



Case Report

Effectiveness of Noninvasive Brain Stimulation (NIBS) in Combination with Cognitive Analytic Psychotherapy (CAP); A Complex Cocaine Abuser Case

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Introduction: Drug addiction, a global problem affecting 275 million people, is a complex disorder characterized by compulsive substance use despite negative consequences. Neuroplasticity changes in the brain's circuits, particularly those involving dopamine, play a crucial role in addiction. Non-invasive brain stimulation techniques, such as transcranial magnetic stimulation and transcranial direct current stimulation, show promise as adjunctive treatments for substance use disorders, including cocaine use disorder. Combining these brain stimulation therapies with psychological interventions may enhance treatment outcomes and reduce relapse rates.

Case Report: In this study, a 38-year-old Iranian woman, diagnosed with cocaine use disorder, underwent a multi-faceted neuropsychological treatment program. Her husband also received psychological treatment but not biological treatment. After treatment, both the woman and her husband were able to completely stop using cocaine for more than three years. The study used various assessments, including self-report tests and brain mapping, to evaluate the effectiveness of the interventions. The woman showed a significant reduction in symptoms and improvement in mood regulation.

Conclusion: This study highlights the effectiveness of a multifaceted approach to treating cocaine addiction, including neurological and psychological interventions. It suggests that non-invasive brain manipulation and Cognitive Analytic Psychotherapy (CAP) may be effective in treating complex cases. However, further research is needed to establish the efficacy of CAP for bipolar affective disorder. The study emphasizes the importance of considering biological, psychological, and social factors in treatment of substance use disorders.

Keywords: Case report, Cocaine, Cognitive Analytic Psychotherapy (CAP), Noninvasive Brain Stimulation (NIBS)

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Introduction

Substance use disorder (SUD) is a major public health problem, affecting an estimated 275 million people worldwide and contributing to profound medical, psychological, and social harm (UNODC, 2022). The global prevalence of drug use has increased by 26% in the past decade, and cocaine production reached a record 1,982 tons in 2020, alongside record levels of global seizures. Cocaine use is associated with high rates of psychiatric comorbidity, severe cardiovascular complications, and poor treatment outcomes, yet no approved pharmacological treatment exists for cocaine use disorder (CUD).¹ This gap highlights the urgent need for novel and more effective interventions.

Addiction is now recognized as a neurobiological-psychosocial disorder marked by compulsive drug seeking and use despite harmful consequences.² Chronic substance exposure induces maladaptive neuroplasticity in fronto-limbic circuits, particularly the dorsolateral prefrontal cortex (DLPFC) and anterior cingulate cortex (ACC), contributing to deficits in executive control,

emotion regulation, and decision-making.^{3,4} In recent years, non-invasive brain stimulation (NIBS) techniques, such as repetitive transcranial magnetic stimulation (rTMS) and transcranial direct current stimulation (tDCS), have shown promising results in reducing craving and improving cognitive control in various substance use disorders.^{5,6} Recent meta-analytic evidence supports this notion, showing that repetitive transcranial magnetic stimulation (rTMS) produces moderate-to-large reductions in craving and substance use when targeting the left DLPFC.⁷ Combining NIBS with psychosocial interventions may enhance neuroplasticity and treatment response.⁸ A 2024 narrative review similarly emphasized the growing role of non-invasive brain stimulation as an adjunctive treatment across neuropsychiatric disorders, urging standardized protocols and integration with psychotherapeutic approaches.⁹

While traditional Cognitive Analytic Therapy (CAT) focuses on identifying and reformulating maladaptive relational patterns rooted in early experiences, the present treatment approach employs an adapted model

referred to as Cognitive Analytic Psychotherapy (CAP). CAP is a novel integrative framework that combines analytic exploration with cognitive restructuring within a structured, experiential therapeutic setting. In this approach, Thematic Apperception Test (TAT) cards are used as projective tools to elicit patients' spontaneous narratives and emotional associations. Following the patient's description of each card, the cognitive-analytic psychotherapist encourages free association and reflection on the emerging feelings and interpersonal themes, allowing unconscious conflicts and relational patterns to surface. These are then examined through cognitive techniques, including identification and restructuring of maladaptive beliefs, reappraisal of distorted interpretations, and development of adaptive cognitive-emotional responses. By integrating the analytic depth of unconscious exploration with the clarity and structure of cognitive interventions, CAP facilitates insight, emotional regulation, and behavioral change. This approach appears particularly beneficial for complex clinical profiles such as cocaine use disorder with comorbid mood instability, where both cognitive and unconscious processes contribute to symptom persistence. Cognitive Analytic Psychotherapy (CAP) is a time-limited, integrative psychotherapy that focuses on helping individuals identify, understand, and revise maladaptive interpersonal and self-management patterns rooted in early life experiences.¹⁰ Although CAP has not been widely studied in substance use disorders, its emphasis on relational triggers, self-regulation, and identity reformulation may complement the neurophysiological effects of NIBS. This case report describes the use of combined NIBS and CAP in a patient with cocaine use disorder and comorbid bipolar disorder, aiming to illustrate feasibility and generate hypotheses for future controlled studies.

