     |        |       |       |
| Baseline STAI State Score                               |                                        | −0.59*   | −0.66  | −0.51 | <0.01 |
| Change in STAI State for Mild Symptoms Sample (n = 319) |                                        |          |        |       |       |
| Intercept                                               |                                        | −0.63    | −10.31 | 9.05  | 0.90  |
| tDCS                                                    | Active                                 | −1.04    | −2.27  | 0.19  | 0.10  |
|                                                         | Sham                                   | 0.00     |        |       |       |

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**Table A.8** (continued)

| Variable                                                                 | Category                               | Imputed  |        |       |       |
|--------------------------------------------------------------------------|----------------------------------------|----------|--------|-------|-------|
|                                                                          |                                        | Estimate | 95% CI |       | p     |
| Education or Cognitive Training                                          | CT                                     | –1.25    | –3.92  | 1.41  | 0.35  |
|                                                                          | ET                                     | 0.00     |        |       |       |
| Age                                                                      |                                        | 0.21*    | 0.09   | 0.34  | <0.01 |
| Sex                                                                      | Female                                 | 1.14     | –0.17  | 2.45  | 0.09  |
|                                                                          | Male                                   | 0.00     |        |       |       |
| Site                                                                     | UF                                     | –0.06    | –1.44  | 1.32  | 0.93  |
|                                                                          | UA                                     | 0.00     |        |       |       |
| Education Level                                                          | Bachelor's degree or above             | –0.87    | –2.23  | 0.49  | 0.21  |
|                                                                          | Some college/associate degree or below | 0.00     |        |       |       |
| Stimulation Adherence                                                    | Yes                                    | –0.62    | –2.83  | 1.58  | 0.58  |
|                                                                          | No                                     | 0.00     |        |       |       |
| Cognitive Training Adherence                                             | Yes                                    | 1.06     | –1.08  | 3.21  | 0.33  |
|                                                                          | No                                     | 0.00     |        |       |       |
| Baseline STAI State Score                                                |                                        | –0.50*   | –0.61  | –0.38 | <0.01 |
| <i>Change in STAI State for Moderate/Severe Symptoms Sample (n = 59)</i> |                                        |          |        |       |       |
| Intercept                                                                |                                        | 36.87    | –4.39  | 78.13 | 0.08  |
| tDCS                                                                     | Active                                 | –5.92*   | –10.40 | –1.44 | 0.01  |
|                                                                          | Sham                                   | 0.00     |        |       |       |
| Education or Cognitive Training                                          | CT                                     | 5.84     | –2.74  | 14.42 | 0.18  |
|                                                                          | ET                                     | 0.00     |        |       |       |
| Age                                                                      |                                        | 0.15     | –0.24  | 0.54  | 0.45  |
| Sex                                                                      | Female                                 | 1.58     | –3.11  | 6.26  | 0.50  |
|                                                                          | Male                                   | 0.00     |        |       |       |
| Site                                                                     | UF                                     | 1.17     | –3.60  | 5.93  | 0.62  |
|                                                                          | UA                                     | 0.00     |        |       |       |
| Education Level                                                          | Bachelor's degree or above             | 1.87     | –2.98  | 6.72  | 0.44  |
|                                                                          | Some college/associate degree or below | 0.00     |        |       |       |
| Stimulation Adherence                                                    | Yes                                    | 2.93     | –4.14  | 10.01 | 0.41  |
|                                                                          | No                                     | 0.00     |        |       |       |
| Cognitive Training Adherence                                             | Yes                                    | –7.69*   | –13.78 | –1.60 | 0.01  |
|                                                                          | No                                     | 0.00     |        |       |       |
| Baseline STAI State Score                                                |                                        | –1.36*   | –1.89  | –0.83 | <0.01 |

Notes: CI = confidence interval, CT = cognitive training, ET = education training, UF = University of Florida, UA = University of Arizona, STAI = State-Trait Anxiety Inventory, Mild Symptoms = STAI state scores below 39, Moderate/Severe Symptoms = STAI state scores greater than or equal to 39.

\*Significant at  $p < 0.05$ .

**Table A.9**

State Anxiety Results from Baseline to One-Year.

| Variable                                                | Category                               | Imputed  |        |       |       |
|---------------------------------------------------------|----------------------------------------|----------|--------|-------|-------|
|                                                         |                                        | Estimate | 95% CI |       | p     |
| Change in STAI State for Total Sample (n = 378)         |                                        |          |        |       |       |
| Intercept                                               |                                        | 13.54    | 4.78   | 22.29 | <0.01 |
| tDCS                                                    | Active                                 | −0.67    | −1.86  | 0.52  | 0.27  |
|                                                         | Sham                                   | 0.00     |        |       |       |
| Education or Cognitive Training                         | CT                                     | −0.71    | −3.21  | 1.80  | 0.58  |
|                                                         | ET                                     | 0.00     |        |       |       |
| Age                                                     |                                        | 0.02     | −0.09  | 0.14  | 0.68  |
| Sex                                                     | Female                                 | 1.34*    | 0.09   | 2.60  | 0.04  |
|                                                         | Male                                   | 0.00     |        |       |       |
| Site                                                    | UF                                     | −0.23    | −1.55  | 1.09  | 0.73  |
|                                                         | UA                                     | 0.00     |        |       |       |
| Education Level                                         | Bachelor's degree or above             | −1.37*   | −2.67  | −0.07 | 0.04  |
|                                                         | Some college/associate degree or below | 0.00     |        |       |       |
| Stimulation Adherence                                   | Yes                                    | −0.13    | −2.18  | 1.92  | 0.90  |
|                                                         | No                                     | 0.00     |        |       |       |
| Cognitive Training Adherence                            | Yes                                    | −0.20    | −2.18  | 1.78  | 0.84  |
|                                                         | No                                     | 0.00     |        |       |       |
| Baseline STAI State Score                               |                                        | −0.51*   | −0.58  | −0.43 | <0.01 |
| Change in STAI State for Mild Symptoms Sample (n = 319) |                                        |          |        |       |       |
| Intercept                                               |                                        | 20.70    | 11.34  | 30.06 | <0.01 |
| tDCS                                                    | Active                                 | 0.00     | −1.18  | 1.19  | 1.00  |
|                                                         | Sham                                   | 0.00     |        |       |       |
| Education or Cognitive Training                         | CT                                     | −1.76    | −4.34  | 0.81  | 0.18  |
|                                                         | ET                                     | 0.00     |        |       |       |
| Age                                                     |                                        | −0.08    | −0.20  | 0.04  | 0.19  |
| Sex                                                     | Female                                 | 1.22     | −0.04  | 2.49  | 0.06  |
|                                                         | Male                                   | 0.00     |        |       |       |
| Site                                                    | UF                                     | 0.32     | −1.02  | 1.66  | 0.64  |
|                                                         | UA                                     | 0.00     |        |       |       |
| Education Level                                         | Bachelor's degree or above             | −1.70*   | −3.01  | −0.38 | 0.01  |

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**Table A.9** (continued)

| Variable                                                                 | Category                               | Imputed  |        |       |       |
|--------------------------------------------------------------------------|----------------------------------------|----------|--------|-------|-------|
|                                                                          |                                        | Estimate | 95% CI |       | p     |
| Stimulation Adherence                                                    | Some college/associate degree or below | 0.00     |        |       |       |
|                                                                          | Yes                                    | −0.98    | −3.11  | 1.14  | 0.36  |
| Cognitive Training Adherence                                             | No                                     | 0.00     |        |       |       |
|                                                                          | Yes                                    | 0.80     | −1.27  | 2.88  | 0.45  |
|                                                                          | No                                     | 0.00     |        |       |       |
|                                                                          | Yes                                    | −0.48*   | −0.59  | −0.36 | <0.01 |
| <i>Change in STAI State for Moderate/Severe Symptoms Sample (n = 59)</i> |                                        |          |        |       |       |
| Intercept                                                                |                                        | 18.52    | −18.21 | 55.25 | 0.32  |
| tDCS                                                                     | Active                                 | −4.03*   | −8.02  | 0.04  | 0.048 |
|                                                                          | Sham                                   | 0.00     |        |       |       |
| Education or Cognitive Training                                          | CT                                     | 2.46     | −5.18  | 10.09 | 0.52  |
|                                                                          | ET                                     | 0.00     |        |       |       |
| Age                                                                      |                                        | 0.28     | −0.07  | 0.62  | 0.12  |
| Sex                                                                      | Female                                 | 1.34     | −2.83  | 5.52  | 0.52  |
|                                                                          | Male                                   | 0.00     |        |       |       |
| Site                                                                     | UF                                     | −1.82    | −6.06  | 2.42  | 0.39  |
|                                                                          | UA                                     | 0.00     |        |       |       |
| Education Level                                                          | Bachelor's degree or above             | −1.59    | −5.91  | 2.72  | 0.46  |
|                                                                          | Some college/associate degree or below | 0.00     |        |       |       |
| Stimulation Adherence                                                    | Yes                                    | 2.71     | −3.59  | 9.01  | 0.39  |
|                                                                          | No                                     | 0.00     |        |       |       |
| Cognitive Training Adherence                                             | Yes                                    | −3.44    | −8.86  | 1.98  | 0.21  |
|                                                                          | No                                     | 0.00     |        |       |       |
| Baseline STAI State Score                                                |                                        | −1.04*   | −1.51  | −0.57 | <0.01 |

Notes: CI = confidence interval, CT = cognitive training, ET = education training, UF = University of Florida, UA = University of Arizona, STAI = State-Trait Anxiety Inventory, Mild Symptoms = STAI state scores below 39, Moderate/Severe Symptoms = STAI state scores greater than or equal to 39.

