The Effectiveness of MBSR Training on Attention, Memory and Interpretation Bias to Emotional Stimuli in People with GAD Symptoms

Hesam Goodarzi[1], Mohammad Ali Ameri[2*]

[1]Department of Clinical Psychology, Shahid Beheshti University, Tehran, Iran; [2]Department of Social Study, Research Institute of Science and Social Studies, Tehran, Iran

ABSTRACT

Objectives: The aim of this study was to investigate the effectiveness of Mindfulness-Based Stress Reduction (MBSR) training on the cognitive biases toward emotional stimuli in individuals with generalized anxiety disorder.

Methods: In this study, using the GAD-7 questionnaire, 40 individuals with a mean age of 32.53 who were diagnosed with generalized anxiety disorder were selected. The participants in the experimental group underwent an 8-session MBSR training program after the pre-test. In the pre-test, post-test and follow-up stages, the participants were evaluated using dot-probe, N-back and eye-reading tests, which were used to measure attentional bias, memory bias and interpretative bias, respectively. After data collection, the data were analyzed using SPSS 26 and repeated-measures ANOVA.

Results: The results of the dot-probe test showed that MBSR training led to a significant decrease in the reaction time to emotional and non-emotional stimuli in the post-test and follow-up stages compared to the pre-test stage. In the eye-reading test, we observed that the accuracy of identifying the test items in the post-test and follow-up stages differed significantly from the accuracy in the pre-test stage due to the intervention.

Conclusion: The results indicate that mindfulness-based stress reduction training can be effective in reducing cognitive biases toward emotional stimuli.

Keywords: Generalized anxiety disorder; Cognitive bias; Attentional bias; Memory bias; Interpretative bias

INTRODUCTION

Generalized Anxiety Disorder (GAD) is considered one of the most common psychiatric disorders, characterized by excessive and uncontrollable worry. It has a high comorbidity with other anxiety disorders and depression. The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) defines GAD as a type of severe anxiety and worry about multiple events or activities that persist on most days for at least 6 months, is difficult to control and is accompanied by physical symptoms such as muscle tension, irritability, sleep disturbances and restlessness. The 12-month prevalence of GAD is estimated to be around 0.4% to 3.6% in the DSM-5.

Over the past few decades, several theoretical models have been proposed to explain the underlying mechanisms of anxiety disorders, with some of these models focusing on cognitive processes. The cognitive models of anxiety disorders are based on the idea that cognitive factors such as "maladaptive beliefs" and "irrational thoughts" play a crucial role in the development and maintenance of anxiety disorders. In recent years, there has also been increased attention and emphasis on information processing models, which refer to the way individuals perceive environmental stimuli and the belief that "bias" in the processing of emotional information is the underlying basis of anxiety disorders, with this bias existing in all stages of information processing, including attention, interpretation and memory.

One of the key features of the cognitive models is the hypothesis that various biases in the processing of emotion-congruent information led to the development and maintenance of emotional disorders, such as generalized anxiety disorder. It is worth noting that according to research, the distinctive characteristic of the attentional bias in anxiety is a bias in the processing of information related to threat. Williams and colleagues propose the hypothesis that the attentional bias towards threat-related stimuli plays a crucial role in vulnerability to anxiety. Therefore, according to the Williams et al. model, the attentional bias is the primary cognitive vulnerability factor in generalized anxiety disorder.

In a meta-analysis conducted by Bani Hashemi and colleagues, it was concluded that the bias towards threat-related stimuli in anxious individuals is highly consistent research finding, which even if all the subsequent 11,339 studies only had non-significant results, cannot be reduced to insignificance [1].

Emotional stimuli have three main dimensions: Capacity (level of desirability), arousal and control (controllability). These three dimensions are what make emotional stimuli valuable to the cognitive system. In fact, our value distribution/attribution system evaluates input information from the perspective of these three dimensions, taking into account prior experience. The value distribution/attribution system helps us select relevant information in the environment. Particularly, stimuli associated with emotions related to social interaction or life are interconnected and this feature does not apply to non-emotional stimuli. Thus, the function of the social brain norm provides a preference or priority to the processing of emotional stimuli, but this preference/prioritization is balanced and flexible. In contrast, attributing a strong biased value or a normative value to information can lead to pathological consequences, especially when it prevents adaptation to environmental conditions and requirements. Therefore, over-attribution of value or obsession with certain emotional stimuli, at the expense of not valuing other emotional stimuli, prevents information processing at multiple levels. This bias involves cognitive processes at various levels of complexity, such as attention allocation, memory functions and higher cognitive functions like decision-making, judgment, reasoning and interpretation.

Attention bias has been defined as the priority in allocating attention to specific information in the person's surrounding environment. The characteristic of attention bias is a tendency to find emotionally valuable stimuli, align oneself with them and select this type of stimuli (as opposed to neutral stimuli) [2]. Specifically, attention bias is a kind of biased selection of information that is consistent with a particular class of environmental stimuli (such as certain events or information) and this occurs at the initial stage of sensory processing. Attention bias determines the path of information selection for processing and leads to the neglect of information that is not in this path. Numerous studies indicate that in anxiety, there is an attention bias towards threat-related stimuli.