Case Report

Patient Information

Mrs. H is a 38-year-old Iranian woman, married and mother of a 15-year-old child, diagnosed with cocaine use disorder. She had a family history of obsessive-compulsive disorder in her mother and aggression in her father.

She was first referred in 2016, presenting with severe depression, multiple extramarital relationships, and a request for divorce and separation from her husband. At that time, she denied any drug use.

Substance Use History

Mrs. H reported first using cocaine at age 36. She had been using regularly for about two years, up to 5 g per day, with fluctuations based on access and availability. Since the onset, she has had 2–3 relapse episodes separated by periods of abstinence, but she has remained abstinent for more than three years. Before cocaine use, she had a pattern of multiple sexual relationships, which stopped after achieving stable abstinence.

Psychosocial and Treatment Background

She had a history of hospitalization, drug therapy, and

psychotherapy before current treatment.

At the time of entering this study, she was receiving a multidisciplinary neuropsychological treatment program comprising:

- Psychological interventions: individual Cognitive Analytic Psychotherapy (CAP) and family therapy
- Pharmacotherapy
- Non-invasive neuromodulation: repetitive transcranial magnetic stimulation (rTMS), transcranial direct current stimulation (tDCS), and biofeedback.

Her husband was also admitted at the same time for cocaine use disorder and received only psychological treatment (CAP) without biological interventions. He achieved abstinence two years earlier than Mrs. H and had no relapses. Ultimately, both maintained complete abstinence for more than three years after treatment. CAP sessions were continued as a relapse-prevention follow-up.

Clinical Assessment

After providing written informed consent, Mrs. H met the inclusion criteria and did not have any of the exclusion criteria and participated in baseline assessment, which included: ASR, AMEN, BDI, BAI, Craving Test, MMPI, and Objective EEG/ERP-based functional brain evaluation.

- ASR (Adult Self-Report): A self-report questionnaire assessing emotional, behavioral, and social functioning in adults.
- AMEN (Amen Brain System Checklist): A symptom-based checklist used to screen functional brain system involvement related to psychiatric and behavioral symptoms.
- BDI (Beck Depression Inventory): A widely used self-report scale measuring the severity of depressive symptoms.
- BAI (Beck Anxiety Inventory): A self-report instrument designed to assess the severity of anxiety symptoms.
- Craving Test: A self-report measure evaluating the intensity and frequency of substance craving.
- MMPI (Minnesota Multiphasic Personality Inventory): A standardized psychometric test assessing personality structure and psychopathology.
- Objective EEG/ERP-based functional brain evaluation: A neurophysiological assessment using electroencephalography and event-related potentials to objectively evaluate brain function and cognitive processing.

Interventions

Psychotherapy: Long-term CAP sessions (individual) and family therapy

Pharmacotherapy: Tegretol, Trancopine (quetiapine), Desipramine, Normazine

Non-invasive brain stimulation:

5 sessions of biofeedback

5 sessions of tDCS

20 sessions (30 min each) of rTMS using a bilateral protocol.

All neuromodulation sessions were accompanied by mindfulness-based exercises.

The treatment protocol was designed as a multimodal and sequential intervention, integrating psychotherapy, pharmacotherapy, and non-invasive brain stimulation (NIBS), with the aim of addressing the psychological, neurobiological, and behavioral aspects of cocaine dependence.

Psychotherapy constituted the core and longitudinal component of the intervention. The patient underwent long-term individual Cognitive Analytic Psychotherapy (CAP) sessions, complemented by family therapy, which continued throughout the treatment period. Psychotherapy provided a stable therapeutic framework to enhance insight, emotional regulation, and relational patterns, and to facilitate the integration of other interventions.

