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The effect of Alpha-Stim cranial electrotherapy stimulation on anxiety, depression, sleep quality, stress, and self-efficacy: a longitudinal study in a non-clinical population

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Keywords:	Neuromodulation, Alpha-Stim, Anxiety, Sleep Quality, Stress, Self-Efficacy
Abstract:	Our previous studies demonstrated that Alpha-Stim, a cranial electrotherapy stimulation (CES) device, improves anxiety and depression symptoms in a clinical population over six and twelve weeks. The aim of the current study was to assess the longer-term effect of Alpha-Stim in a population with no current formal mental health diagnosis over a 21-day course of daily treatment by expanding standardised tests of anxiety, depression, sleep quality, stress, and self-efficacy. Twenty-seven participants were recruited to receive 40-60 minutes per day of CES treatment, using an Alpha-Stim device for 21 days, with a follow-up assessment at 3 weeks after the end of treatment (day 42). The primary outcomes were remission, reliable improvement, and recovery at days 10, 21, and 42 of anxiety and depression measured by the GAD-7 and PHQ-9 scales. Secondary outcomes were perceived sleep quality, stress, and self-efficacy. Remission, reliable improvement, and recovery on day 21 were 81.0%, 57.1%, and 42.8% for GAD-7 and 90.5%, 61.9%, and 52.4% for PHQ-9. On day 42, they remained high at 73.3%, 66.7%, and 60.0% for GAD-7 and 93.3%, 53.3%, and 53.3% for PHQ-9. The levels of stress decreased, and sleep quality and self-efficacy increased significantly from baseline to day 21 and day 42 with a large effect size. The findings suggest that Alpha-Stim treatment can be an effective option for treating anxiety and depression, reducing stress, and improving sleep and self-efficacy in a non-clinical population. As with other interventions, not all individuals respond to Alpha-Stim treatment; however, Alpha-Stim treatment shows promise for health and wellbeing treatment providers especially where waiting lists are long and mental illness is less severe or related to transient issues. The findings therefore warrant experimental follow-up with a randomised control trial (RCT) and the delineation of the role of sleep and stressful events during mental health recovery.

Title

The effect of Alpha-Stim cranial electrotherapy stimulation on anxiety, depression, sleep quality, stress, and self-efficacy: a longitudinal study in a non-clinical population

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Data Availability Statement (DAS)

Data available on request from the authors: The data that support the findings of this study are available from the corresponding author, KMDS, upon reasonable request.

Abstract

Our previous studies demonstrated that Alpha-Stim, a cranial electrotherapy stimulation (CES) device, improves anxiety and depression symptoms in a clinical population over six and twelve weeks. The aim of the current study was to assess the longer-term effect of Alpha-Stim in a population with no current formal mental health diagnosis over a 21-day course of daily treatment by expanding standardised tests of anxiety, depression, sleep quality, stress, and self-efficacy. Twenty-seven participants were recruited to receive 40-60 minutes per day of CES treatment, using an Alpha-Stim device for 21 days, with a follow-up assessment at 3 weeks after the end of treatment (day 42). The primary outcomes were remission, reliable improvement, and recovery at days 10, 21, and 42 of anxiety and depression measured by the GAD-7 and PHQ-9 scales. Secondary outcomes were perceived sleep quality, stress, and self-efficacy. Remission, reliable improvement, and recovery on day 21 were 81.0%, 57.1%, and 42.8% for GAD-7 and 90.5%, 61.9%, and 52.4% for PHQ-9. On day 42, they remained high at 73.3%, 66.7%, and 60.0% for GAD-7 and 93.3%, 53.3%, and 53.3% for PHQ-9. The levels of stress decreased, and sleep quality and self-efficacy increased significantly from baseline to day 21 and day 42 with a large effect size. The findings suggest that Alpha-Stim treatment can be an effective option for treating anxiety and depression, reducing stress, and improving sleep and self-efficacy in a non-clinical population. As with other interventions, not all individuals respond to Alpha-Stim treatment; however, Alpha-Stim treatment shows promise for health and wellbeing treatment providers especially where waiting lists are long and mental illness is less severe or related to transient issues. The findings therefore warrant experimental follow-up with a randomised control trial (RCT) and the delineation of the role of sleep and stressful events during mental health recovery.

Keywords

Neuromodulation; Alpha-Stim; Anxiety; Depression; Sleep Quality; Stress; Self-Efficacy.

1. Introduction

Psychopharmacology and psychotherapy can be effective in treating anxiety and depression for some people; however, both approaches have limitations, for example, adverse side effects, high financial costs, and over 50% non-response rates (Bandelow et al., 2017; Griffiths & Griffiths, 2015). The growing crisis related to mortality and morbidity of untreated mental illness (World Health Organisation, 2011) has put pressure on developing alternative treatment options that address the limitations of psychopharmacology and psychotherapy while retaining high effectiveness.