Various theories explain the cognitive biases in mental disorders. For example, Beck's schema theory: It believes that depressed individuals have acquired negative schemas during their past and therefore tend to view the world in a negative way and structure their life according to this perceptual set. Ultimately, schema theory is based on the principle that the stored knowledge and automatic negative thoughts in long-term memory are usually accompanied by disrupted behaviors.

Mindfulness-based treatments can serve as alternative treatments for current anxiety treatments. These treatments promote and encourage the acceptance of thoughts and emotions without judging them. These treatments, which are also referred to as "present-focused" treatments, have also advanced in effectiveness alongside evidence-based treatments. Mindfulness, which is defined as "the awareness that arises from paying attention in the present moment, non-judgmentally", has carved out its place as an alternative treatment for the symptoms of avoidance and negative cognitions including self-criticism, shame and guilt among those with anxiety [3].

The core of Mindfulness-Based Stress Reduction (MBSR) is the ancient traditions of mindfulness as well as Western psychology. For this reason, it offers approaches that are considered soothing for stress-related problems, including those associated with chronic illnessesand also enhances resilience and overall well-being [4].

Long et al. described three components of mindfulness that likely improve the release from the grip of anxiety: Attention, mindful cognitive style and non-judgment. According to these researchers, shifting conscious and intentional attention to the present moment creates the capacity to control attention and leads to a reduction in attentional bias towards anxiety-provoking stimuli.

Based on this, the current study hypothesized that training in the mindfulness-based stress reduction program would lead to a reduction in attentional bias and interpretative bias towards emotional stimuli in individuals with generalized anxiety disorder.

MATERIALS AND METHODS

Participants

The present research is a kind of experimental design with pre-test, post-test and follow-up. The research population consisted of 20 personnel from the Yasuj police unit. In analysis of variance methods, the minimum number of participants is between 20 and 30 people. The GAD-7 questionnaire was used to select the participants. The inclusion criteria included: Anxiety score above 10, absence of comorbid disorders, no psychological or drug treatments and no substance or alcohol abuse. The exclusion criteria included: absence from even one session and the occurrence of acute stress during the intervention.

Measure

Dot prob software: This test is the modified version of the original test. This test is used to examine attentional bias. For this purpose, two versions of the test were provided. In the first version, facial expressions with emotional states of anxiety and neutral from the NimStim face dataset were used as stimuli. In

the second test, emotional images related to anxiety from the International Affective Picture System (IAPS) were used. The images and a dot are presented in two rectangular frames, 2 cm away from the central fixation point on the display. The participant is seated 50 cm away from the computer. First, an empty frame and a fixation point (+) are presented for 500 milliseconds. Then, two faces are presented on the left and right sides of the fixation point for 500 milliseconds. The participant has to indicate the location of the dot (star) by pressing the corresponding arrow key on the keyboard and the computer records the response and reaction time to the nearest millisecond. The test was administered using a laptop. Scoring of the modified dot-probe test with facial and emotional images: The total number of correct responses (accuracy) and the mean response time for each condition (congruent and incongruent) are calculated separately for each participant. The attentional bias index is calculated by subtracting the reaction time in the congruent condition from the reaction time in the incongruent condition. In Iran, Alboughbish, Shanabi Boushehri, Daneshfarand Abedanzadeh reported the reliability of this test using Cronbach's alpha as 0.74.

Reading Mind from Eyes Test (RMET): The reading the mind in the eyes test, which was originally introduced by Professor Baron-Cohen from the University of Cambridge, is considered one of the most reliable tests for assessing the theory of mind. In this test, 36 images of different people's eyes, showing various mental/emotional states, are presented to the participants and they are asked to determine the mental state of the person in the image. For each image, four words are provided that describe the thought or feeling of the person in the picture. The new scoring method of this test provides a kind of interpretation score. In this new scoring, the image and choices are placed on three levels (positive, negativeor neutral). The interpretation score is evaluated based on the bias towards positive and negative responses, regardless of the correct answer [5]. For example, receiving 1 point for selecting a positive choice for a neutral image and losing 2 points for selecting a negative choice for a positive image. The maximum score on this test is 36. A score between 20 and 30 is considered average, a score above 30 indicates high ability in identifying facial emotions and a score below 20 indicates difficulty in identifying facial emotions. Bakhshipour et al. conducted a preliminary study on a sample of 100 people, in which the internal consistency reliability using the Kuder-Richardson method was 0.69 and the reliability was 0.71.