Pharmacotherapy was initiated early in the treatment process and maintained concurrently with psychotherapy and neuromodulation. Medications included carbamazepine (Tegretol), quetiapine (Trancopine), desipramine, and chlorpromazine (Normazine), prescribed and adjusted by a psychiatrist to stabilize mood, reduce impulsivity, manage craving-related symptoms, and improve overall psychiatric stability.

Non-invasive brain stimulation (NIBS) interventions were implemented after initial clinical stabilization was achieved through psychotherapy and pharmacotherapy. Neuromodulation was delivered in a stepwise and progressive sequence:

Five sessions of biofeedback were administered first to enhance self-regulation, body awareness, and engagement with neurophysiological feedback. This was followed by five sessions of transcranial direct current stimulation (tDCS) to modulate cortical excitability and prepare neural networks for more intensive stimulation. Subsequently, 20 sessions of repetitive transcranial magnetic stimulation (rTMS) (30 minutes per session) were conducted using a bilateral protocol, targeting brain regions implicated in craving, executive control, and emotional regulation.

All neuromodulation sessions were accompanied by mindfulness-based exercises, aiming to strengthen attentional control, promote emotional awareness, and facilitate the integration of neurophysiological changes into subjective and behavioral experiences.

This combined and sequential approach was designed to maximize therapeutic synergy between psychological, pharmacological, and neurostimulation-based interventions.

Outcomes and Follow-up

After the two-month course of NIBS, all initial assessments were repeated, showing a marked reduction in symptoms. To maintain recovery, psychotherapy and

pharmacotherapy were continued for about two years, and CAP-based psychotherapy was provided every two weeks as follow-up.

Mrs. H has remained completely abstinent from cocaine for over three years. She showed significant reductions across all self-report test subscales.

In qEEG brain mapping, there were notable improvements in indices related to substance use and mood regulation.

Previously, irregular sleep and daily cigarette use had remained problematic; however, by the most recent evaluation, her sleep had normalized and she had switched from cigarettes to electronic cigarettes.

Objective Test Results

MMPI: After interventions, the K scale indicated a tendency to present positively, but all other scales were within normal limits. Depression and somatic symptom scales were borderline (Figure 1).

SCL-90-R: Scores improved across all dimensions to the normal range (Figure 2).

DSM-5 symptoms: Scores were ≤ 2 on all symptoms, indicating normal levels, except for sleep and substance use scales, which were related to prior irregular sleep and cigarette use (Figure 3).

qEEG: Pre-treatment findings were consistent with the literature,^{11,12} showing increased beta, delta, and alpha power mainly in anterior cortical regions. Post-treatment, Mrs. H showed decreased delta/theta power and increased alpha activity, indicating improved mood regulation and reduced substance-use-related dysfunction (Figures 4–6).

Discussion

This case report presents a rare example of the potential effectiveness of a multifaceted treatment approach for cocaine use disorder (CUD) and management of craving and use-related symptoms. The first key finding was the effectiveness of combining neurological interventions with psychological therapies. In addition, psychological

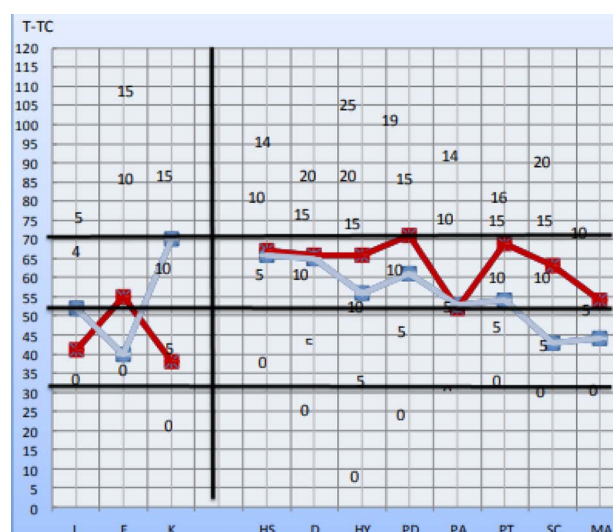


Figure 1. MMPI test before and after treatment (Red color before treatment and blue color after treatment)

