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Research Paper

Investigating the effectiveness of repeated and intensified bifrontal transcranial direct current stimulation (tDCS) on the improvement of love trauma syndrome in romantic relationship breakup: A case report

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ABSTRACT

Objective: Experiencing stress and emotional disturbances due to ending and separating from a romantic relationship is one of the most painful events for some people. We aimed to evaluate a repetitive transcranial direct current stimulation (tDCS) protocol on a girl experiencing an unmarried relationship break-up.

Methods: We aimed to evaluate a tDCS protocol to the left dorsolateral prefrontal cortex (DLPFC) (10 sessions, 2 mA current intensity for 20 minutes, one session each day) on a girl experiencing an unmarried relationship break-up (In Iran, the year 2022). In order to evaluate the effect of this protocol, the assessment of love trauma (Love Trauma Inventory (LTI), depression (Beck Depression Inventory (BDI-II), anxiety Hamilton Anxiety Rating Scale (HAM-A), Cognitive Emotion Regulation Questionnaire (CERQ) and Positive and Negative Affect Schedule (PANAS) was done at different time intervals, before and after the intervention and follow-up.

Results: Repetitive tDCS stimulation protocol with left anodal/right cathodal DLPFC montage may effectively reduce emotional disturbances after the experience of separating from a romantic relationship and lead to improved mood.

Conclusion: In order to generalize the introduced stimulation protocol, it is necessary to investigate more in large groups of people who have experienced a romantic relationship breakup.

1. Introduction

The ending and failure of a romantic relationship are some of the saddest losses an adult experiences (Slotter et al., 2010), and romantic breakups can be accompanied by symptoms such as heartbreak and grief (Davis et al., 2003). One of the romantic separations in human relationships is the separation from non-marital romantic relationships, which are important in their own way (Van der Watt et al., 2023). Although most adults adjust after romantic breakups, some experience symptoms similar to those of grief, including intrusive thoughts, insomnia, and depression (Field, 2011). An important component related to romantic breakups is love trauma syndrome, which was first proposed by Rosse (1999). The syndrome of love trauma includes many severe symptoms and signs that appear for a long time after the failure of a romantic relationship, which disrupts a person's functioning in many fields (educational, social, or professional) and leads to incompatible reactions (Rosse, 2007). Separation in romantic relationships leads to emotional disturbances and is associated with love trauma syndromes, such as sleep disorders,

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worry, anger, conflict, discomfort, concentration problems, despair about the future (del Palacio-Gonzalez et al., 2017), negative emotions (Sbarra, 2006) and negative consequences such as suicide attempts (Donald et al., 2006). These negative effects can be seen even in the phenomenon of divorce (Ataeimehr et al., 2023; Porzoor & Ghorbani Polkoei, 2023). Considering these symptoms generally delay people's recovery and disrupt their performance (McKiernan et al., 2018), treatment and improvement of these symptoms are necessary.

Recently, the use of non-invasive brain stimulation (NIBS) techniques has shown promise in the treatment of various psychological and psychiatric problems (Hyde et al., 2022). One of the common techniques is transcranial direct current stimulation (tDCS), which is technically a more straightforward method and, therefore, potentially suitable for wider clinical use. In tDCS, a direct current of low intensity (1-2 mA) is applied to the scalp by two electrodes to modulate the activity of the cerebral cortex (Nitsche & Paulus, 2001). Anodal tDCS leads to increased neuronal excitability in the target region and promotes the mechanisms involved in long-term potentiation (LTP). In contrast, cathodal tDCS has the opposite effect and reduces neuronal excitability in that region (Callan & Perrey, 2019).

The findings suggest the potential of left frontal tDCS to attenuate negative emotional reactions to maladaptive content (Clarke et al., 2020). Several studies have shown the effectiveness of tDCS in the left DLPFC region on emotional disorders such as depression (D'Urso et al., 2022; Nejati et al., 2022; Zhou et al., 2020) and anxiety (Jafari et al., 2021; Vicario et al., 2020; Xiang et al., 2021). Also, several studies have shown that tDCS has a positive effect on reducing negative emotions (Zhang et al., 2022). The reason this region has been targeted in the above research for mood disorders is that clinical studies have shown that depressive states are often associated with dysfunctional functioning of the left DLPFC, while damage to the right DLPFC results in elevated mood (Schmitz et al., 2006).On the other hand, left DLPFC hypoactivity seems to play a key role in the pathophysiology of depression, which is sometimes associated with increased right DLPFC function (Hecht, 2010).