\*Significant at  $p < 0.05$ .

**Table A.10**

Trait Anxiety Results from Baseline to Post-Intervention

| Variable                                                          | Category                               | Imputed  |        |       |       |
|-------------------------------------------------------------------|----------------------------------------|----------|--------|-------|-------|
|                                                                   |                                        | Estimate | 95% CI |       | p     |
| Change in STAI Trait for Total Sample (n = 378)                   |                                        |          |        |       |       |
| Intercept                                                         |                                        | 9.25     | 2.56   | 15.94 | <0.01 |
| tDCS                                                              | Active                                 | −0.45    | −1.35  | 0.45  | 0.33  |
|                                                                   | Sham                                   | 0.00     |        |       |       |
| Education or Cognitive Training                                   | CT                                     | −0.99    | −2.89  | 0.91  | 0.31  |
|                                                                   | ET                                     | 0.00     |        |       |       |
| Age                                                               |                                        | 0.04     | −0.05  | 0.13  | 0.35  |
| Sex                                                               | Female                                 | −0.29    | −1.24  | 0.65  | 0.54  |
|                                                                   | Male                                   | 0.00     |        |       |       |
| Site                                                              | UF                                     | −0.49    | −1.48  | 0.51  | 0.33  |
|                                                                   | UA                                     | 0.00     |        |       |       |
| Education Level                                                   | Bachelor's degree or above             | −1.15*   | −2.14  | −0.17 | 0.02  |
|                                                                   | Some college/associate degree or below | 0.00     |        |       |       |
| Stimulation Adherence                                             | Yes                                    | −0.19    | −1.74  | 1.37  | 0.81  |
|                                                                   | No                                     | 0.00     |        |       |       |
| Cognitive Training Adherence                                      | Yes                                    | 0.18     | −1.32  | 1.68  | 0.81  |
|                                                                   | No                                     | 0.00     |        |       |       |
| Baseline STAI Trait Score                                         |                                        | −0.38*   | −0.44  | −0.31 | <0.01 |
| Change in STAI Trait for Mild Symptoms Sample (n = 334)           |                                        |          |        |       |       |
| Intercept                                                         |                                        | 7.71     | 10.3   | 14.39 | 0.02  |
| tDCS                                                              | Active                                 | −0.32    | −1.17  | 0.53  | 0.46  |
|                                                                   | Sham                                   | 0.00     |        |       |       |
| Education or Cognitive Training                                   | CT                                     | −1.37    | −3.14  | 0.39  | 0.13  |
|                                                                   | ET                                     | 0.00     |        |       |       |
| Age                                                               |                                        | 0.01     | −0.07  | 0.10  | 0.74  |
| Sex                                                               | Female                                 | −0.01    | −0.88  | 0.90  | 0.98  |
|                                                                   | Male                                   | 0.00     |        |       |       |
| Site                                                              | UF                                     | −0.21    | −1.14  | 0.72  | 0.66  |
|                                                                   | UA                                     | 0.00     |        |       |       |
| Education Level                                                   | Bachelor's degree or above             | −0.98*   | −1.91  | −0.05 | 0.04  |
|                                                                   | Some college/associate degree or below | 0.00     |        |       |       |
| Stimulation Adherence                                             | Yes                                    | −0.62    | −2.07  | 0.83  | 0.40  |
|                                                                   | No                                     | 0.00     |        |       |       |
| Cognitive Training Adherence                                      | Yes                                    | 1.09     | −0.35  | 2.52  | 0.14  |
|                                                                   | No                                     | 0.00     |        |       |       |
| Baseline STAI Trait Score                                         |                                        | −0.26*   | −0.34  | −0.17 | <0.01 |
| Change in STAI Trait for Moderate/Severe Symptoms Sample (n = 44) |                                        |          |        |       |       |
| Intercept                                                         |                                        | 34.66    | −8.73  | 78.05 | 0.11  |

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**Table A.10** (continued)

| Variable                        | Category                               | Imputed  |        |       |       |
|---------------------------------|----------------------------------------|----------|--------|-------|-------|
|                                 |                                        | Estimate | 95% CI |       | p     |
| tDCS                            | Active                                 | −2.59    | −7.07  | 1.90  | 0.25  |
|                                 | Sham                                   | 0.00     |        |       |       |
| Education or Cognitive Training | CT                                     | −0.55    | −12.47 | 11.37 | 0.93  |
|                                 | ET                                     | 0.00     |        |       |       |
| Age                             |                                        | 0.09     | −0.28  | 0.46  | 0.64  |
| Sex                             | Female                                 | −2.57    | −6.98  | 1.84  | 0.25  |
|                                 | Male                                   | 0.00     |        |       |       |
| Site                            | UF                                     | −0.57    | −5.49  | 4.34  | 0.81  |
|                                 | UA                                     | 0.00     |        |       |       |
| Education Level                 | Bachelor's degree or above             | −3.56    | −8.24  | 1.12  | 0.13  |
|                                 | Some college/associate degree or below | 0.00     |        |       |       |
| Stimulation Adherence           | Yes                                    | 3.77     | −3.50  | 11.04 | 0.30  |
|                                 | No                                     | 0.00     |        |       |       |
| Cognitive Training Adherence    | Yes                                    | −5.76    | −11.86 | 0.34  | 0.06  |
|                                 | No                                     | 0.00     |        |       |       |
| Baseline STAI Trait Score       |                                        | −0.95*   | −1.54  | −0.36 | <0.01 |

Notes: CI = confidence interval, CT = cognitive training, ET = education training, UF = University of Florida, UA = University of Arizona, STAI = State-Trait Anxiety Inventory, Mild Symptoms = STAI trait scores below 39, Moderate/Severe Symptoms = STAI trait scores greater than or equal to 39.

\*Significant at  $p < 0.05$ .

**Table A.11**

Trait Anxiety Results from Baseline to One-Year.

