



## Comparing the Effectiveness of Neurofeedback Exercises with Mindfulness-Based Cognitive Therapy on Rumination and Negative Automatic Thoughts of Adults with Major Depressive Disorder.

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### Abstract

This study aimed to compare the effectiveness of neurofeedback exercises with mindfulness-based cognitive therapy on rumination and negative automatic thoughts of adults with major depressive disorder. It was a semi-experimental design with pre-test and post-test with the control group and random assignment. The research statistical population included all those who were referred to Rahnamon Counseling and psychological services center (from the 10th of January 2021 to the 10th of May 2022). The sampling was purposeful and 45 people who got the highest score on the Beck depression questionnaire (1961) were selected as a sample. Then, by random assignment, 15 people were assigned to experimental group A (related to neurofeedback exercises), 15 people to experimental group B (related to mindfulness-based cognitive therapy), and 15 people to group C (control). Experimental group A received neurofeedback intervention for 16 sessions and experimental group B received mindfulness-based cognitive therapy for 8 sessions but group C (control) did not receive any intervention. In addition, Nolen Hoeksema and Morrow's (1991) [rumination](#) questionnaire, Hollon and Kendall's (1980) negative automatic thoughts questionnaire, were used in the pre-test and post-test stages. Finally, the data were analyzed using univariate analysis of covariance and post hoc Bonferroni test. The results showed that neurofeedback and mindfulness-based cognitive therapy have an effect on rumination and negative automatic thoughts of adults with major depressive disorder. In addition, there is no difference between the effectiveness of neurofeedback exercises and mindfulness-based cognitive therapy on rumination and negative automatic thoughts of adults.

**Keywords:** Neurofeedback exercises, Mindfulness-based cognitive therapy, Rumination, Negative automatic thoughts, depression

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### Introduction

Major depressive disorder is one of the mental disorders that has the highest lifetime prevalence (about 17%) among mental disorders (Sadock 2015). The depressive disorder involves periods of symptoms in which a person usually experiences an extremely sad mood. The essential element of this disorder is a very high sad mood called boredom (Halgin&Whitbourne, 2013). Major depression is a common problem and accounts for 35-45% of mental illnesses in Iran and usually covers about 8-20% of the population (Pak-Tinatan; Chin-Aveh and Feridouni, 2022). Major depressive disorder

belongs to the category of emotional disorders, which is considered a chronic, debilitating, and recurring problem (Kesler et al., 2011; quoted by Watkins, 2016).

In recent years, researchers have focused on thinking patterns in emotional disorders and unwanted thoughts and their role in the persistence of emotional disorders. One of the types of unwanted thoughts in emotional disorders is rumination. The metacognitive perspective of emotional disorders considers rumination as one of the main components in the beginning and continuation of depression



(Szabo, Warnecke, Newton & Valentine, 2017).

Rumination is defined as persistent and recurring thoughts that revolve around a common topic. These thoughts involuntarily enter the consciousness and divert attention from the desired topics and current goals (Jorman, 2016). This type of thinking is observed in some emotional disorders such as depression, obsessive-compulsive disorder, generalized anxiety disorder, and post-traumatic stress disorder (Jabo et al., 2017). Rumination causes abnormalities in the cognitive base of depressed patients and is related to poor psychological adjustment and increase negative emotions such as anger and psychological stress (Jorman, 2016).

The results showed a positive relationship between rumination and negative automatic thoughts (DuPre&Spreng, 2018). Negative recurring thoughts generally play a significant role in the development and persistence of mood and anxiety disorders (Topper, Emmelkamp&Ehring, 2020). Ehring, Tuschen-Caffier, Schnulle, Fischer & Gross (2020) found that negative automatic thoughts are one of the effective factors in depression. In addition, the research results of Gao, Chen, Biswal, Lei & Yuan (2019) showed a positive relationship between negative automatic thoughts and negative cognitive processes and depression in children. Negative automatic thoughts play an important role in physical and verbal aggression, which may cause difficulties by affecting the behavioral and cognitive process.

Researchers have suggested different solutions for patients with major depression, among which neurofeedback or Electroencephalography biofeedback training can be mentioned (Eskandari, Tarmian, Nazari, Bakhtiari, Mumtazi, Rezaei, 2014). Neurofeedback tries to teach self-regulation by recording electrical responses and providing feedback to the subject. Neurofeedback helps the brain to regulate itself and eliminate its functional defects (Moin, AsadiGandomani, Amiri, 2018).