According to the review of studies, it can be said that the abnormal activities of DLPFC are probably related to many psychiatric diseases. Therefore, modulation of the DLPFC may have potential beneficial effects in many neurological and psychiatric disorders. Studies in this field show that the stimulatory effect of tDCS lasts up to 90 minutes (Nitsche & Paulus, 2001). On the other hand, repeated daily tDCS causes long-lasting effects (Alonzo et al., 2012). Considering that romantic relationship breakup leads to emotional disorders and emotional dysregulation, (Najib et al., 2004) showed that acute bereavement was associated with reduced activity in the anterior and left side, such as the dorsal and ventral anterior cingulate (Najib et al., 2004). Therefore, the appropriate stimulation montage "left anodal DLPFC/right cathodal DLPFC" was determined in the present study. To the best of our knowledge, this is the first study on the effect of tDCS in improving the emotional dysregulation of people with a romantic relationship breakup experience. According to the above, we aim to investigate the effects of repeated stimulation of the DLPFC (10 sessions, 2 mA for 20 min, 1 session daily) on symptoms of emotional distress and love trauma in a girl after an unmarried romantic relationship breakup.

2. Materials and Methods

Case Report

The participant in the present study was a 29-year-old girl (In Iran in 2022). She has a master's degree and is not currently employed. She was experiencing very intense emotional turmoil after a month of separation from an emotional relationship, and it was as if she had suffered a major psychological blow. She said that this was the first experience of a romantic relationship that she had experienced, and she could not bear the loss of her partner in any way. According to the participant's report, relationship variables were as follows: 1) time after separation: 38 days; 2) Length of relationship: 2 months; 3) Number of previous relationships: None; Time spent together during the relationship: 6 or 7 hours a day.

Ruminative thoughts expressed about the end of the relationship such as "I say, God, I'm tired, why did my partner do this to me", "I'm not going to meet someone like him again, and I'm not going to be loved by someone like him again". "I miss him so much", "My partner is all in front of my eyes and the places we went together", "He promised to marry me, why did everything go wrong?" The intensity of emotional disturbance was so high that it scored higher than the cut-off point in the scales of love trauma, depression and anxiety.

Evaluation of emotional disturbances and love trauma syndrome was done in three stages: 1) one week before the start of stimulation intervention with tDCS, 2) immediately after the intervention of ten stimulation sessions, and 3) follow-up after 5 weeks after the post-test. The following tools were used to evaluate love trauma syndrome and emotional disturbances:

Love Trauma Inventory (LTI): The LTI questionnaire was developed by Rosse in 1999 to measure the severity of love trauma. It consists of 10 self-report items, each with

four response choices ranging from zero to three. The total score can thus range from zero to 30, with a higher score indicating a higher intensity of love trauma. The questionnaire has a cut-off point of 20, meaning that individuals who score 20 or higher are considered to have experienced love trauma. Individuals determine the extent of mental, physical, emotional, cognitive, and behavioral damage by selecting the answer that best reflects their situation. Cronbach's alpha for this inventory is 0.81, indicating good reliability. The test-retest reliability coefficient, which measures consistency over time, is reported as 0.83 when assessed after one week (Rosse, 2007).

Beck Depression Inventory II (BDI-II): The BDI-II (Beck et al., 1996) is a 21-item self-report inventory about how the subject has felt in the last two weeks. The internal correlation coefficient of the BDI-II is between 0.7- 0.92, and the test-retest reliability coefficient is 0.93 for a one-week interval (Beck et al., 1988). A native language version of the BDI-II with adequate psychometric properties was used in this study (Ghassemzadeh et al., 2005). A score of 20–28 and higher in the BDI-II is indicative of moderate to severe depression. A Cronbach's alpha of 0.94 is reported for the Persian language version of the BDI-II (Alipoor & Nori, 2006).

Hamilton Anxiety Rating Scale (HAM-A): HAM-A is a 14-item measure that assesses different psychological and somatic symptoms associated with anxiety. Interviewers rated the scale from 0 to 4. Internal consistency of the HAM-A was high in both MDE (α = 0.83) and no MDE (α = 0.83) groups (Hamilton, 1959).

Cognitive Emotion Regulation Questionnaire (CERQ): CERQ is a 36-item self-report measure designed to assess individual differences in cognitive regulation of emotions in response to stressful, threatening or traumatic life events. The instrument assesses nine 4-item dimensions: Self-blame, Blaming others, Acceptance, Refocusing on planning, Positive refocusing, Rumination, Positive reappraisal, Putting into perspective, and Catastrophizing. Responses are given on a 5-point Likert scale ranging from 1 "(almost) never" to "(almost) always." Therefore, subscale scores can range from 4 to 20, with higher subscale scores indicating greater frequency of use of the specific cognitive strategy (Garnefski et al., 2001).