| Variable                                                          | Category                               | Imputed  |        |        |       |
|-------------------------------------------------------------------|----------------------------------------|----------|--------|--------|-------|
|                                                                   |                                        | Estimate | 95% CI |        | p     |
| Change in STAI Trait for Total Sample (n = 378)                   |                                        |          |        |        |       |
| Intercept                                                         |                                        | 7.26     | 0.08   | 14.44  | 0.05  |
| tDCS                                                              | Active                                 | 0.11     | −0.86  | 1.07   | 0.83  |
|                                                                   | Sham                                   | 0.00     |        |        |       |
| Education or Cognitive Training                                   | CT                                     | −0.10    | −2.14  | 1.94   | 0.92  |
|                                                                   | ET                                     | 0.00     |        |        |       |
| Age                                                               |                                        | 0.06     | −0.04  | 0.15   | 0.24  |
| Sex                                                               | Female                                 | −0.30    | −1.31  | 0.72   | 0.57  |
|                                                                   | Male                                   | 0.00     |        |        |       |
| Site                                                              | UF                                     | 0.12     | −0.95  | 1.19   | 0.82  |
|                                                                   | UA                                     | 0.00     |        |        |       |
| Education Level                                                   | Bachelor's degree or above             | −1.90*   | −2.96  | −0.84  | <0.01 |
|                                                                   | Some college/associate degree or below | 0.00     |        |        |       |
| Stimulation Adherence                                             | Yes                                    | −0.63    | −2.30  | 1.03   | 0.46  |
|                                                                   | No                                     | 0.00     |        |        |       |
| Cognitive Training Adherence                                      | Yes                                    | 0.23     | −1.38  | 1.84   | 0.78  |
|                                                                   | No                                     | 0.00     |        |        |       |
| Baseline STAI Trait Score                                         |                                        | −0.34*   | −0.41  | −0.27  | <0.01 |
| Change in STAI Trait for Mild Symptoms Sample (n = 334)           |                                        |          |        |        |       |
| Intercept                                                         |                                        | 8.39     | 1.08   | 15.69  | 0.02  |
| tDCS                                                              | Active                                 | 0.37     | −0.55  | 1.30   | 0.43  |
|                                                                   | Sham                                   | 0.00     |        |        |       |
| Education or Cognitive Training                                   | CT                                     | −0.47    | −2.40  | 1.46   | 0.63  |
|                                                                   | ET                                     | 0.00     |        |        |       |
| Age                                                               |                                        | 0.03     | −0.07  | 0.12   | 0.57  |
| Sex                                                               | Female                                 | 0.11     | −0.86  | 1.08   | 0.82  |
|                                                                   | Male                                   | 0.00     |        |        |       |
| Site                                                              | UF                                     | 0.34     | −0.67  | 1.36   | 0.51  |
|                                                                   | UA                                     | 0.00     |        |        |       |
| Education Level                                                   | Bachelor's degree or above             | −1.85*   | −2.87  | −0.83  | <0.01 |
|                                                                   | Some college/associate degree or below | 0.00     |        |        |       |
| Stimulation Adherence                                             | Yes                                    | −1.30    | −2.88  | 0.29   | 0.11  |
|                                                                   | No                                     | 0.00     |        |        |       |
| Cognitive Training Adherence                                      | Yes                                    | 1.13     | −0.44  | 2.70   | 0.16  |
|                                                                   | No                                     | 0.00     |        |        |       |
| Baseline STAI Trait Score                                         |                                        | −0.31*   | −0.41  | −0.22  | <0.01 |
| Change in STAI Trait for Moderate/Severe Symptoms Sample (n = 44) |                                        |          |        |        |       |
| Intercept                                                         |                                        | 59.27    | 15.84  | 102.70 | <0.01 |
| tDCS                                                              | Active                                 | −1.46    | −5.95  | 3.03   | 0.51  |
|                                                                   | Sham                                   | 0.00     |        |        |       |
| Education or Cognitive Training                                   | CT                                     | −4.79    | −16.72 | 7.14   | 0.42  |
|                                                                   | ET                                     | 0.00     |        |        |       |
| Age                                                               |                                        | −0.02    | −0.39  | 0.35   | 0.91  |
| Sex                                                               | Female                                 | −1.88    | −6.29  | 2.54   | 0.39  |
|                                                                   | Male                                   | 0.00     |        |        |       |
| Site                                                              | UF                                     | −1.46    | −6.38  | 3.46   | 0.55  |

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**Table A.11** (continued)

| Variable                     | Category                               | Imputed  |        |       |       |
|------------------------------|----------------------------------------|----------|--------|-------|-------|
|                              |                                        | Estimate | 95% CI |       | p     |
| Education Level              | UA                                     | 0.00     |        |       |       |
|                              | Bachelor's degree or above             | −2.64    | −7.32  | 2.05  | 0.26  |
| Stimulation Adherence        | Some college/associate degree or below | 0.00     |        |       |       |
|                              | Yes                                    | 5.76     | −1.53  | 13.04 | 0.12  |
| Cognitive Training Adherence | No                                     | 0.00     |        |       |       |
|                              | Yes                                    | −4.76    | −10.87 | 1.35  | 0.12  |
| Baseline STAI Trait Score    | No                                     | 0.00     |        |       |       |
|                              |                                        | −1.25*   | −1.85  | −0.66 | <0.01 |

Notes: CI = confidence interval, CT = cognitive training, ET = education training, UF = University of Florida, UA = University of Arizona, STAI = State-Trait Anxiety Inventory, Mild Symptoms = STAI trait scores below 39, Moderate/Severe Symptoms = STAI trait scores greater than or equal to 39.

\*Significant at  $p < 0.05$ .

**Table A.12**

Medication Effects on Depression Results from Baseline to Post-Intervention.

| Variable                                                      | Category                               | Imputed  |        |       |       |
|---------------------------------------------------------------|----------------------------------------|----------|--------|-------|-------|
|                                                               |                                        | Estimate | 95% CI | p     |       |
| Change in BDI-II for Total Sample (n = 378)                   |                                        |          |        |       |       |
| Intercept                                                     |                                        | −1.01    | −5.03  | 3.02  | 0.62  |
| tDCS                                                          | Active                                 | −0.72*   | −1.27  | −0.18 | <0.01 |
|                                                               | Sham                                   | 0.00     |        |       |       |
| Education or Cognitive Training                               | CT                                     | −0.44    | −1.58  | 0.70  | 0.45  |
|                                                               | ET                                     | 0.00     |        |       |       |
| Age                                                           |                                        | 0.03     | −0.03  | 0.08  | 0.30  |
| Sex                                                           | Female                                 | 0.59*    | 0.02   | 1.16  | 0.04  |
|                                                               | Male                                   | 0.00     |        |       |       |
| Site                                                          | UF                                     | 0.42     | −0.17  | 1.02  | 0.16  |
|                                                               | UA                                     | 0.00     |        |       |       |
| Education Level                                               | Bachelor's degree or above             | −0.14    | −0.73  | 0.46  | 0.65  |
|                                                               | Some college/associate degree or below | 0.00     |        |       |       |
| Stimulation Adherence                                         | Yes                                    | −0.03    | −0.96  | 0.90  | 0.95  |
|                                                               | No                                     | 0.00     |        |       |       |
| Cognitive Training Adherence                                  | Yes                                    | 0.06     | −0.84  | 0.97  | 0.89  |
|                                                               | No                                     | 0.00     |        |       |       |
| Taking a prescription drug that can be for anxiety/depression | Yes                                    | 0.64     | −0.05  | 1.33  | 0.07  |
|                                                               | No                                     | 0.00     |        |       |       |
| Baseline BDI-II Score                                         |                                        | −0.4*    | −0.47  | −0.33 | <0.01 |
| Change in BDI-II for Minimal Symptoms Sample (n = 362)        |                                        |          |        |       |       |
| Intercept                                                     |                                        | −1.33    | −5.22  | 2.55  | 0.50  |
| tDCS                                                          | Active                                 | −0.49    | −1.01  | 0.03  | 0.06  |
|                                                               | Sham                                   | 0.00     |        |       |       |
| Education or Cognitive Training                               | CT                                     | −0.21    | −1.31  | 0.89  | 0.70  |
|                                                               | ET                                     | 0.00     |        |       |       |
| Age                                                           |                                        | 0.03     | −0.02  | 0.08  | 0.30  |
| Sex                                                           | Female                                 | 0.67*    | 0.12   | 1.21  | 0.02  |
|                                                               | Male                                   | 0.00     |        |       |       |
| Site                                                          | UF                                     | 0.49     | −0.08  | 1.06  | 0.09  |
|                                                               | UA                                     | 0.00     |        |       |       |
| Education Level                                               | Bachelor's degree or above             | −0.16    | −0.73  | 0.41  | 0.58  |
|                                                               | Some college/associate degree or below | 0.00     |        |       |       |
| Stimulation Adherence                                         | Yes                                    | 0.22     | −0.69  | 1.13  | 0.64  |
|                                                               | No                                     | 0.00     |        |       |       |
| Cognitive Training Adherence                                  | Yes                                    | −0.12    | −1.01  | 0.76  | 0.78  |
|                                                               | No                                     | 0.00     |        |       |       |
| Taking a prescription drug that can be for anxiety/depression | Yes                                    | 0.56     | −0.11  | 1.22  | 0.10  |
|                                                               | No                                     | 0.00     |        |       |       |
| Baseline BDI-II Score                                         |                                        | −0.42*   | −0.50  | −0.34 | <0.01 |
| Change in BDI-II for Mild Symptoms Sample (n = 16)            |                                        |          |        |       |       |
| Intercept                                                     |                                        | −22.14   | −94.17 | 49.88 | 0.47  |
| tDCS                                                          | Active                                 | −10.03*  | −16.50 | −3.56 | 0.01  |
|                                                               | Sham                                   | 0.00     |        |       |       |
| Education or Cognitive Training                               | CT                                     | −1.8     | −16.36 | 12.77 | 0.76  |
|                                                               | ET                                     | 0.00     |        |       |       |
| Age                                                           |                                        | 0.41     | −0.13  | 0.95  | 0.11  |
| Sex                                                           | Female                                 | −6.63    | −13.60 | 0.35  | 0.06  |
|                                                               | Male                                   | 0.00     |        |       |       |
| Site                                                          | UF                                     | −6.38    | −14.16 | 1.40  | 0.09  |
|                                                               | UA                                     | 0.00     |        |       |       |
| Education Level                                               | Bachelor's degree or above             | −0.61    | −5.88  | 4.66  | 0.78  |
|                                                               | Some college/associate degree or below | 0.00     |        |       |       |
| Stimulation Adherence                                         | Yes                                    | −2.62    | −12.48 | 7.25  | 0.53  |