Mindfulness-based cognitive therapy is another treatment used in patients with major depression. Mindfulness-based interventions are one of the third-generation or third-wave cognitive-behavioral treatments. Mindfulness is a type of meditation that originates in Eastern religious teachings and rituals, especially Buddhism (Mac Kenzie, Abbott&Kocovski, 2018).

In recent years, the costs of psychiatric care have dramatically grown in different countries. The controlled care approach that has been formed in recent decades in the field of psychiatric services in developed countries aims to reduce treatment costs. Therefore, researchers carry out comparative studies to choose the most efficient and least costly treatment among various treatments. Sometimes this issue indicates that combining different treatment methods is more effective than each treatment method alone. Based on this, the present study aims to compare the effectiveness of neurofeedback exercises with mindfulness-based cognitive therapy on rumination and negative automatic thoughts of adults with major depressive disorder.

### Research Methodology

The current research is a part of applied research in terms of its purpose, and it is a semi-experimental research with pre-test-post-test design with a control group in terms of the researcher's control over research variables. The research statistical population included all the people who were referred to the counseling and psychological services center of Rahnamon (from the 10th of Bahman 2021 to the 10th of June 2022).

Among the people who were referred to Rahnamon Counseling and Psychological Services Center during four months (from the 30th of January 2021 to the 31st of May 2022), the people who get the highest score in the research tool (Beck Depression Questionnaire (1961)) have been identified using purposeful sampling. Then, 45 people were selected as sample people based on the criteria for entering and exiting the research. Then, by random assignment, 15 people were assigned to experimental group A (related to neurofeedback exercises), 15 people to experimental group B (related to mindfulness-based cognitive therapy), and 15 people to group C (control). The inclusion criteria include having willingness and interest in participating in the study, having a score of at least 30 on the Beck Depression Inventory (1961), having the ability to share information and experiences, and not having a history of physical disorder that involves mental effort. Exit criteria include absence of more than 2 meetings, lack of active participation in meetings and not doing homework, and unwillingness to continue participating in



meetings.

## Research tools

### 1. Beck Depression Inventory 2 (BDI-II)

The Beck Depression Inventory was first introduced in 1961 by Aaron T. Beck et al. and was revised in 1971. Based on the obtained scores, each person can be placed in one of the depression classes. Each question has 0 to 3 points and a higher score indicates the severity of depression. The total score of the questionnaire is between 0 and 63. Depression is evaluated based on the total score. Its validity and reliability were 76% and 79%, respectively in Kaviani et al.'s research (2002). This questionnaire reported 0.78 reliability, 0.84 validity, and 0.83 internal consistency in an adult sample, as well as a 0.80 reliability coefficient for a sample of Iranian teenagers. (Khosravi, Mehrabi, AziziMoghadam, 2008).

### 2. Nolen Hoeksema and Morrow (1991) rumination response scale - (RRS)

It is a 22-question questionnaire that was designed and implemented to check the level of rumination of people. This questionnaire has 22 questions and 3 components, which are: "Reflection", thinking, and depression. The range of scores in this test is from 22 to 88, and the total rumination score is calculated by the sum of all items. Treynor, Gonzalez & Nolen-Hoeksema (2003) have reported the alpha coefficient of this scale as 0.90 and the test-retest reliability as 0.67, and Cronbach's alpha of this scale was 0.89. The Cronbach's alpha obtained in the Iranian sample is reported to be 0.90 (Kaviani, Javaheri, and Bahirai, 2005).

### 3. Hollon and Kendall's negative automatic thoughts questionnaire (1980) - (ATQ)

The negative automatic thoughts questionnaire was designed and validated by Hollon and Kendall (1980). This questionnaire includes 30 questions and 4 components of individual incompatibility and desire to change, negative self-concepts and expectations, low self-esteem, and helplessness. This questionnaire was validated by Kavian Far. et

al. (2017).

The opinions of the supervisor and several other professors and experts were used to obtain the validity of the questionnaire. They were asked about the relevance of the questions, the clarity, and comprehensibility of the questions, and whether these questions were appropriate for and assessed the research questions. In addition, the reliability of this questionnaire was 0.93 in the study of Kavianfar et al. (2016), which indicates the appropriate reliability of this tool. In addition, the reliability of this questionnaire in Hollon and Kendall's research (1980) was 0.79.

In this research, a neurofeedback system was used for therapeutic intervention for experimental group A. The participants in this study were studied individually and for about 3 months in 16 sessions of 55 minutes through the neurofeedback device. In this research, the Iranian BIOLINE 12-channel device was used, which can be implemented with a computer system and related software. During neurofeedback training, sensors are placed on a person's scalp and then connected to sensitive electronic components and computer software that detects, amplifies, and records specific brain activities. The resulting information is immediately fed back to the learner. Changes in the feedback signal indicate whether the learner's brain activity is within the specified range or not. In addition, a group intervention of mindfulness-based cognitive therapy was used for experimental group B, which was conducted during 8 group sessions and once a week.