Positive and Negative Affect Schedule (PANAS): This questionnaire was used to evaluate affect (Watson et al., 1988). This questionnaire contains 20 items, divided into two parts of 10 items, each related to positive or negative effects. The participants scored each statement from 1 (very slightly) to 5 (very much). A score between 10 and 50 is obtained from the sum of the items, which indicates the amount of positive and negative effects separately. Cronbach´s alpha coefficient scores range from 0.86 to 0.90 for the Positive Affect Scale and 0.84 to 0.87 for the Negative Affect Scale (Magyar-Moe, 2009). The participant answered these questions in three stages of the research. Also, after each stimulation session, she filled in the side effects questionnaire.

Before starting the intervention, the overall objective was fully explained. She was evaluated for using tDCS based on inclusion/exclusion criteria such as no previous history of neurological diseases, brain surgery, epilepsy, seizures, brain injury, head injury or metal brain implants. She signed a written informed consent for tDCS treatment. The treatment consisted of ten repeated stimulation sessions using a left anodal DLPFC/right cathodal DLPFC montage (one session per day, 2 mA for 20 minutes). The current was delivered through a tDCS electrical brain stimulation device (Oasis Pro model manufactured by Mind Alive, Canada) using a pair of saline-soaked sponge electrodes (5 x 7 cm). You can see the study protocol in Figure (1).

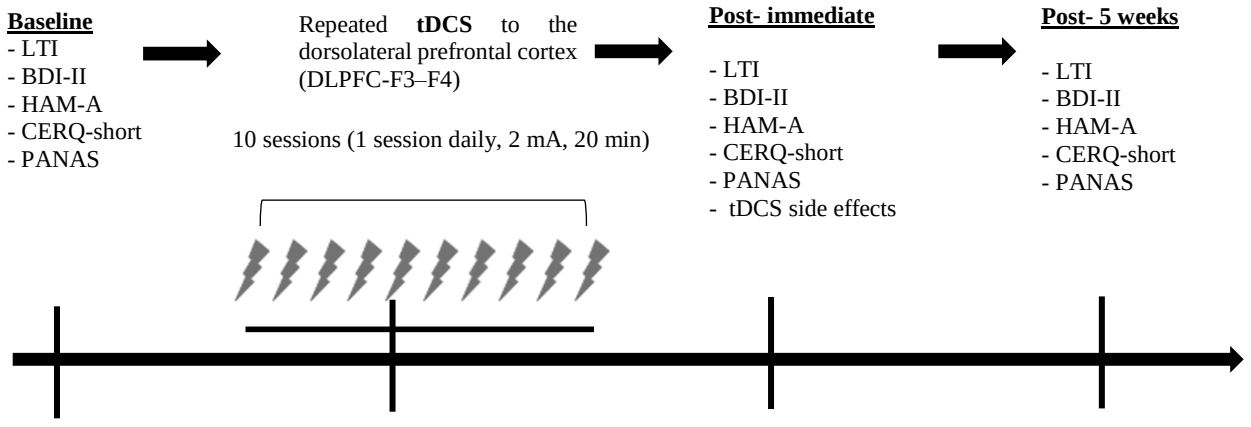

Figure 1. Study protocol

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3. Results

The evaluation results of love trauma syndrome and emotional disturbances (depression, anxiety, cognitive emotion regulation, positive and negative affect) are reported in Table 1 and Figure 2. In the baseline stage, the participant scored (24) higher than the cut-off point (20) in the love trauma variable, which indicates a high level of trauma. After the intervention and in the follow-up phase, we saw a significant decrease in the love trauma score, so the percentage of changes from pre-test to post-test was -25.00% and from pre-test to follow-up -33.33%.

The level of depression in the baseline phase (34) showed the severity of depression in the participant. However, after intervention (19) and follow-up (15), a significant improvement in depression symptoms was observed. The percentage of changes from the pre-test to the post-test was -44.11%, and from the pre-test to the follow-up was -55.88%. Also, in anxiety, we saw a significant improvement from baseline (34) to post-test (22) and follow-up (24), so that the percentage of changes from pre-test to post-test was -35.29% and from pre-test to follow-up - 29.41% was obtained.

In the variable of cognitive emotion regulation, we saw positive changes in all 9 components, similar to other variables, after the intervention. Finally, in the positive and negative affect variable, the results showed that positive affect scores improved from baseline (20) to post-test (29) and follow-up (26), and negative affect scores improved from baseline (38) to post-test (25) and follow-up (28) had a significant decrease.