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**Table A.12** (continued)

| Variable                                                      | Category | Imputed  |        |       |       |
|---------------------------------------------------------------|----------|----------|--------|-------|-------|
|                                                               |          | Estimate | 95% CI |       | p     |
| Cognitive Training Adherence                                  | No       | 0.00     |        |       |       |
|                                                               | Yes      | −2.94    | −11.97 | 6.09  | 0.44  |
| Taking a prescription drug that can be for anxiety/depression | No       | 0.00     |        |       |       |
|                                                               | Yes      | 6.55*    | 0.17   | 12.93 | 0.046 |
| Baseline BDI-II Score                                         | No       | 0.00     |        |       |       |
|                                                               | Yes      | 0.34     | −2.34  | 3.02  | 0.76  |

Notes: Models controlling for participants taking a prescription drug that can be used for anxiety or depression. CI = confidence interval, CT = cognitive training, ET = education training, UF = University of Florida, UA = University of Arizona, BDI-II = Beck Depression Inventory – Second Edition, Minimal Symptoms = BDI-II scores between 0 and 13, Mild Symptoms = BDI-II scores between 14 and 19.

\*Significant at  $p < 0.05$ .

**Table A.13**

Medication Effects on Depression Results from Baseline to One-Year.

| Variable                                                      | Category                               | Imputed  |        |       |       |
|---------------------------------------------------------------|----------------------------------------|----------|--------|-------|-------|
|                                                               |                                        | Estimate | 95% CI |       | p     |
| Change in BDI-II for Total Sample (n = 378)                   |                                        |          |        |       |       |
| Intercept                                                     |                                        | 1.93     | −2.60  | 6.47  | 0.40  |
| tDCS                                                          | Active                                 | 0.11     | −0.50  | 0.72  | 0.72  |
|                                                               | Sham                                   | 0.00     |        |       |       |
| Education or Cognitive Training                               | CT                                     | 0.84     | −0.44  | 2.13  | 0.20  |
|                                                               | ET                                     | 0.00     |        |       |       |
| Age                                                           |                                        | −0.01    | −0.08  | 0.05  | 0.63  |
| Sex                                                           | Female                                 | 0.57     | −0.08  | 1.21  | 0.08  |
|                                                               | Male                                   | 0.00     |        |       |       |
| Site                                                          | UF                                     | −0.42    | −1.09  | 0.26  | 0.23  |
|                                                               | UA                                     | 0.00     |        |       |       |
| Education Level                                               | Bachelor's degree or above             | −0.13    | −0.79  | 0.54  | 0.71  |
|                                                               | Some college/associate degree or below | 0.00     |        |       |       |
| Stimulation Adherence                                         | Yes                                    | 0.23     | −0.82  | 1.27  | 0.67  |
|                                                               | No                                     | 0.00     |        |       |       |
| Cognitive Training Adherence                                  | Yes                                    | −0.84    | −1.86  | 0.18  | 0.10  |
|                                                               | No                                     | 0.00     |        |       |       |
| Taking a prescription drug that can be for anxiety/depression | Yes                                    | 0.50     | −0.28  | 1.27  | 0.21  |
|                                                               | No                                     | 0.00     |        |       |       |
| Baseline BDI-II Score                                         |                                        | −0.28*   | −0.35  | −0.20 | <0.01 |
| Change in BDI-II for Minimal Symptoms Sample (n = 362)        |                                        |          |        |       |       |
| Intercept                                                     |                                        | 1.22     | −3.40  | 5.84  | 0.60  |
| tDCS                                                          | Active                                 | 0.19     | −0.42  | 0.81  | 0.54  |
|                                                               | Sham                                   | 0.00     |        |       |       |
| Education or Cognitive Training                               | CT                                     | 0.77     | −0.54  | 2.08  | 0.25  |
|                                                               | ET                                     | 0.00     |        |       |       |
| Age                                                           |                                        | 0.00     | −0.07  | 0.06  | 0.90  |
| Sex                                                           | Female                                 | 0.67*    | 0.03   | 1.32  | 0.04  |
|                                                               | Male                                   | 0.00     |        |       |       |
| Site                                                          | UF                                     | −0.44    | −1.12  | 0.24  | 0.20  |
|                                                               | UA                                     | 0.00     |        |       |       |
| Education Level                                               | Bachelor's degree or above             | −0.04    | −0.71  | 0.64  | 0.91  |
|                                                               | Some college/associate degree or below | 0.00     |        |       |       |
| Stimulation Adherence                                         | Yes                                    | 0.05     | −1.03  | 1.14  | 0.93  |
|                                                               | No                                     | 0.00     |        |       |       |
| Cognitive Training Adherence                                  | Yes                                    | −0.66    | −1.71  | 0.39  | 0.22  |
|                                                               | No                                     | 0.00     |        |       |       |
| Taking a prescription drug that can be for anxiety/depression | Yes                                    | 0.40     | −0.39  | 1.19  | 0.32  |
|                                                               | No                                     | 0.00     |        |       |       |
| Baseline BDI-II Score                                         |                                        | −0.33*   | −0.43  | −0.24 | <0.01 |
| Change in BDI-II for Mild Symptoms Sample (n = 16)            |                                        |          |        |       |       |
| Intercept                                                     |                                        | 6.31     | −57.36 | 69.98 | 0.81  |
| tDCS                                                          | Active                                 | −4.02    | −9.74  | 1.70  | 0.13  |
|                                                               | Sham                                   | 0.00     |        |       |       |
| Education or Cognitive Training                               | CT                                     | −1.75    | −14.63 | 11.12 | 0.74  |
|                                                               | ET                                     | 0.00     |        |       |       |
| Age                                                           |                                        | 0.03     | −0.45  | 0.51  | 0.88  |
| Sex                                                           | Female                                 | −4.91    | −11.07 | 1.26  | 0.10  |
|                                                               | Male                                   | 0.00     |        |       |       |
| Site                                                          | UF                                     | −5.24    | −12.12 | 1.64  | 0.11  |
|                                                               | UA                                     | 0.00     |        |       |       |
| Education Level                                               | Bachelor's degree or above             | −1.24    | −5.90  | 3.41  | 0.52  |
|                                                               | Some college/associate degree or below | 0.00     |        |       |       |
| Stimulation Adherence                                         | Yes                                    | 1.59     | −7.13  | 10.31 | 0.66  |
|                                                               | No                                     | 0.00     |        |       |       |

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**Table A.13** (continued)

| Variable                                                      | Category | Imputed  |        |      |      |
|---------------------------------------------------------------|----------|----------|--------|------|------|
|                                                               |          | Estimate | 95% CI |      | p    |
| Cognitive Training Adherence                                  | Yes      | −4.28    | −12.26 | 3.71 | 0.23 |
|                                                               | No       | 0.00     |        |      |      |
| Taking a prescription drug that can be for anxiety/depression | Yes      | 3.00     | −2.64  | 8.64 | 0.23 |
|                                                               | No       | 0.00     |        |      |      |
| Baseline BDI-II Score                                         |          | 0.15     | −2.22  | 2.51 | 0.88 |

Notes: Models controlling for participants taking a prescription drug that can be used for anxiety or depression. CI = confidence interval, CT = cognitive training, ET = education training, UF = University of Florida, UA = University of Arizona, BDI-II = Beck Depression Inventory – Second Edition, Minimal Symptoms = BDI-II scores between 0 and 13, Mild Symptoms = BDI-II scores between 14 and 19.

\*Significant at  $p < 0.05$ .