This research project was registered with the ethics code number IR.IAU.SARI.REC.1401.139 on 8/22/2022, Islamic Azad University, Sari branch. Spss version 24 software is also used for data analysis.

## Findings

Descriptive findings of the research variables by control and experimental groups in the pre-test and post-test phases are presented in Table(1)

Table 1: Mean and standard deviation of research variables

| Group | Stages | Variable | Number | The lowest score | The highest score | Average | Standard deviation |
|-------|--------|----------|--------|------------------|-------------------|---------|--------------------|
|-------|--------|----------|--------|------------------|-------------------|---------|--------------------|



|  |           |                             |    |    |     |       |        |
|--|-----------|-----------------------------|----|----|-----|-------|--------|
| Control  | pre-test  | Rumination                  | 15 | 47 | 67  | 54.20 | 5.685  |
|  |           | Negative automatic thoughts | 15 | 69 | 97  | 85.53 | 7.482  |
|  | post-test | Rumination                  | 15 | 41 | 69  | 54.40 | 8.542  |
|  |           | Negative automatic thoughts | 15 | 66 | 102 | 85.20 | 9.458  |
| Experiment (neurofeedback exercises)             | pre-test  | Rumination                  | 15 | 44 | 68  | 55.73 | 7.206  |
|  |           | Negative automatic thoughts | 15 | 66 | 101 | 84.20 | 9.237  |
|  | post-test | Rumination                  | 15 | 35 | 65  | 44.87 | 8.408  |
|  |           | Negative automatic thoughts | 15 | 57 | 88  | 70.40 | 9.664  |
| Experiment (Mindfulness-Based Cognitive Therapy) | pre-test  | Rumination                  | 15 | 50 | 65  | 57.27 | 4.773  |
|  |           | Negative automatic thoughts | 15 | 61 | 111 | 87.80 | 11.118 |
|  | post-test | Rumination                  | 15 | 36 | 56  | 44.53 | 070. 7 |
|  |           | Negative automatic thoughts | 15 | 63 | 87  | 73.33 | 7.148  |

Descriptive results (averages) in Table (1) show that the scores of the research variables in the experimental groups have changed in the post-

test compared to the pre-test but no noticeable changes are observed in the control group.

Table 2: Multiple statistics of covariance analysis of rumination in the pre-test

| Source                | the sum of squares | degrees of freedom | the mean of the squares | F      | significance level | Eta coefficient | statistical power |
|-----------------------|--------------------|--------------------|-------------------------|--------|--------------------|-----------------|-------------------|
| Modified model        | 714.119            | 2                  | 357.060                 | 4.872  | 0.016              | 0.265           | 1                 |
| Intervention          | 1333.239           | 1                  | 1330.239                | 18.150 | 0.000              | 0.402           | 1                 |
| Rumination (pre-test) | 32.486             | 1                  | 32.486                  | 0.443  | 0.511              | 0.016           | 1                 |
| Group                 | 636.215            | 1                  | 636.215                 | 8.681  | 0.007              | 0.243           | 1                 |
| Error                 | 1978.848           | 27                 | 73.291                  |        |                    |                 |                   |
| Total                 | 76597              | 30                 |                         |        |                    |                 |                   |

According to Table (2) based on the results of univariate analysis of covariance (ANCOVA), (sig<0.05, F=8.681) was obtained for rumination score. The significance level of dependent variables in the results of univariate covariance

analysis is smaller than 0.05. Therefore, neurofeedback exercises affect the rumination of adults with major depressive disorder. In addition, the effect size (eta) in the post-test stage in rumination equals (0.243), which means



24.3% of post-test score changes in rumination were related to neurofeedback exercises. The statistical power of 1 indicates the adequacy of the sample size.