The participant answered the side effects questionnaire after each tDCS session. The report showed that she tolerated the stimulation well and had no serious complications.

Table 1. Love trauma syndrome and emotional disturbances symptoms evaluations one week before intervention (baseline), immediately after the end of the stimulation sessions, and after 5 weeks of the post-test stage (follow-up)

Measure	Variable	Cut-off	Time			Percentage of changes (%)	
			Pre (M)	Post-immediate (M)	Post-5 weeks (M)	Pre to Post-immediate	Pre to Post-5 weeks
LTI	love trauma syndrome	0 – 30: total score ranges 20 – 30: extreme 10 – 19: moderate 0 – 9: Controllable and bearable	24	18	16	-25.00	-33.33
BDI-II	Depression	0–13= minimal range, 14–19= mild 20–28 = moderate 29–63= severe	34	19	15	-44.11	-55.88
HAM-A	Anxiety	mild anxiety = 8-14 moderate = 15-23 severe ≥ 24	34	22	24	-35.29	-29.41
CERQ	Self-blame	-	8	5	5	-37.50	-37.50
	Acceptance		4	7	6	75.00	50.00
	Rumination		10	4	5	-60.00	-50.00
	Positive Refocusing		4	6	6	33.33	33.33
	Planning		5	9	8	80.00	60.00
	Positive Reappraisal		4	7	6	75.00	50.00
	Perspective		3	3	6	0	100.00
	Catastrophizing		8	4	3	-50.00	-62.50
	Other-blame		4	3	2	-25.00	-50.00
PANAS	Negative Affect	-	38	25	28	-34.12	-26.31
	Positive Affect		20	29	26	45.00	30.00

Note: M = Mean; LTI = Love Trauma Inventory; BDI-II= Beck Depression Inventory II; HAM-A= Hamilton Anxiety Rating Scale; CERQ = Cognitive Emotion Regulation Questionnaire; PANAS= Positive and Negative Affect Schedule