Cranial Electrotherapy Stimulation (CES) is a safe and effective treatment for depression and anxiety, with approval from the US Food and Drug Administration (FDA) in 1979 (Kirsch & Nichols, 2013). A systematic review found that Alpha-Stim reduces symptoms of anxiety and depression and is safe without serious side effects (Shekelle et al., 2018). In the UK, Morriss and Price (2020) demonstrated Alpha-Stim treatment provided a saving of £540.88 per patient compared to traditional treatment routes and anticipate CES will become an accepted means of psychiatric treatment by 2030. However, there is a lack of appropriately designed and powered RCTs demonstrating effectiveness in treating anxiety outside of clinical settings (Brunyé et al., 2021). In a recent RCT, Alpha-Stim was found to be beneficial but no more clinically effective than sham Alpha-Stim in major depression (Morriss et al., 2023). In the UK, recommendations from National Institute for Health and Care Excellence (NICE) call for further research on the long-term efficacy, its position in the care pathway, and a better understanding of the effect of the device on functioning before it can be approved for routine use (NICE, 2021).

The current study is a response to NICE's call to evaluate the longer-term efficacy of Alpha-Stim outside of the healthcare system for the treatment of depression and anxiety and assess additional psychological functioning: perceived stress, self-efficacy, and sleep.

2. Methods

Design: within participant, open-label cohort trial with no control group. The treatment was the daily use of Alpha-Stim Stim (delivering 0.5 Hz, 100 - 500 µA, 50% duty cycle, biphasic asymmetrical rectangular waves) for 40-60 minutes per day for 21 days. Anxiety, depression, stress, self-efficacy, and sleep quality were measured at baseline, on days 10, 21 (end of treatment), and 42.

Participants: Participants were recruited from the general population using a snowball technique. Exclusion criteria were current or recent treatment for depression or anxiety, known pregnancy, having a pacemaker, history of seizures, or a lack of capacity to consent. Power analysis, using GPowerNT software, recommended an appropriate sample size for 80% power and 0.05% alpha error probability was 25. Of the 27 recruited participants, 21 remained in the study by day 21 (22% attrition) and 15 by day 42 (44% attrition rate, see *Fig 1*).

Procedure: Alpha-Stim was handed to participants with instructions and a link to the online Gorilla Experiment Builder. Further prompts were automatically emailed to the participants at each time point. The devices were collected from participants after 21 days and a debrief letter was provided after the follow-up tests on day 42. The study was conducted in accordance with the British Psychological Society's (BPS) ethical code of

conduct and ethical approval was gained from Coventry University Research Ethics Committee (reference number P130628).

***Measures**:* The CES treatment was self-administered in the participants' homes using the Alpha-Stim II AID (CE-marked medical device) as per the manufacturer's recommendations (Electromedical Products Ltd). The following self-report measures were used: the Generalised Anxiety Disorder (GAD-7; Spitzer et al., 2006), the Personal Health Questionnaire (PHQ-9; Kroenke et al., 2001), the Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1989), the Perceived Stress Scale (PSS; Cohen, 1988) and the General Self-Efficacy Scale (GSE; Schwarzer & Jerusalem, 1995).

3. Results

Twenty-seven participants (age range 19-75 years, 68% women) completed the baseline tests. The mean baseline GAD-7 and PHQ-9 scores were in the moderately severe range for anxiety and depression. The mean PSQI score indicated the presence of sleep disturbances, the mean PSS score indicated moderately high perceived stress, and the mean GSE score a relatively high perceived general self-efficacy (*Table 1*).

There was a statistically significant decrease in GAD-7 scores across the four-time points. Post-hoc pairwise comparisons showed a statistically significant decrease between baseline and days 10, 21, and 42, and between days 10 and 21. 33.3% of participants did not meet the criteria for anxiety at baseline. Remission increased by 49% from baseline to day 10 and the effect was sustained at day 21 and the follow-up (*Table 2*). Only one participant reported a deterioration in GAD-7 scores over the 42-day intervention from 10 to 12 points, and all but two participants had no or mild symptoms of anxiety by day 42.

A similar trend was reported for PHQ-9 scores, with a significant decrease across all time points. Post-hoc pairwise comparisons showed a statistically significant decrease between baseline and days 10, 21, and 42. 44.4% of participants did not meet the criteria for depression at baseline; by day 42 this increased to 93.3% (*Table 2*). Only one participant reported clinically significant symptoms of depression by day 42.

PSQI scores decreased significantly from baseline to day 21. At baseline, 33.3% of participants had good sleep quality, which increased to 43.5% on day 10, and 57.1% on day 21, and was sustained at 53.3% on day 42.

The mean PSS scores decreased significantly from the beginning of treatment to days 10, 21, and 42. Only two participants (7.4%) had low levels of perceived stress at baseline, which increased to 26.1% on day 21, and 47.6% on day 21, and remained steady at 46.7% on day 42.

The mean GSE scores increased significantly from the beginning of treatment to the end of treatment on day 21 and remained high at follow-up.