Table 3: Multiple statistics of covariance analysis of negative automatic spontaneous thoughts in the pre-test

| Source                                 | The sum of the squares | Degree of freedom | The mean of the squares | F      | Significance level | Eta coefficient |
|--|------------------------|-------------------|-------------------------|--------|--------------------|-----------------|
| Modified model                         | 1662.860               | 2                 | 831.430                 | 8.838  | 0.001              | 0.396           |
| Intervention                           | 1305.302               | 1                 | 1305.302                | 13.876 | 0.000              | 0.339           |
| Negative automatic thoughts (pre-test) | 20.060                 | 1                 | 20.060                  | 0.213  | 0.648              | 0.008           |
| Group                                  | 1602.327               | 1                 | 1602.327                | 17.033 | 0.000              | 0.387           |
| Error                                  | 2539.940               | 27                | 94.072                  |        |                    |                 |
| Total                                  | 185788                 | 30                |                         |        |                    |                 |

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According to Table (3) based on the results of univariate analysis of covariance (ANCOVA), ( $\text{sig} < 0.05$ ,  $F = 17.033$ ) was found for the score of negative automatic thoughts. The significance level of dependent variables in the results of univariate covariance analysis is smaller than 0.05. Therefore, neurofeedback exercises affect

the negative automatic thoughts of adults with major depressive disorder. In addition, the effect size (eta) in the post-test stage in negative automatic thoughts equals (0.387), which means 38.7% of post-test score changes in negative automatic thoughts were related to neurofeedback exercises.

Table 4: Multiple analysis of covariance analysis of post-test rumination

| Source                | The sum of the squares | Degree of freedom | The mean of the squares | F      | Significance level | Eta coefficient |
|-----------------------|------------------------|-------------------|-------------------------|--------|--------------------|-----------------|
| Modified model        | 893.826                | 2                 | 446.913                 | 7.747  | 0.002              | 0.365           |
| Intervention          | 1390.569               | 1                 | 1390.596                | 24.104 | 0.000              | 0.472           |
| Rumination (pre-test) | 163.693                | 1                 | 163.693                 | 2.837  | 0.104              | 0.095           |
| Group                 | 491.109                | 1                 | 491.109                 | 8.513  | 0.007              | 0.240           |
| Error                 | 1557.640               | 27                | 57.690                  |        |                    |                 |
| Total                 | 75860                  | 30                |                         |        |                    |                 |

According to Table (4) based on the results of univariate analysis of covariance (ANCOVA), ( $\text{sig} < 0.05$ ,  $F = 8.513$ ) was obtained for rumination score. The significance level of dependent variables in the results of univariate covariance analysis is smaller than 0.05. Therefore, mindfulness-based cognitive therapy affects the

rumination of adults with major depressive disorder. In addition, the effect size (eta) in the post-test stage in rumination equals (0.240), which means 24% of post-test score changes in rumination were related to mindfulness-based cognitive therapy.

Table 5: Multiple statistics of covariance analysis of negative automatic spontaneous thoughts in the post-test



| Source                                 | The sum of the squares | Degree of freedom | The mean of the squares | F      | Significance level | Eta coefficient |
|--|------------------------|-------------------|-------------------------|--------|--------------------|-----------------|
| Modified model                         | 1111.353               | 2                 | 555.677                 | 7.845  | 0.002              | 0.368           |
| Intervention                           | 2808.581               | 1                 | 2808.581                | 39.650 | 0.000              | 0.595           |
| Negative automatic thoughts (pre-test) | 55.220                 | 1                 | 55.220                  | 0.780  | 0.385              | 0.028           |
| Group                                  | 982.132                | 1                 | 982.132                 | 13.865 | 0.001              | 0.339           |
| Error                                  | 1912.513               | 27                | 70.834                  |        |                    |                 |
| Total                                  | 191520                 | 30                |                         |        |                    |                 |

According to Table (5) based on the results of univariate analysis of covariance (ANCOVA), (sig<0.05, F=13.865) was obtained for the score of negative automatic thoughts. The significance level of dependent variables in the results of univariate covariance analysis is smaller than 0.05. Therefore, mindfulness-based cognitive therapy affects the negative automatic thoughts

of adults with major depressive disorder. In addition, the effect size (eta) in the post-test stage in negative automatic thoughts equals (0.339), which means 33.9% of post-test score changes in negative automatic thoughts were related to mindfulness-based cognitive therapy.

Table 6: The results of the Bonferroni follow-up test to compare the effectiveness of neurofeedback exercises and mindfulness-based cognitive therapy on rumination, and negative automatic thoughts of adults with major depressive disorder.

| Variable                    | First Intervention      | Second intervention                 | Mean difference | Standard deviation error | Significance level |
|-----------------------------|-------------------------|-------------------------------------|-----------------|--------------------------|--------------------|
| Rumination                  | neurofeedback exercises | mindfulness-based cognitive therapy | 0.648           | 2.92                     | 1.00               |
| Negative automatic thoughts | neurofeedback exercises | mindfulness-based cognitive therapy | -2.66           | 3.36                     | 1.00               |

According to Table (6), the level of significance is greater than 0.05. Therefore, there is no significant difference between the effectiveness of neurofeedback exercises and mindfulness-based cognitive therapy on rumination and negative automatic thoughts of adults with depression.