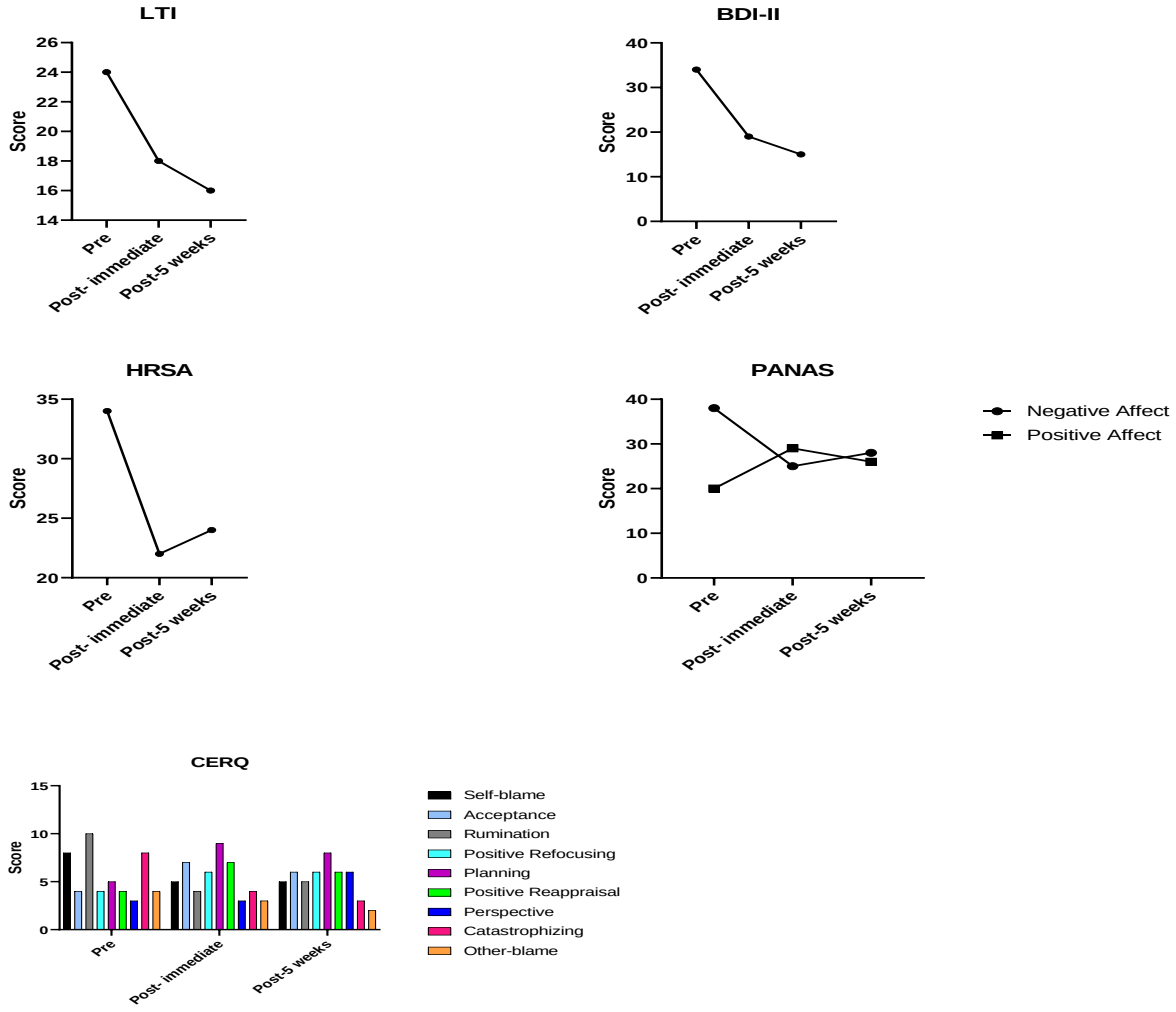

Figure 2. The impact of repeated tDCS over the left DLPFC on love trauma syndrome and emotional disturbances symptoms

4. Discussion and Conclusion

In this study, we aim to investigate the effects of repeated stimulation of the DLPFC (10 sessions, 2 mA for 20 min, 1 session daily) on symptoms of emotional distress and love trauma in a girl after an unmarried romantic relationship breakup. To the best of our knowledge, this is the first study to investigate the effect of a repeated tDCS protocol in an unmarried romantic relationship breakup. At different stages of the intervention, we observed that the proposed tDCS protocol, including ten repeated sessions once a day, led to a significant improvement in love trauma syndrome, emotional distress and emotional regulation of the participant.

The results of the present study are consistent with the results of previous studies that anodal TDCS of the DLPFC have shown promising results as a treatment for emotional disorders such as depression (D'Urso et al., 2022; Nejati et al., 2022; Zhou et al., 2020), anxiety (Jafari et al., 2021; Vicario et al., 2020; Xiang et al., 2021) and emotional dysregulation (Alizadehgoradel, 2021; Alizadehgoradel et al., 2020; Salehinejad et al., 2017; Zemestani et al., 2022; Zhang et al., 2022).

Among other frontal regions, the dorsolateral prefrontal cortex (DLPFC) has been proposed as the center of the emotion regulation system (Morawetz et al., 2016). The DLPFC plays an important role in emotion regulation through top-down modulation of amygdala activity (Luo et al., 2018). For this reason, increasing neural activity in the left DLPFC and its associated frontal-limbic network using non-invasive brain stimulation techniques, such as tDCS, has been shown to have beneficial effects on emotional reactivity and emotional regulation processes in healthy individuals (Vanderhasselt et al., 2013). In the studies conducted in this field, the application of anal tDCS on the left DLPFC led to a decrease in emotional response to negative stimuli (Brunoni et al., 2013) and a decrease in ruminative thinking after an experimental stressor (De Raedt et al., 2017). In other words, in people who suffer

from emotional disorders such as depression, the left dorsolateral prefrontal cortex (DLPFC) is less active, while the activity of the right DLPFC increases; tDCS corrects this pathological excitability and improves mood and gets used to (Nitsche et al., 2012). According to the above, and since a romantic relationship breakup leads to emotional disorder and dysregulation, the findings of our research can be explained.

Another stimulation parameter that was investigated in the present study was the use of repeated daily stimulation. tDCS treatment at higher doses and increasing the total number of stimulations has promising effects, and there is growing evidence that tDCS has a dose-dependent effect (Palm et al., 2015). For example, the results of Alonzo et al. (2012) demonstrate that daily tDCS produces a greater increase in cortical excitability (Alonzo et al., 2012). Therefore, another innovative aspect of the current research is testing the parameter of repetitive daily electrical stimulation in improving emotional disorders of romantic relationship breakups.

The results of this case study show that the repeated tDCS protocol (10 sessions, 2 mA for 20 min, 1 session daily) on the left DLPFC is a safe and promising treatment option for improving symptoms of emotional distress, love trauma and emotional dysregulation in people with the experience of a romantic relationship breakup, which is worth further study and investigation in large randomized controlled trials. However, like any case study, this study has major limitations. The absence of sham control conditions and the patient not being blinded to the treatment method makes it difficult to draw definitive conclusions from the present study. Therefore, it is suggested that future researchers conduct complete experimental work on a larger number of people who have experienced a romantic relationship breakup of this proposed intervention to generalize the results better. This research was conducted in Iranian culture, so its generalization to other countries is limited.