**Table A.14**

Medication Effects on State Anxiety Results from Baseline to Post-Intervention.

| Variable                                                          | Category                               | Imputed  |        |       |       |
|-------------------------------------------------------------------|----------------------------------------|----------|--------|-------|-------|
|                                                                   |                                        | Estimate | 95% CI |       | p     |
| Change in STAI State for Total Sample (n = 378)                   |                                        |          |        |       |       |
| Intercept                                                         |                                        | −1.98    | −11.26 | 7.29  | 0.67  |
| tDCS                                                              | Active                                 | −1.83*   | −3.10  | −0.57 | <0.01 |
|                                                                   | Sham                                   | 0.00     |        |       |       |
| Education or Cognitive Training                                   | CT                                     | −0.01    | −2.67  | 2.66  | 1.00  |
|                                                                   | ET                                     | 0.00     |        |       |       |
| Age                                                               |                                        | 0.24*    | 0.12   | 0.37  | <0.01 |
| Sex                                                               | Female                                 | 1.26     | −0.07  | 2.60  | 0.06  |
|                                                                   | Male                                   | 0        |        |       |       |
| Site                                                              | UF                                     | −0.29    | −1.69  | 1.11  | 0.69  |
|                                                                   | UA                                     | 0.00     |        |       |       |
| Education Level                                                   | Bachelor's degree or above             | −0.22    | −1.60  | 1.16  | 0.76  |
|                                                                   | Some college/associate degree or below | 0.00     |        |       |       |
| Stimulation Adherence                                             | Yes                                    | 0.93     | −1.25  | 3.10  | 0.40  |
|                                                                   | No                                     | 0.00     |        |       |       |
| Cognitive Training Adherence                                      | Yes                                    | −0.60    | −2.71  | 1.50  | 0.57  |
|                                                                   | No                                     | 0.00     |        |       |       |
| Taking a prescription drug that can be for anxiety/depression     | Yes                                    | 2.37*    | 0.80   | 3.94  | <0.01 |
|                                                                   | No                                     | 0.00     |        |       |       |
| Baseline STAI State Score                                         |                                        | −0.60*   | −0.67  | −0.52 | <0.01 |
| Change in STAI State for Mild Symptoms Sample (n = 319)           |                                        |          |        |       |       |
| Intercept                                                         |                                        | −0.83    | −10.43 | 8.78  | 0.87  |
| tDCS                                                              | Active                                 | −0.97    | −2.19  | 0.25  | 0.12  |
|                                                                   | Sham                                   | 0.00     |        |       |       |
| Education or Cognitive Training                                   | CT                                     | −1.39    | −4.04  | 1.25  | 0.30  |
|                                                                   | ET                                     | 0.00     |        |       |       |
| Age                                                               |                                        | 0.21*    | 0.09   | 0.34  | <0.01 |
| Sex                                                               | Female                                 | 1.01     | −0.30  | 2.31  | 0.13  |
|                                                                   | Male                                   | 0.00     |        |       |       |
| Site                                                              | UF                                     | −0.14    | −1.51  | 1.23  | 0.84  |
|                                                                   | UA                                     | 0.00     |        |       |       |
| Education Level                                                   | Bachelor's degree or above             | −0.81    | −2.16  | 0.54  | 0.24  |
|                                                                   | Some college/associate degree or below | 0.00     |        |       |       |
| Stimulation Adherence                                             | Yes                                    | −0.49    | −2.68  | 1.70  | 0.66  |
|                                                                   | No                                     | 0.00     |        |       |       |
| Cognitive Training Adherence                                      | Yes                                    | 1.21     | −0.93  | 3.34  | 0.27  |
|                                                                   | No                                     | 0.00     |        |       |       |
| Taking a prescription drug that can be for anxiety/depression     | Yes                                    | 1.89*    | 0.36   | 3.43  | 0.02  |
|                                                                   | No                                     | 0.00     |        |       |       |
| Baseline STAI State Score                                         |                                        | −0.51*   | −0.63  | −0.39 | <0.01 |
| Change in STAI State for Moderate/Severe Symptoms Sample (n = 59) |                                        |          |        |       |       |
| Intercept                                                         |                                        | 38.50    | −2.17  | 79.17 | 0.06  |
| tDCS                                                              | Active                                 | −5.64*   | −10.07 | −1.21 | 0.01  |
|                                                                   | Sham                                   | 0.00     |        |       |       |
| Education or Cognitive Training                                   | CT                                     | 3.97     | −4.79  | 12.73 | 0.37  |
|                                                                   | ET                                     | 0.00     |        |       |       |
| Age                                                               |                                        | 0.17     | −0.21  | 0.56  | 0.38  |
| Sex                                                               | Female                                 | 1.13     | −3.52  | 5.77  | 0.63  |
|                                                                   | Male                                   | 0.00     |        |       |       |
| Site                                                              | UF                                     | 0.84     | −3.87  | 5.55  | 0.72  |
|                                                                   | UA                                     | 0.00     |        |       |       |
| Education Level                                                   | Bachelor's degree or above             | 1.03     | −3.86  | 5.92  | 0.67  |
|                                                                   | Some college/associate degree or below | 0.00     |        |       |       |
| Stimulation Adherence                                             | Yes                                    | 3.13     | −3.84  | 10.10 | 0.37  |
|                                                                   | No                                     | 0.00     |        |       |       |
| Cognitive Training Adherence                                      | Yes                                    | −6.82*   | −12.91 | −0.72 | 0.03  |

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**Table A.14** (continued)

| Variable                                                      | Category | Imputed  |        |       |       |
|---------------------------------------------------------------|----------|----------|--------|-------|-------|
|                                                               |          | Estimate | 95% CI |       | p     |
| Taking a prescription drug that can be for anxiety/depression | No       | 0.00     |        |       |       |
|                                                               | Yes      | 4.33     | –1.06  | 9.72  | 0.11  |
|                                                               | No       | 0.00     |        |       |       |
| Baseline STAI State Score                                     |          | –1.43*   | –1.95  | –0.90 | <0.01 |

Notes: Models controlling for participants taking a prescription drug that can be used for anxiety or depression. CI = confidence interval, CT = cognitive training, ET = education training, UF = University of Florida, UA = University of Arizona, STAI = State-Trait Anxiety Inventory, Mild Symptoms = STAI state scores below 39, Moderate/Severe Symptoms = STAI state scores greater than or equal to 39.

\*Significant at  $p < 0.05$ .

**Table A.15**

Medication Effects on State Anxiety Results from Baseline to One-Year.

| Variable                                                          | Category                               | Imputed  |        |       |       |
|-------------------------------------------------------------------|----------------------------------------|----------|--------|-------|-------|
|                                                                   |                                        | Estimate | 95% CI |       | p     |
| Change in STAI State for Total Sample (n = 378)                   |                                        |          |        |       |       |
| Intercept                                                         |                                        | 13.56*   | 4.80   | 22.33 | <0.01 |
| tDCS                                                              | Active                                 | −0.68    | −1.88  | 0.51  | 0.26  |
|                                                                   | Sham                                   | 0.00     |        |       |       |
| Education or Cognitive Training                                   | CT                                     | −0.67    | −3.19  | 1.85  | 0.60  |
|                                                                   | ET                                     | 0.00     |        |       |       |
| Age                                                               |                                        | 0.02     | −0.09  | 0.14  | 0.69  |
| Sex                                                               | Female                                 | 1.36*    | 0.10   | 2.62  | 0.03  |
|                                                                   | Male                                   | 0.00     |        |       |       |
| Site                                                              | UF                                     | −0.22    | −1.54  | 1.10  | 0.74  |
|                                                                   | UA                                     | 0.00     |        |       |       |
| Education Level                                                   | Bachelor’s degree or above             | −1.36*   | −2.67  | −0.06 | 0.04  |
|                                                                   | Some college/associate degree or below | 0.00     |        |       |       |
| Stimulation Adherence                                             | Yes                                    | −0.14    | −2.19  | 1.92  | 0.90  |
|                                                                   | No                                     | 0.00     |        |       |       |
| Cognitive Training Adherence                                      | Yes                                    | −0.23    | −2.22  | 1.76  | 0.82  |
|                                                                   | No                                     | 0.00     |        |       |       |
| Taking a prescription drug that can be for anxiety/depression     | Yes                                    | −0.27    | −1.76  | 1.22  | 0.72  |
|                                                                   | No                                     | 0.00     |        |       |       |
| Baseline STAI State Score                                         |                                        | −0.51*   | −0.58  | −0.43 | <0.01 |
| Change in STAI State for Mild Symptoms Sample (n = 319)           |                                        |          |        |       |       |
| Intercept                                                         |                                        | 20.74*   | 11.37  | 30.11 | <0.01 |
| tDCS                                                              | Active                                 | −0.01    | −1.20  | 1.18  | 0.99  |
|                                                                   | Sham                                   | 0.00     |        |       |       |
| Education or Cognitive Training                                   | CT                                     | −1.74    | −4.32  | 0.84  | 0.19  |
|                                                                   | ET                                     | 0.00     |        |       |       |
| Age                                                               |                                        | −0.08    | −0.20  | 0.04  | 0.19  |
| Sex                                                               | Female                                 | 1.25     | −0.02  | 2.52  | 0.05  |
|                                                                   | Male                                   | 0.00     |        |       |       |
| Site                                                              | UF                                     | 0.34     | −1.00  | 1.68  | 0.62  |
|                                                                   | UA                                     | 0.00     |        |       |       |
| Education Level                                                   | Bachelor’s degree or above             | −1.71*   | −3.03  | −0.39 | 0.01  |
|                                                                   | Some college/associate degree or below | 0.00     |        |       |       |
| Stimulation Adherence                                             | Yes                                    | −1.01    | −3.14  | 1.12  | 0.35  |
|                                                                   | No                                     | 0.00     |        |       |       |
| Cognitive Training Adherence                                      | Yes                                    | 0.78     | −1.31  | 2.86  | 0.46  |
|                                                                   | No                                     | 0.00     |        |       |       |
| Taking a prescription drug that can be for anxiety/depression     | Yes                                    | −0.37    | −1.87  | 1.12  | 0.62  |
|                                                                   | No                                     | 0.00     |        |       |       |
| Baseline STAI State Score                                         |                                        | −0.47*   | −0.59  | −0.36 | <0.01 |
| Change in STAI State for Moderate/Severe Symptoms Sample (n = 59) |                                        |          |        |       |       |
| Intercept                                                         |                                        | 18.69    | −18.47 | 55.85 | 0.32  |
| tDCS                                                              | Active                                 | −4.00    | −8.04  | 0.05  | 0.05  |
|                                                                   | Sham                                   | 0.00     |        |       |       |
| Education or Cognitive Training                                   | CT                                     | 2.26     | −5.75  | 10.26 | 0.57  |
|                                                                   | ET                                     | 0.00     |        |       |       |
| Age                                                               |                                        | 0.28     | −0.07  | 0.63  | 0.12  |
| Sex                                                               | Female                                 | 1.3      | −2.95  | 5.54  | 0.54  |
|                                                                   | Male                                   | 0.00     |        |       |       |
| Site                                                              | UF                                     | −1.85    | −6.16  | 2.45  | 0.39  |
|                                                                   | UA                                     | 0.00     |        |       |       |
| Education Level                                                   | Bachelor’s degree or above             | −1.68    | −6.14  | 2.79  | 0.45  |
|                                                                   | Some college/associate degree or below | 0.00     |        |       |       |
| Stimulation Adherence                                             | Yes                                    | 2.73     | −3.64  | 9.10  | 0.39  |
|                                                                   | No                                     | 0.00     |        |       |       |
| Cognitive Training Adherence                                      | Yes                                    | −3.35    | −8.92  | 2.22  | 0.23  |
|                                                                   | No                                     | 0.00     |        |       |       |