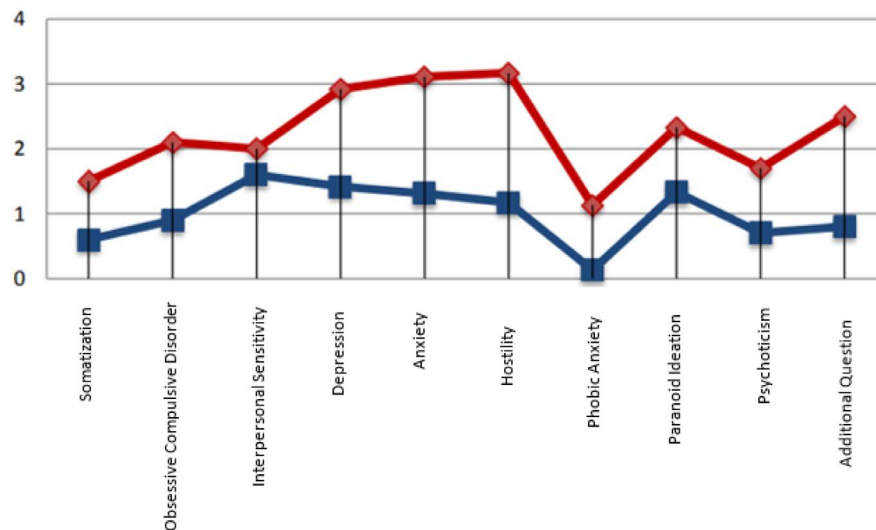


Figure 2. SCL-90 test before and after treatment (Red color before treatment and blue color after treatment)

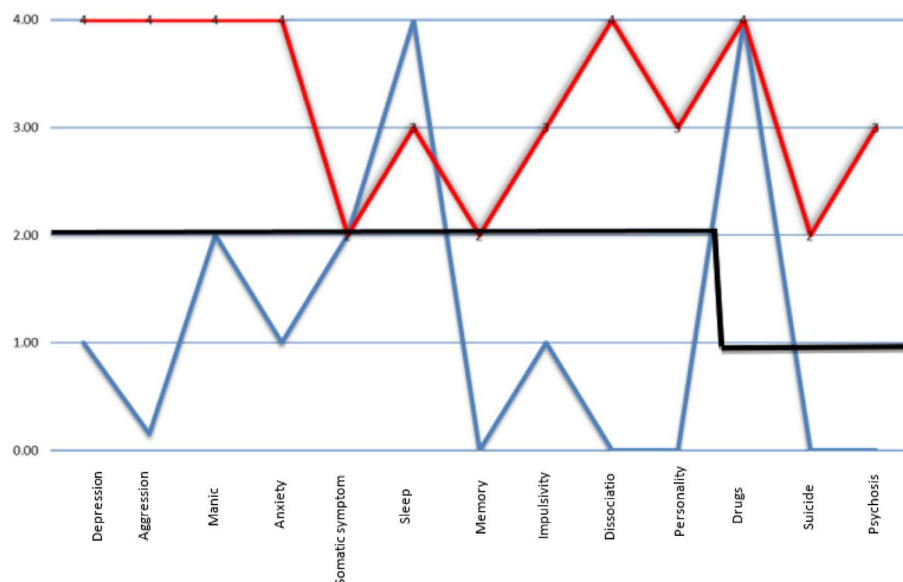


Figure 3. DSM-5 test before and after treatment (Red color before treatment and blue color after treatment)

and cognitive rehabilitation appear to have played an important role in enhancing the durability of treatment effects and reducing the frequency and severity of relapses.

Given the well-established dysfunction of prefrontal and dorsolateral prefrontal cortex regions in both cocaine use disorder and mood-related disorders with affective instability, the observed effectiveness of neuromodulation protocols—including repetitive transcranial magnetic stimulation (rTMS) and transcranial direct current stimulation (tDCS)—in this case suggests that such personalized neurobiological interventions, guided by clinical evaluation and brain mapping, may be beneficial. This aligns with recent evidence from deep TMS studies in 2025, which demonstrated large effects on craving reduction in substance use disorders.¹³ Reductions in craving and improvements in mood regulation were observed during treatment, both at the subjective experience level and at the objective brain functional level (qEEG).