Data availability: The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

5. Ethical Considerations

Compliance with ethical guidelines

This article considered all ethical principles. The participants were informed about the research objective and its implementation phases. They were also assured about the confidentiality of their information and allowed to leave the study whenever they wished. Moreover, the research results would be available if they desired.

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Authors' contributions

All authors have participated in the design, implementation, and writing of all sections of the present study.

Conflicts of interest

The authors have no conflicts of interest.

References:

Alipoor, A., & Nori, N. (2006). A study on reliability and validity of the Depression-Happiness Scale in justice's staff of Isfahan city. *Journal of fundamentals of mental health*, *8*(32), 85-96. Doi:10.22038/JFMH.2006.1807

Alizadehgoradel, J. (2021). The effects of combined transcranial direct current stimulation (tDCS) with mindfulness on negative emotions and craving in adolescents with methamphetamine dependence. International Journal of High Risk Behaviors and Addiction, 10(1). Doi:10.5812/ijhrba.100909

Alizadehgoradel, J., Nejati, V., Movahed, F. S., Imani, S., Taherifard, M., Mosayebi-Samani, M., Vicario, C. M., Nitsche, M. A., & Salehinejad, M. A. (2020). Repeated stimulation of the dorsolateral-prefrontal cortex improves executive dysfunctions and craving in drug addiction: A randomized, double-blind, parallel-group study. Brain Stimulation, 13(3), 582-593. Doi:10.1016/j.brs.2019.12.028

Alonzo, A., Brassil, J., Taylor, J. L., Martin, D., & Loo, C. K. (2012). Daily transcranial direct current stimulation (tDCS) leads to greater increases in cortical excitability than second daily transcranial direct current stimulation. Brain Stimulation, 5(3), 208-213. Doi:10.1016/j.brs.2011.04.006

Ataeimehr, N., Babakhani, V., Alijani, F., & Pouyamanesh, J. (2023). Comparing the Effectiveness of Emotionally Focused Couple Therapy and Self-Regulation Couple Therapy in Ego Strength in Couples on the Verge of Divorce. Journal of Family Relations Studies, 3(10), 17-25. Doi:10.22098/JHRS.2022.11640.1072

Beck, A. T., Epstein, N., Brown, G., & Steer, R. A. (1988). An inventory for measuring clinical anxiety: psychometric properties. Journal of consulting and clinical psychology, 56(6), 893. Doi:10.1037/0022-006X.56.6.893

Brunoni, A. R., Vanderhasselt, M.-A., Boggio, P. S., Fregni, F., Dantas, E. M., Mill, J. G., Lotufo, P. A., & Benseñor, I. M. (2013). Polarity-and valence-dependent effects of prefrontal transcranial direct current stimulation on heart rate variability and salivary cortisol. Psychoneuroendocrinology, 38(1), 58-66. Doi:10.1016/j.psyneuen.2012.04.020

Callan, D., & Perrey, S. (2019). The use of tDCS and rTMS methods in neuroergonomics. In Neuroergonomics (pp. 31-33). Elsevier. Doi:10.1016/B978-0-12-811926-6.00005-1

Clarke, P. J., Van Bockstaele, B., Marinovic, W., Howell, J. A., Boyes, M. E., & Notebaert, L. (2020). The effects of left DLPFC tDCS on emotion regulation, biased attention, and emotional reactivity to negative content. Cognitive, Affective, & Behavioral Neuroscience, 20, 1323-1335. Doi:10.3758/s13415-020-00840-2

D'Urso, G., Dini, M., Bonato, M., Gallucci, S., Parazzini, M., Maiorana, N., Bortolomasi, M., Priori, A., & Ferrucci, R. (2022). Simultaneous bilateral frontal and bilateral cerebellar transcranial direct current stimulation in treatment-resistant depression—clinical effects and electrical field modelling of a novel electrodes montage. Biomedicines, 10(7), 1681. Doi:10.3390/biomedicines10071681

Davis, D., Shaver, P. R., & Vernon, M. L. (2003). Physical, emotional, and behavioral reactions to breaking up: The roles of gender, age, emotional involvement, and attachment style. Personality and social psychology bulletin, 29(7), 871-884. Doi: 10.1177/0146167203029007006