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**Table A.15** (continued)

| Variable                                                      | Category | Imputed  |        |       |       |
|---------------------------------------------------------------|----------|----------|--------|-------|-------|
|                                                               |          | Estimate | 95% CI |       | p     |
| Taking a prescription drug that can be for anxiety/depression | Yes      | 0.46     | –4.47  | 5.38  | 0.85  |
|                                                               | No       | 0.00     |        |       |       |
| Baseline STAI State Score                                     |          | –1.04*   | –1.52  | –0.56 | <0.01 |

Notes: Models controlling for participants taking a prescription drug that can be used for anxiety or depression. CI = confidence interval, CT = cognitive training, ET = education training, UF = University of Florida, UA = University of Arizona, STAI = State-Trait Anxiety Inventory, Mild Symptoms = STAI state scores below 39, Moderate/Severe Symptoms = STAI state scores greater than or equal to 39.

\*Significant at  $p < 0.05$ .

**Table A.16**

Medication Effects on Trait Anxiety Results from Baseline to Post-Intervention

| Variable                                                          | Category                               | Imputed  |        |       |       |
|-------------------------------------------------------------------|----------------------------------------|----------|--------|-------|-------|
|                                                                   |                                        | Estimate | 95% CI |       | p     |
| Change in STAI Trait for Total Sample (n = 378)                   |                                        |          |        |       |       |
| Intercept                                                         |                                        | 9.31*    | 2.65   | 15.97 | <0.01 |
| tDCS                                                              | Active                                 | −0.39    | −1.29  | 0.51  | 0.40  |
|                                                                   | Sham                                   | 0.00     |        |       |       |
| Education or Cognitive Training                                   | CT                                     | −1.14    | −3.03  | 0.76  | 0.24  |
|                                                                   | ET                                     | 0.00     |        |       |       |
| Age                                                               |                                        | 0.04     | −0.04  | 0.13  | 0.32  |
| Sex                                                               | Female                                 | −0.38    | −1.33  | 0.56  | 0.43  |
|                                                                   | Male                                   | 0.00     |        |       |       |
| Site                                                              | UF                                     | −0.55    | −1.54  | 0.45  | 0.28  |
|                                                                   | UA                                     | 0.00     |        |       |       |
| Education Level                                                   | Bachelor's degree or above             | −1.17*   | −2.15  | −0.19 | 0.02  |
|                                                                   | Some college/associate degree or below | 0.00     |        |       |       |
| Stimulation Adherence                                             | Yes                                    | −0.12    | −1.67  | 1.43  | 0.88  |
|                                                                   | No                                     | 0.00     |        |       |       |
| Cognitive Training Adherence                                      | Yes                                    | 0.3      | −1.20  | 1.80  | 0.69  |
|                                                                   | No                                     | 0.00     |        |       |       |
| Taking a prescription drug that can be for anxiety/depression     | Yes                                    | 1.24*    | 0.10   | 2.38  | 0.03  |
|                                                                   | No                                     | 0.00     |        |       |       |
| Baseline STAI Trait Score                                         |                                        | −0.39*   | −0.45  | −0.33 | <0.01 |
| Change in STAI Trait for Mild Symptoms Sample (n = 334)           |                                        |          |        |       |       |
| Intercept                                                         |                                        | 7.78*    | 1.12   | 14.44 | 0.02  |
| tDCS                                                              | Active                                 | −0.27    | −1.12  | 0.57  | 0.53  |
|                                                                   | Sham                                   | 0.00     |        |       |       |
| Education or Cognitive Training                                   | CT                                     | −1.43    | −3.19  | 0.33  | 0.11  |
|                                                                   | ET                                     | 0.00     |        |       |       |
| Age                                                               |                                        | 0.01     | −0.07  | 0.10  | 0.73  |
| Sex                                                               | Female                                 | −0.04    | −0.93  | 0.84  | 0.92  |
|                                                                   | Male                                   | 0.00     |        |       |       |
| Site                                                              | UF                                     | −0.26    | −1.19  | 0.67  | 0.59  |
|                                                                   | UA                                     | 0.00     |        |       |       |
| Education Level                                                   | Bachelor's degree or above             | −0.96*   | −1.89  | −0.03 | 0.04  |
|                                                                   | Some college/associate degree or below | 0.00     |        |       |       |
| Stimulation Adherence                                             | Yes                                    | −0.56    | −2.01  | 0.89  | 0.45  |
|                                                                   | No                                     | 0.00     |        |       |       |
| Cognitive Training Adherence                                      | Yes                                    | 1.12     | −0.31  | 2.55  | 0.12  |
|                                                                   | No                                     | 0.00     |        |       |       |
| Taking a prescription drug that can be for anxiety/depression     | Yes                                    | 0.96     | −0.13  | 2.05  | 0.08  |
|                                                                   | No                                     | 0.00     |        |       |       |
| Baseline STAI Trait Score                                         |                                        | −0.27*   | −0.36  | −0.18 | <0.01 |
| Change in STAI Trait for Moderate/Severe Symptoms Sample (n = 44) |                                        |          |        |       |       |
| Intercept                                                         |                                        | 33.92    | −9.06  | 76.90 | 0.12  |
| tDCS                                                              | Active                                 | −2.53    | −6.97  | 1.91  | 0.26  |
|                                                                   | Sham                                   | 0.00     |        |       |       |
| Education or Cognitive Training                                   | CT                                     | −2.15    | −14.21 | 9.90  | 0.72  |
|                                                                   | ET                                     | 0.00     |        |       |       |
| Age                                                               |                                        | 0.12     | −0.25  | 0.49  | 0.51  |
| Sex                                                               | Female                                 | −3.23    | −7.72  | 1.25  | 0.15  |
|                                                                   | Male                                   | 0.00     |        |       |       |
| Site                                                              | UF                                     | −0.83    | −5.72  | 4.05  | 0.73  |
|                                                                   | UA                                     | 0.00     |        |       |       |
| Education Level                                                   | Bachelor's degree or above             | −4.44    | −9.27  | 0.39  | 0.07  |
|                                                                   | Some college/associate degree or below | 0.00     |        |       |       |
| Stimulation Adherence                                             | Yes                                    | 3.75     | −3.45  | 10.96 | 0.30  |
|                                                                   | No                                     | 0.00     |        |       |       |
| Cognitive Training Adherence                                      | Yes                                    | −4.45    | −10.82 | 1.91  | 0.16  |
|                                                                   | No                                     | 0.00     |        |       |       |
| Taking a prescription drug that can be for anxiety/depression     | Yes                                    | 3.21     | −1.72  | 8.13  | 0.19  |

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**Table A.16** (continued)

| Variable                  | Category | Imputed  |        |       |       |
|---------------------------|----------|----------|--------|-------|-------|
|                           |          | Estimate | 95% CI | p     |       |
| Baseline STAI Trait Score | No       | 0.00     |        |       |       |
|                           |          | −0.98*   | −1.57  | −0.39 | <0.01 |

Notes: Models controlling for participants taking a prescription drug that can be used for anxiety or depression. CI = confidence interval, CT = cognitive training, ET = education training, UF = University of Florida, UA = University of Arizona, STAI = State-Trait Anxiety Inventory, Mild Symptoms = STAI trait scores below 39, Moderate/Severe Symptoms = STAI trait scores greater than or equal to 39.