4. Discussion

The Alpha-Stim CES device was shown to be feasible, acceptable, and effective in a non-clinical population in reducing the symptoms of anxiety, depression, and stress, and increasing sleep quality and self-efficacy over a 21-day treatment course. Importantly, the effect was maintained at a follow-up 3 weeks after the end of treatment.

There was a greater reliable improvement in GAD-7 scores for participants than observed by Griffiths et al (2023) after 21 days of treatment, suggesting Alpha-Stim may be

well-suited to people with moderate/severe symptoms and no clinical diagnosis. Further, reliable improvement in PHQ-9 scores as early as day 10, demonstrated a faster response to CES treatment than expected (Morriss & Price, 2020). Treatment effects were sustained for all five scales 21 days after stopping the treatment, including for self-efficacy, a measure believed to be more stable and trait-like (Schwarzer & Jerusalem, 1995). However, while the PSQI scale is a widely used measure and indicated that CES may specifically improve dimension 2 (shortening sleep latency), it failed to delineate the exact sleep patterns that are at play during mental health recovery. Conducting further studies involving a sleep assessment wearable device alongside CES treatment could elucidate the causes of these sleep improvements and pinpoint the exact sleep patterns that are related to a reduction in symptoms of anxiety and depression.

Our findings suggest CES could be an appropriate intervention for those waiting for psychotherapeutic or other treatments or in instances where psychopharmacology or psychotherapy is not as acceptable due to cultural issues, neurodivergent diagnoses, co-morbid health conditions, or during pregnancy and the postnatal period. As improvement also occurred in individuals with low GAD-7 and PHQ-9 scores, CES could be an early intervention at the onset of mental disorders, could improve the lives of those who do not meet the threshold for medical treatment, and could assist in cases where mental ill health is less severe, related to transient issues or exists for a finite period, such as temporary periods of high levels of stressors, e.g. taking exams. The attrition rate was low up to day 21 suggesting the device was deemed acceptable and manageable in daily life.

However, an appropriately designed and powered RCT is required. Future studies should control for the presence of stressful events to separate the effects of treatment and transient stress. There was not enough data to compare effects between genders and greater male representation is needed, especially considering the sexual dimorphism evident in experiences of anxiety. Finally, several participants mentioned the increase in clarity of thought and general lightness of being which could be related to the proposed effect of CES on brainwave frequencies. Qualitative research related to these factors might provide direction for future studies, especially in relation to long-Covid where ‘brain fog’ is a key symptom.

Conclusion

CES could be considered an effective treatment for anxiety, depression, and sleep in non-clinical populations, those who are waiting for psychotherapeutic treatment, and those where more traditional routes with medications and psychotherapy are not acceptable or possible. As the findings of this study suggest, CES offers the possibility of treating anxiety, depression, sleep quality, and stress prior to the patient requiring clinical attention, potentially preventing the need for medication which can have negative side effects and issues related to withdrawal and reducing pressure on the healthcare system as a result.

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Tables

Table 1.

Descriptive statistics (M, SD) and repeated measures ANOVA results for the effects on the scales at regular time points during CES treatment.

	Baseline	Day 10	Day 21	Day 42	*F*	*p*	*Partial eta²*
GAD-7	11.78 (7.07)	6.48 (5.25)	5.00 (4.90)	5.00 (2.95)	21.850⁺	<.001	.609
PHQ-9	12.74 (7.96)	7.48 (7.10)	4.59 (4.26)	4.07 (4.18)	13.137⁺	<.001	.484
PSQI	7.19 (3.34)	6.04 (3.69)	4.82 (2.77)	5.80 (4.31)	11.31	<.001	.170
PSS	22.52 (6.08)	18.52 (6.65)	14.82 (6.90)	15.60 (6.78)	21.033	<.001	.600
GSE	27.89 (3.96)	30.04 (3.89)	31.64 (2.66)	31.47 (2.82)	7.240	<.001	.341

⁺ Sphericity not assumed

Table 2.

Remission, reliable improvement, and recovery for GAD-7 and PHQ-9 at regular time points during CES treatment.

	Baseline	Day 10			Day 21			Day 42		
	Rem	Rem	Rel.imp	Rec	Rem	Rel.imp	Rec	Rem	Rel.imp	Rec
GAD-7	33.3%	82.6%	39.1%	39.1 %	81.0%	57.1%	42.8%	73.3%	66.7%	60.0%
PHQ-9	44.4%	73.9%	47.8%	43.5 %	90.5%	61.9%	52.4%	93.3%	53.3%	53.3%

Rem = Remission (no clinically significant symptoms) is defined as ≤7 for GAD-7 and ≤9 for PHQ-9.

Rel.imp = Reliable improvement is defined as a change index of ≥4 points for GAD-7 and ≥6 points for PHQ-9.

Rec = Recovery is achieved when both remission and reliable improvement are recorded.

Figure 1

Flow of Progress Through the Study.