Non-invasive brain stimulation shows promise as an emerging tool for treating cocaine addiction by targeting and retraining the function of brain circuits through neuroplasticity-based mechanisms. Alongside this, Cognitive Analytic Psychotherapy (CAP) focuses on identifying and modifying maladaptive patterns that link past experiences to current difficulties. Although research on CAP specifically for cocaine addiction is limited, cognitive-behavioral therapy (CBT) has shown efficacy for substance use disorders, including cocaine addiction.¹⁴ In line with this integrative direction, the ConNECT framework proposed in 2025 highlights the convergence of neuroscience and psychotherapy, supporting combined cognitive-analytic and neurobiological approaches.¹⁵

Moreover, CAP has shown potential for complex psychiatric conditions, including bipolar affective disorder. A pilot randomized controlled trial suggested that CAP may be feasible, safe, and helpful for bipolar affective disorder.¹⁶ It has been also described as a

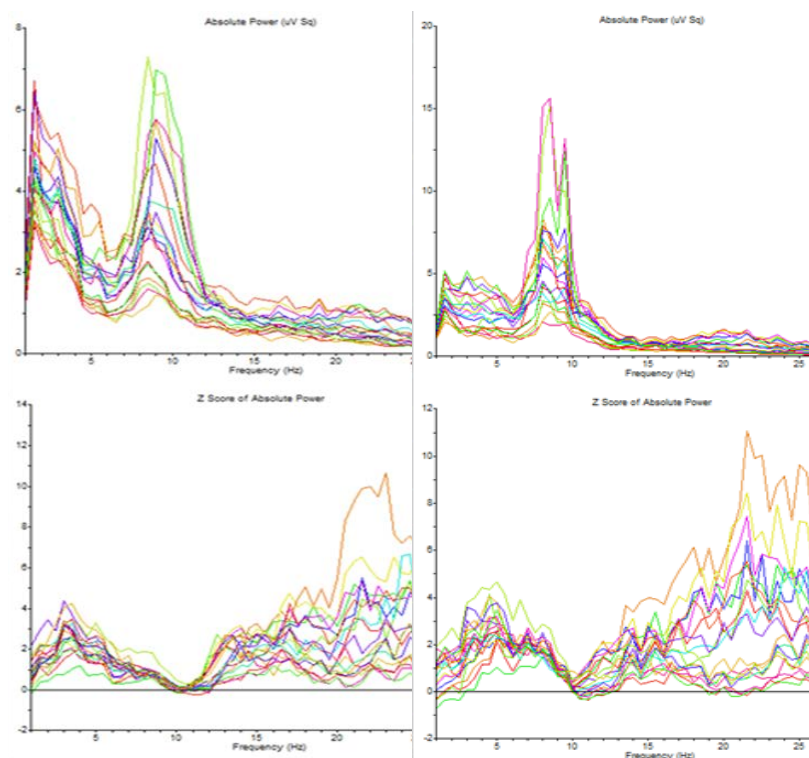


Figure 4. Brain alpha peak before and after treatment (Left side before treatment and right side after treatment)