De Raedt, R., Remue, J., Loeys, T., Hooley, J. M., & Baeken, C. (2017). The effect of transcranial direct current stimulation of the prefrontal cortex on implicit self-esteem is mediated by rumination after criticism. Behaviour Research and Therapy, 99, 138-146. Doi:10.1016/j.brat.2017.10.009

del Palacio-Gonzalez, A., Clark, D. A., & O'Sullivan, L. F. (2017). Distress severity following a romantic breakup is associated with positive relationship memories among emerging adults. Emerging Adulthood, 5(4), 259-267. Doi:10.1177/2167696817704117

Donald, M., Dower, J., Correa-Velez, I., & Jones, M. (2006). Risk and protective factors for medically serious suicide attempts: a comparison of hospital-based with population-based samples of young adults. Australian & New Zealand Journal of Psychiatry, 40(1), 87-96. Doi:10.1080/j.1440-1614.2006.01747.x

Field, T. (2011). Romantic breakups, heartbreak and bereavement—Romantic breakups. Psychology, 2(04), 382. Doi:10.4236/psych.2011.24060

Garnefski, N., Kraaij, V., & Spinhoven, P. (2001). Negative life events, cognitive emotion regulation and emotional problems. Personality and Individual Differences, 30(8), 1311-1327. Doi:10.1016/S0191-8869(00)00113-6

Ghassemzadeh, H., Mojtabai, R., Karamghadiri, N., & Ebrahimkhani, N. (2005). Psychometric properties of a Persian-language version of the Beck Depression Inventory-Second edition: BDI-II-PERSIAN. Depression and anxiety, 21(4), 185-192. Doi:10.1002/da.20070

Hamilton, M. (1959). The assessment of anxiety states by rating. British journal of medical psychology. Doi:10.1111/j.2044-8341.1959.tb00467.x

Hecht, D. (2010). Depression and the hyperactive right-hemisphere. Neuroscience research, 68(2), 77-87. Doi:10.1016/j.neures.2010.06.013

Hyde, J., Carr, H., Kelley, N., Seneviratne, R., Reed, C., Parlatini, V., Garner, M., Solmi, M., Rosson, S., & Cortese, S. (2022). Efficacy of neurostimulation across mental disorders: systematic review and meta-analysis of 208 randomized controlled trials. Molecular Psychiatry, 27(6), 2709-2719. Doi:10.1038/s41380-022-01524-8

Jafari, E., Alizadehgoradel, J., Koluri, F. P., Nikoozadehkordmirza, E., Refahi, M., Taherifard, M., Nejati, V., Hallajian, A.-H., Ghanavati, E., & Vicario, C. M. (2021). Intensified electrical stimulation targeting lateral and medial prefrontal cortices for the treatment of social anxiety disorder: A randomized, double-blind, parallel-group, dose-comparison study. Brain Stimulation, 14(4), 974-986. Doi:10.1016/j.brs.2021.06.005

Luo, Y., Fernández, G., Hermans, E., Vogel, S., Zhang, Y., Li, H., & Klumpers, F. (2018). How acute stress may enhance subsequent memory for threat stimuli outside the focus of attention: DLPFC-amygdala decoupling. NeuroImage, 171, 311-322. Doi:10.1016/j.neuroimage.2018.01.010

Magyar-Moe, J. L. (2009). Therapist's guide to positive psychological interventions. Academic press.

McKiernan, A., Ryan, P., McMahon, E., Bradley, S., & Butler, E. (2018). Understanding young people's relationship breakups using the dual processing model of coping and bereavement. Journal of Loss and Trauma, 23(3), 192-210. Doi:10.1080/15325024.2018.1426979

Morawetz, C., Bode, S., Baudewig, J., Kirilina, E., & Heekeren, H. R. (2016). Changes in effective connectivity between dorsal and ventral prefrontal regions moderate emotion regulation. Cerebral Cortex, 26(5), 1923-1937. Doi:10.1093/cercor/bhv005

Najib, A., Lorberbaum, J. P., Kose, S., Bohning, D. E., & George, M. S. (2004). Regional brain activity in women grieving a romantic relationship breakup. American Journal of Psychiatry, 161(12), 2245-2256. Doi:10.1176/appi.ajp.161.12.2245

Nejati, V., Majidinezhad, M., & Nitsche, M. (2022). The role of the dorsolateral and ventromedial prefrontal cortex in emotion regulation in females with major depressive disorder (MDD): A tDCS study. Journal of Psychiatric Research, 148, 149-158. Doi:10.1016/j.jpsychires.2022.01.030

Nitsche, M. A., Koschack, J., Pohlers, H., Hullemann, S., Paulus, W., & Happe, S. (2012). Effects of frontal transcranial direct current stimulation on emotional state and processing in healthy humans. Frontiers in psychiatry, 3, 58. Doi:10.3389/fpsyt.2012.00058