### Discussion

According to the results, neurofeedback exercises affect the rumination of adults with major depressive disorder. These results are consistent with the findings of BegiHarchgani et al. (2022) and Tsuchiagaito et al. (2021). To explain the above finding, it can be noted that based on

cognitive behavioral theories, people with depression have certain emotional patterns that are experienced in the form of negative automatic thoughts such as cognitive avoidance, rumination, and continued worry. Rumination includes the tendency to repeatedly think about the causes and consequences of a negative emotional experience. In other words, it is passive stopping and repetitive thinking about stressful matters (Nolen Hoeksma et al., 2008).

According to the obtained results, neurofeedback exercises affect the negative automatic thoughts of adults with major depressive disorder. To explain the above finding, it can be noted that depression is one of the most common



psychiatric disorders and the general problem of human life in today's world, and it is tangible in almost all countries and cultures. Various studies indicate that women are twice as depressed as men. Stressful factors such as insufficient social skills and the difference in psycho-social pressures between men and women are responsible for its occurrence. Depression is a mood or an emotional state characterized by sadness, meaninglessness, and reduced ability to enjoy life. Neurofeedback can help a person to safely control their psychological state and gain the ability to deal with negative automatic thoughts throughout life.

According to the obtained results, mindfulness-based cognitive therapy affects the rumination of adults with major depressive disorder. These results are consistent with the findings of Lobres et al. (2021), Kim et al. (2018). To explain the above finding, it can be noted that major depressive disorder is one of the most common anxiety disorders, which makes people's lives difficult. The symptoms of this disorder have a significant effect on the general functioning of the affected people and lead to incompatibility in the family. Rumination is one of the cognitive characteristics of these patients, which includes excessive emotional cognitions that lead to the continuation and aggravation of the symptoms of the disorder. Rumination is defined as persistent and recurring thoughts that revolve around a common topic. These thoughts involuntarily enter the consciousness and divert the attention from the desired topics and current goals. As a result of this training, people suffering from depression with certain mental and emotional problems learn to accept their physical and mental feelings and symptoms and improve their quality of life and positive emotions by controlling their thoughts and emotions and accepting these feelings. Mindfulness is a non-judgmental and balanced feeling that helps to accept emotions and physical phenomena as they happen. Therefore, teaching mindfulness to depressed people with more rumination helps them accept their feelings and psychological symptoms and reduces their excessive attention and sensitivity to their symptoms. According to the obtained results, mindfulness-based cognitive therapy affects the negative automatic thoughts of adults with major depressive disorder, and the fifth hypothesis of the research was confirmed. These results are consistent with the findings of

Peyghambari et al. (2021), Lubbers et al. (2021). To explain the above finding, it can be noted that mindfulness-based cognitive therapy has high effectiveness for treating clinical disorders and physical diseases due to its effect on physical and mental dimensions. The process of mindfulness and practicing concentration increases internal capacities, including tolerating, waiting, and being patient in stressful situations. Mindfulness a person reduces negative attitude, which can reduce worries and negative automatic thoughts. negative automatic thoughts may affect a person's evaluations of his ability to solve problems, which can be done correctly and with more focus through mindfulness-based exercises of the self-evaluation process.

According to the obtained results, there is no difference between the effectiveness of neurofeedback exercises and mindfulness-based cognitive therapy on rumination and negative automatic thoughts of adults with major depressive disorder, as a result, the seventh hypothesis of the research was rejected. These results are consistent with the findings of KhoshchinGolu et al (2021). To explain the above finding, it can be noted that a mental disorder is a syndrome that is characterized by clinically significant impairment in cognition, emotion regulation, or behavior. It also reflects distortions in the psychological, biological, or developmental processes underlying psychological functioning. Mindfulness-based cognitive therapy can be considered a suitable approach in the treatment of psychological components of a person with psychological injuries. Mindfulness-based cognitive therapy by increasing people's cognitive and metacognitive awareness causes them to gain more ability to control, manage and monitor their thoughts and behavior and experience higher self-regulation. Based on this, mindfulness-based exercises increase one's awareness of oneself, others, and situations in the present, instead of the past and future. The present study did not have a follow-up period. Therefore, the result of the intervention is effective but it can not be sure about the stability of its beneficial effects over time, especially in long-term periods. Suitable programs are suggested to be prepared on radio and television for the effectiveness of promoting and getting to know more about this approach and to get people to know their behavior. Counselors and planners in the field of health are recommended



to expand interventions based on mindfulness-based cognitive therapy to increase the awareness of depressed people.

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