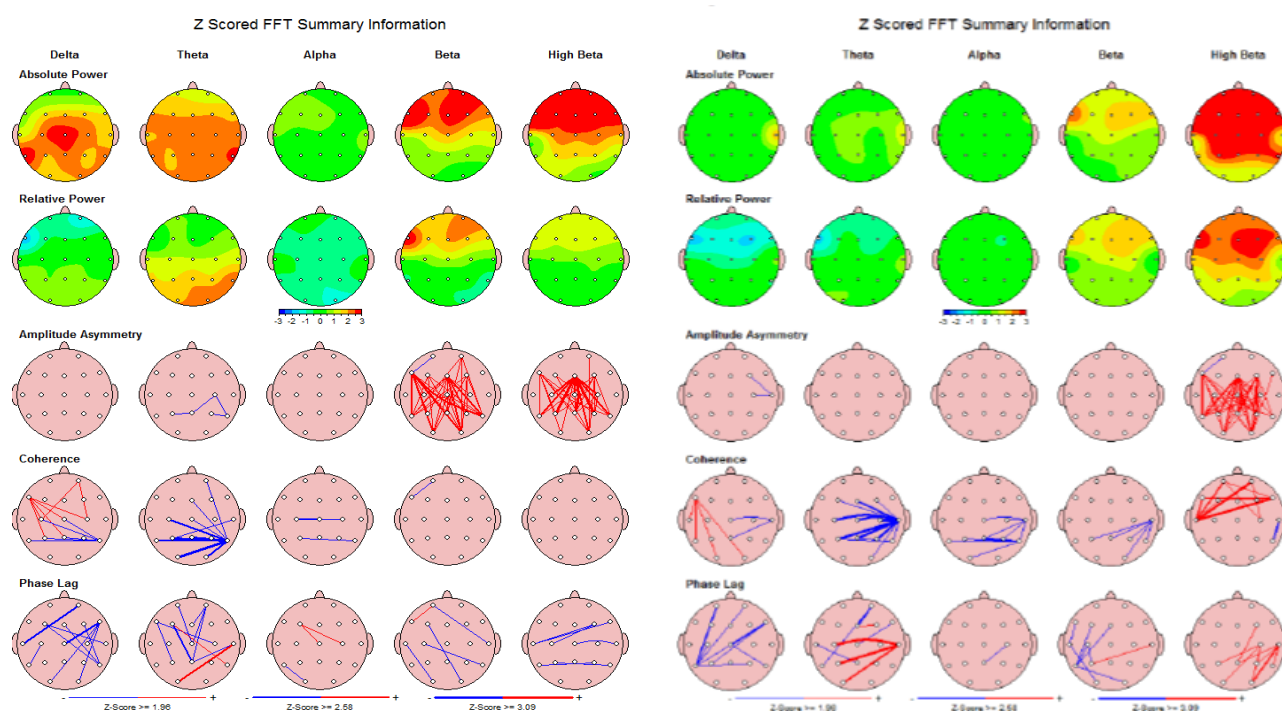


Figure 5. Brain map before and after treatment (Left side before treatment and right side after treatment)

relatively acceptable and effective brief psychotherapy for individuals with complex psychological disorders.¹⁷ Nonetheless, current evidence remains limited, and further research is needed to establish its efficacy definitively.¹⁸

In line with this case's findings, optimizing neuromodulation parameters could further enhance treatment outcomes. Given the multifaceted nature of psychological disorders, their treatment must be also

multidimensional, addressing biological, psychological, and social factors. In this case, the inclusion of family-based therapy appeared to enhance the interventions' impact, underscoring the importance of systemic and relational contexts in treatment.

Conclusion

This case highlights the observation that a comprehensive approach combining neuromodulation, psychological

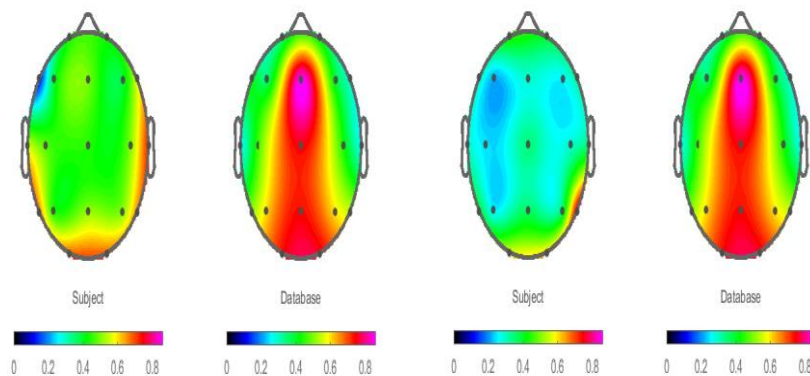


Figure 6. Theta to beta brain ratio before and after the treatment (Left side before treatment and right side after treatment)

psychotherapy (CAP), pharmacotherapy, and family interventions can be beneficial for complex cases of cocaine use disorder.

Future research should evaluate these combined treatment patterns in controlled clinical trials to confirm their efficacy, safety, and mechanisms of action. Such studies will help clarify the specific contribution of each component and guide the development of personalized, evidence-based interventions for cocaine use disorder.

Overall, integration of cognitive-analytic psychotherapy with noninvasive neuromodulation is consistent with recent international efforts to bridge neurobiological and psychotherapeutic models for treating complex psychiatric disorders.¹⁹

Authors' Contribution

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 Formal Analysis: Mahnoosh Kamranvand
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 Project Administration: Mahnoosh Kamranvand
 Resources: Mohammad Khodayarifard, Reza Rostami
 Software: Not Applicable
 Supervision: Mohammad Khodayarifard, Reza Rostami
 Validation: Mohammad Khodayarifard, Reza Rostami
 Visualization: Mahnoosh Kamranvand
 Writing – Original Draft: Mahnoosh Kamranvand
 Writing – Review & Editing: Mohammad Khodayarifard, Reza Rostami, Mahnoosh Kamranvand

Conflict of Interests

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Data Availability Statement

The data that support the findings of this study are available from the corresponding authors on responsible request.

Ethical Approval

The participant provided informed consent prior to their participation in the study. The study was conducted with the highest ethical standards, and all data were collected and analyzed anonymously to protect the privacy and confidentiality of the participant. The study was designed to minimize any potential risks to the participant and to maximize the benefits of the interventions.

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