\*Significant at  $p < 0.05$ .

**Table A.17**

Medication Effects on Trait Anxiety Results from Baseline to One-Year

| Variable                                                             | Category                               | Imputed  |        |        |       |
|----------------------------------------------------------------------|----------------------------------------|----------|--------|--------|-------|
|                                                                      |                                        | Estimate | 95% CI | p      |       |
| Change in STAI Trait for Total Sample (n = 378)                      |                                        |          |        |        |       |
| Intercept                                                            |                                        | 7.27     | 0.09   | 14.46  | 0.05  |
| tDCS                                                                 | Active                                 | 0.12     | −0.85  | 1.09   | 0.81  |
|                                                                      | Sham                                   | 0.00     |        |        |       |
| Education or Cognitive Training                                      | CT                                     | −0.13    | −2.18  | 1.91   | 0.90  |
|                                                                      | ET                                     | 0.00     |        |        |       |
| Age                                                                  |                                        | 0.06     | −0.04  | 0.15   | 0.23  |
| Sex                                                                  | Female                                 | −0.32    | −1.34  | 0.71   | 0.54  |
|                                                                      | Male                                   | 0.00     |        |        |       |
| Site                                                                 | UF                                     | 0.11     | −0.96  | 1.18   | 0.84  |
|                                                                      | UA                                     | 0.00     |        |        |       |
| Education Level                                                      | Bachelor's degree or above             | −1.91*   | −2.97  | −0.85  | <0.01 |
|                                                                      | Some college/associate degree or below | 0.00     |        |        |       |
| Stimulation Adherence                                                | Yes                                    | −0.62    | −2.29  | 1.05   | 0.47  |
|                                                                      | No                                     | 0.00     |        |        |       |
| Cognitive Training Adherence                                         | Yes                                    | 0.26     | −1.36  | 1.88   | 0.75  |
|                                                                      | No                                     | 0.00     |        |        |       |
| Taking a prescription drug that can be for anxiety/depression        | Yes                                    | 0.26     | −0.96  | 1.49   | 0.67  |
|                                                                      | No                                     | 0.00     |        |        |       |
| Baseline STAI Trait Score                                            |                                        | −0.34*   | −0.41  | −0.28  | <0.01 |
| Change in STAI Trait for Mild Symptoms Sample (n = 334) <sup>v</sup> |                                        |          |        |        |       |
| Intercept                                                            |                                        | 8.37*    | 1.06   | 15.69  | 0.02  |
| tDCS                                                                 | Active                                 | 0.36     | −0.56  | 1.29   | 0.44  |
|                                                                      | Sham                                   | 0.00     |        |        |       |
| Education or Cognitive Training                                      | CT                                     | −0.46    | −2.40  | 1.47   | 0.64  |
|                                                                      | ET                                     | 0.00     |        |        |       |
| Age                                                                  |                                        | 0.03     | −0.07  | 0.12   | 0.57  |
| Sex                                                                  | Female                                 | 0.12     | −0.85  | 1.10   | 0.81  |
|                                                                      | Male                                   | 0.00     |        |        |       |
| Site                                                                 | UF                                     | 0.35     | −0.67  | 1.37   | 0.50  |
|                                                                      | UA                                     | 0.00     |        |        |       |
| Education Level                                                      | Bachelor's degree or above             | −1.85*   | −2.87  | −0.83  | <0.01 |
|                                                                      | Some college/associate degree or below | 0.00     |        |        |       |
| Stimulation Adherence                                                | Yes                                    | −1.31    | −2.90  | 0.28   | 0.11  |
|                                                                      | No                                     | 0.00     |        |        |       |
| Cognitive Training Adherence                                         | Yes                                    | 1.12     | −0.45  | 2.69   | 0.16  |
|                                                                      | No                                     | 0.00     |        |        |       |
| Taking a prescription drug that can be for anxiety/depression        | Yes                                    | −0.16    | −1.36  | 1.04   | 0.79  |
|                                                                      | No                                     | 0.00     |        |        |       |
| Baseline STAI Trait Score                                            |                                        | −0.31*   | −0.41  | −0.22  | <0.01 |
| Change in STAI Trait for Moderate/Severe Symptoms Sample (n = 44)    |                                        |          |        |        |       |
| Intercept                                                            |                                        | 58.49*   | 15.62  | 101.36 | <0.01 |
| tDCS                                                                 | Active                                 | −1.39    | −5.83  | 3.04   | 0.53  |
|                                                                      | Sham                                   | 0.00     |        |        |       |
| Education or Cognitive Training                                      | CT                                     | −6.49    | −18.52 | 5.53   | 0.28  |
|                                                                      | ET                                     | 0.00     |        |        |       |
| Age                                                                  |                                        | 0.02     | −0.35  | 0.39   | 0.92  |
| Sex                                                                  | Female                                 | −2.59    | −7.06  | 1.89   | 0.25  |
|                                                                      | Male                                   | 0.00     |        |        |       |
| Site                                                                 | UF                                     | −1.74    | −6.61  | 3.14   | 0.47  |
|                                                                      | UA                                     | 0.00     |        |        |       |
| Education Level                                                      | Bachelor's degree or above             | −3.57    | −8.39  | 1.25   | 0.14  |
|                                                                      | Some college/associate degree or below | 0.00     |        |        |       |
| Stimulation Adherence                                                | Yes                                    | 5.74     | −1.44  | 12.92  | 0.11  |
|                                                                      | No                                     | 0.00     |        |        |       |
| Cognitive Training Adherence                                         | Yes                                    | −3.36    | −9.72  | 2.99   | 0.29  |
|                                                                      | No                                     | 0.00     |        |        |       |
| Taking a prescription drug that can be for anxiety/depression        | Yes                                    | 3.41     | −1.50  | 8.33   | 0.17  |
|                                                                      | No                                     | 0.00     |        |        |       |
| Baseline STAI Trait Score                                            |                                        | −1.29*   | −1.87  | −0.70  | <0.01 |

Notes: Models controlling for participants taking a prescription drug that can be used for anxiety or depression. CI = confidence interval, CT = cognitive training, ET = education training, UF = University of Florida, UA = University of Arizona, STAI = State-Trait Anxiety Inventory, Mild Symptoms = STAI trait scores below 39, Moderate/Severe Symptoms = STAI trait scores greater than or equal to 39.

\*Significant at  $p < 0.05$ .