Nitsche, M. A., & Paulus, W. (2001). Sustained excitability elevations induced by transcranial DC motor cortex stimulation in humans. Neurology, 57(10), 1899-1901. Doi:10.1212/WNL.57.10.1899GET ACCESS

Palm, U., Leitner, B., Strube, W., Hasan, A., & Padberg, F. (2015). Safety of repeated twice-daily 30 minutes of 2 mA tDCS in depressed patients. Doi:10.9734/INDJ/2015/19719

Porzoor, P., & Ghorbani Polkoei, H. (2023). The role of self-compassion, patience and optimism with an attitude towards Islamic sources in predicting the tendency of couples to divorce. Journal of Family Relations Studies, 3(10), 37-43. Doi:10.22098/JFRS.2023.12302.1103

Rosse, R. B. (2007). The love trauma syndrome: free yourself from the pain of a broken heart. Da Capo Lifelong Books. https://www.google.com/books/edition/

Salehinejad, M. A., Ghanavai, E., Rostami, R., & Nejati, V. (2017). Cognitive control dysfunction in emotion dysregulation and psychopathology of major depression (MD): Evidence from transcranial brain stimulation of the dorsolateral prefrontal cortex (DLPFC). Journal of affective disorders, 210, 241-248. Doi:10.1016/j.jad.2016.12.036

Sbarra, D. A. (2006). Predicting the onset of emotional recovery following nonmarital relationship dissolution: Survival analyses of sadness and anger. Personality and social psychology bulletin, 32(3), 298-312. Doi:10.1177/0146167205280913

Schmitz, T. W., Rowley, H. A., Kawahara, T. N., & Johnson, S. C. (2006). Neural correlates of self-evaluative accuracy after traumatic brain injury. Neuropsychologia, 44(5), 762-773. Doi:10.1016/j.neuropsychologia.2005.07.012

Slotter, E. B., Gardner, W. L., & Finkel, E. J. (2010). Who am I without you? The influence of romantic breakup on the self-concept. Personality and social psychology bulletin, 36(2), 147-160. Doi:10.1177/0146167209352250

Van der Watt, A. S. J., Kidd, M., Roos, A., Lesch, E., & Seedat, S. (2023). Romantic relationship dissolutions are significantly associated with posttraumatic stress symptoms as compared to a DSM-5 Criterion A event: a case-case–control comparison. European Journal of Psychotraumatology, 14(2), 2238585. Doi:10.1080/20008066.2023.2238585

Vanderhasselt, M.-A., Brunoni, A. R., Loeys, T., Boggio, P. S., & De Raedt, R. (2013). Nosce te ipsum–Socrates revisited? Controlling momentary ruminative self-referent thoughts by neuromodulation of emotional working memory. Neuropsychologia, 51(13), 2581-2589. Doi:10.1016/j.neuropsychologia.2013.08.011

Vicario, C. M., Salehinejad, M. A., Avenanti, A., & Nitsche, M. A. (2020). Transcranial direct current stimulation (tDCS) in anxiety disorders. Non invasive brain stimulation in psychiatry and clinical neurosciences, 301-317. Doi:10.1007/978-3-030-43356-7_21

Xiang, S., Qi, S., Li, Y., Wang, L., Dai, D. Y., & Hu, W. (2021). Trait anxiety moderates the effects of tDCS over the dorsolateral prefrontal cortex (DLPFC) on creativity. Personality and Individual Differences, 177, 110804. Doi:10.1016/j.paid.2021.110804

Zemestani, M., Hoseinpanahi, O., Salehinejad, M. A., & Nitsche, M. A. (2022). The impact of prefrontal transcranial direct current stimulation (tDCS) on theory of mind, emotion regulation and emotional-behavioral functions in children with autism disorder: A randomized, sham-controlled, and parallel-group study. Autism Research, 15(10), 1985-2003. Doi:10.1002/aur.2803

Zhang, Q., Li, X., Liu, X., Liu, S., Zhang, M., Liu, Y., Zhu, C., & Wang, K. (2022). The effect of non-invasive brain stimulation on the downregulation of negative emotions: a meta-analysis. Brain Sciences, 12(6), 786. Doi:10.3390/brainsci12060786

Zhou, Q., Yu, C., Yu, H., Zhang, Y., Liu, Z., Hu, Z., Yuan, T.-F., & Zhou, D. (2020). The effects of repeated transcranial direct current stimulation on sleep quality and depression symptoms in patients with major depression and insomnia. Sleep medicine, 70, 17-26. Doi:10.1016/j.sleep.2020.02.003