**Table A.18**

STAI State and Trait Anxiety Summary Statistics by BDI-II Symptom Severity Subgroup

| Variable           | Time    | Statistic         | BDI-II Minimal | BDI-II Mild    | p      |
|--------------------|---------|-------------------|----------------|----------------|--------|
|                    |         |                   | (N = 362)      | (N = 16)       |        |
| STAI State Anxiety | T1      | Mean $\pm$ SD     | 28.0 $\pm$ 8.2 | 39.0 $\pm$ 7.9 | <0.001 |
|                    |         | Median (Min, Max) | 25 (20, 58)    | 39 (23, 50)    |        |
|                    | T2      | Mean $\pm$ SD     | 26.8 $\pm$ 7.1 | 36.8 $\pm$ 9.7 | <0.001 |
|                    |         | Median (Min, Max) | 25 (20, 54)    | 37 (20, 50)    |        |
|                    | T2 – T1 | Mean $\pm$ SD     | –1.2 $\pm$ 8.0 | –2.3 $\pm$ 9.1 | 0.929  |
|                    |         | Median (Min, Max) | 0 (–31, 27)    | –1 (–25, 11)   |        |
|                    | T3      | Mean $\pm$ SD     | 27.5 $\pm$ 7.1 | 36.0 $\pm$ 7.5 | <0.001 |
|                    |         | Median (Min, Max) | 26 (20, 55)    | 33.5 (26, 49)  |        |
|                    | T3 – T1 | Mean $\pm$ SD     | –0.5 $\pm$ 7.3 | –3.0 $\pm$ 6.2 | 0.094  |
|                    |         | Median (Min, Max) | 0 (–34, 29)    | –5 (–15, 9)    |        |
| STAI Trait Anxiety | T1      | Mean $\pm$ SD     | 28.1 $\pm$ 7.0 | 40.0 $\pm$ 6.1 | <0.001 |
|                    |         | Median (Min, Max) | 26 (20, 56)    | 40.5 (26, 49)  |        |
|                    | T2      | Mean $\pm$ SD     | 27.2 $\pm$ 5.9 | 37.1 $\pm$ 9.5 | <0.001 |
|                    |         | Median (Min, Max) | 26 (20, 52)    | 37 (22, 53)    |        |
|                    | T2 – T1 | Mean $\pm$ SD     | –0.8 $\pm$ 5.1 | –2.9 $\pm$ 7.1 | 0.261  |
|                    |         | Median (Min, Max) | 0 (–30, 25)    | –3 (–18, 8)    |        |
|                    | T3      | Mean $\pm$ SD     | 27.9 $\pm$ 6.4 | 39.5 $\pm$ 8.7 | <0.001 |
|                    |         | Median (Min, Max) | 27 (20, 66)    | 37 (28, 55)    |        |
|                    | T3 – T1 | Mean $\pm$ SD     | –0.2 $\pm$ 5.3 | –0.5 $\pm$ 6.1 | 0.645  |
|                    |         | Median (Min, Max) | 0 (–29, 42)    | –1 (–10, 12)   |        |

Notes: All p-values are from Wilcoxon rank-sum tests. BDI-II = Beck Depression Inventory Second Edition, STAI = State-Trait Anxiety Inventory, T1 = baseline assessment, T2 = post-intervention, T3 = one-year assessment.

**Table A.19**

BDI-II and STAI Trait Anxiety Summary Statistics by STAI State Symptom Severity Subgroup

| Variable           | Time    | Statistic         | STAI State Mild | STAI State Moderate/Severe | p      |
|--------------------|---------|-------------------|-----------------|----------------------------|--------|
|                    |         |                   | (N = 319)       | (N = 59)                   |        |
| BDI-II             | T1      | Mean $\pm$ SD     | 2.9 $\pm$ 3.6   | 7.5 $\pm$ 5.0              | <0.001 |
|                    |         | Median (Min, Max) | 1 (0, 18)       | 8 (0, 19)                  |        |
|                    | T2      | Mean $\pm$ SD     | 2.7 $\pm$ 3.3   | 5.9 $\pm$ 4.9              | <0.001 |
|                    |         | Median (Min, Max) | 1 (0, 16)       | 6 (0, 19)                  |        |
|                    | T2 – T1 | Mean $\pm$ SD     | –0.2 $\pm$ 2.7  | –1.5 $\pm$ 4.6             | 0.025  |
|                    |         | Median (Min, Max) | 0 (–14, 11)     | –1 (–14, 14)               |        |
|                    | T3      | Mean $\pm$ SD     | 3.3 $\pm$ 3.7   | 7.7 $\pm$ 5.4              | <0.001 |
|                    |         | Median (Min, Max) | 2 (0, 22)       | 8 (0, 23)                  |        |
|                    | T3 – T1 | Mean $\pm$ SD     | 0.4 $\pm$ 3.1   | 0.2 $\pm$ 3.5              | 0.487  |
|                    |         | Median (Min, Max) | 0 (–8, 18)      | 0 (–8, 11)                 |        |
| STAI Trait Anxiety | T1      | Mean $\pm$ SD     | 27.0 $\pm$ 5.9  | 37.1 $\pm$ 8.5             | <0.001 |
|                    |         | Median (Min, Max) | 25 (20, 47)     | 37 (20, 56)                |        |
|                    | T2      | Mean $\pm$ SD     | 26.7 $\pm$ 5.7  | 32.9 $\pm$ 7.2             | <0.001 |
|                    |         | Median (Min, Max) | 25 (20, 52)     | 33 (21, 53)                |        |
|                    | T2 – T1 | Mean $\pm$ SD     | –0.3 $\pm$ 4.4  | –4.2 $\pm$ 7.5             | <0.001 |
|                    |         | Median (Min, Max) | 0 (–18, 25)     | –3 (–30, 8)                |        |
|                    | T3      | Mean $\pm$ SD     | 27.2 $\pm$ 6.1  | 34.5 $\pm$ 7.7             | <0.001 |
|                    |         | Median (Min, Max) | 26 (20, 66)     | 34 (20, 55)                |        |
|                    | T3 – T1 | Mean $\pm$ SD     | 0.2 $\pm$ 4.8   | –2.5 $\pm$ 7.6             | 0.005  |
|                    |         | Median (Min, Max) | 0 (–15, 42)     | –1 (–29, 12)               |        |

Notes: All p-values are from Wilcoxon rank-sum tests. BDI-II = Beck Depression Inventory Second Edition, STAI = State-Trait Anxiety Inventory, T1 = baseline assessment, T2 = post-intervention, T3 = one-year assessment.

**Table A.20**

BDI-II and STAI State Anxiety Summary Statistics by STAI Trait Symptom Severity Subgroup

| Variable | Time | Statistic         | STAI Trait Mild | STAI Trait Moderate/Severe | p      |
|----------|------|-------------------|-----------------|----------------------------|--------|
|          |      |                   | (N = 334)       | (N = 44)                   |        |
| BDI-II   | T1   | Mean $\pm$ SD     | 2.9 $\pm$ 3.6   | 8.9 $\pm$ 4.9              | <0.001 |
|          |      | Median (Min, Max) | 1 (0, 18)       | 9 (0, 19)                  |        |
|          | T2   | Mean $\pm$ SD     | 2.7 $\pm$ 3.3   | 6.6 $\pm$ 5.4              | <0.001 |

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Table A.20 (continued)

| Variable           | Time    | Statistic         | STAI Trait Mild | STAI Trait Moderate/Severe | p      |
|--------------------|---------|-------------------|-----------------|----------------------------|--------|
|                    |         |                   | (N = 334)       | (N = 44)                   |        |
| STAI State Anxiety | T2 – T1 | Median (Min, Max) | 1 (0, 15)       | 6 (0, 19)                  | <0.001 |
|                    |         | Mean ± SD         | −0.2 ± 2.7      | −2.3 ± 4.9                 |        |
|                    | T3      | Median (Min, Max) | 0 (−14, 11)     | −2 (−14, 14)               | <0.001 |
|                    |         | Mean ± SD         | 3.4 ± 3.6       | 8.8 ± 6.0                  |        |
|                    | T3 – T1 | Median (Min, Max) | 2 (0, 22)       | 8 (0, 23)                  | 0.068  |
|                    |         | Mean ± SD         | 0.5 ± 2.9       | −0.1 ± 4.9                 |        |
|                    | T1      | Median (Min, Max) | 0 (−8, 14)      | 0 (−8, 18)                 | <0.001 |
|                    |         | Mean ± SD         | 26.6 ± 4.9      | 43.9 ± 3.9                 |        |
|                    | T2      | Median (Min, Max) | 25.5 (20, 38)   | 43 (39, 56)                | <0.001 |
|                    |         | Mean ± SD         | 26.5 ± 5.4      | 36.5 ± 6.8                 |        |
|                    | T2 – T1 | Median (Min, Max) | 25 (20, 52)     | 36 (23, 53)                | <0.001 |
|                    |         | Mean ± SD         | −0.1 ± 4.1      | −7.3 ± 7.9                 |        |
|                    | T3      | Median (Min, Max) | 0 (−16, 25)     | −6 (−30, 8)                | <0.001 |
|                    |         | Mean ± SD         | 27.0 ± 5.5      | 39.2 ± 6.8                 |        |
|                    | T3 – T1 | Median (Min, Max) | 26 (20, 66)     | 38.5 (24, 55)              | <0.001 |
|                    |         | Mean ± SD         | 0.4 ± 4.6       | −4.7 ± 8.2                 |        |
|                    |         | Median (Min, Max) | 0 (−15, 42)     | −5 (−29, 12)               |        |

Notes: All p-values are from Wilcoxon rank-sum tests. BDI-II = Beck Depression Inventory Second Edition, STAI = State-Trait Anxiety Inventory, T1 = baseline assessment, T2 = post-intervention, T3 = one-year assessment.

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