Procedure: After selecting the participants, first, the dot-probe and eye-based mentalizing tests were administered to them as pre-tests; then, the treatment sessions were conducted for 8 weeks based on a pre-determined plan on the participants in the experimental group. After the completion of the training program, the dot-probe and eye-based mentalizing tests were administered again as post-tests to the participants. One month after the completion of the training program, the above tests were also carried out as a follow-up stage. In this study, mindfulness-based stress reduction training based on the model of Woods and Rockman, based on the protocol presented by Patricia Rockman and Susan L. Woods, was provided in 8 sessions of 2.5 hours (Table 1).

Table 1: Summary of the content of mindfulness-based stress reduction training sessions.

Session	Content
1	Introduction to the concept of mindfulness, body scan practice, discussion of homework assignments
2	Sitting meditation, awareness of breathing, discussion of homework assignments
3	Mindful movement, awareness of thoughts and emotions, discussion of homework assignments
4	Sitting meditation, practice of self-compassion, discussion of homework assignments
5	Mindfulness in daily life, dealing with difficulties, discussion of homework assignments
6	Integrating mindfulness into daily life, review of the training process, discussion of homework assignments
*	Yoga exercises (standing and lying), body scan practice, sitting meditation, walking meditation, mountain meditation, lake meditation, loving-kindness meditation and coming out of silence.
7	Sitting meditation, experience sharing, discussion of homework assignments

8	Review of the training process, planning for continuing the practice, post-test assessments

Data analysis

The data analysis was conducted using SPSS version 21 software for Windows. Only participants who attended all eight weekly sessions were included in the analysis. The purpose of the analysis was to examine the effects of the mindfulness-based intervention on participants' performance on the dot-probe task and the Reading the Mind in the Eyes Test as post-tests. Repeated measures analysis of variance was used to determine if participants' scores on these tasks changed over the course of the intervention.

The dependent variables were the Attention Bias Index (ABI) from the dot-probe task and the Interpretation Bias Index (IBI) from the Reading the Mind in the Eyes Test. The normality of the data was assessed using the Shapiro-Wilk test. Post hoc analyses were carried out using the Bonferroni test. All statistical comparisons were performed at a significance level of 0.05.

For inferential data analysis, repeated measures analysis of variance was used. As shown in Table 2, the mean scores of attention bias and interpretation bias in the experimental group show a significant difference between the pre-test and post-test stages. Additionally, the difference between the post-test and follow-up stages is not significant, indicating that the intervention had a sustainable effect.

According to Table 2, the mean response time to emotional stimuli in the dot-probe pre-test was 21.048, which changed to 13.985 in the post-test and 14.868 in the follow-up, indicating that the changes were sustainable.

According to Table 2, the accuracy of emotional stimulus recognition in the pre-test of the Reading the Mind in the Eyes test was 9.850, which changed to 12.800 in the post-test and 12.150 in the follow-up, indicating that the changes were sustainable.

Table 2: Descriptive statistics (mean, standard deviation) of the tasks' measures.

Tasks	Pre-test	Post-test	Follow-up
	Mean (Standard deviation	Mean (Standard deviation	Mean (Standard deviation
Dot Prob	21/048 (4/063)	13/985 (1/828)	14/868 (1/849)
RMET	9/850 (2/641)	12/800 (2/067)	12/150 (2/345)

As observed in Table 3, based on the effect size, 16% of the total variance in the attention bias of the experimental group was attributable to the effect of the independent variable (mindfulness-based stress reduction program) and slightly more than 38% of the total variance in the interpretation bias of the experimental group was attributable to the effect of the independent variable.

Table 3: (ANOVA) to compare the means of attention bias and interpretation bias.

Source	SS	df	F	sig	η^2
ABI	41.411	2	3.616	0.037	0.16
IBI	87.025	1	11.771	0.003	0.383

Note: ABI: Attention Bias Index; IBI: Interpretation Bias Index; df: degree of freedom; F; F-ratio, η^2: Eta-squared

The difference in the mean of attention bias scores at three points was compared using repeated measures of ANOVA. The difference in the mean of attention bias scores at three points of time was found to be statistically significant (p=0.001) in experimental group.

Bonferroni post hoc test was applied and pair wise comparisons was done to find out where the significant difference occurred amongst three time points.

The difference in the mean of interpretation bias scores at three points was compared using repeated measures of ANOVA. The difference in the mean of interpretation bias scores at three points of time was found to be statistically significant (p=0.001) in experimental group [6].

Bonferroni post hoc test was applied and pair wise comparisons was done to find out where the significant difference occurred amongst three time points.

As shown in the Tables 4 and 5, there is a statistically significant difference at the level of p<0.05 between the attention bias towards emotional stimuli in the post-test stage and the pre-test stage. It is worth noting that this significant difference, with a

slight decrease, is still maintained in the follow-up stage, indicating that the effect of the educational program is still sustainable even after one month. On the other hand, in the interpretation bias section (Tables 6 and 7), we observe that the accuracy of emotional stimulus recognition in the post-test stage is significantly different from the same component in the pre-test stage; interestingly, this significant difference is still maintained in the follow-up stage, which means that the effect of the intervention in the study is still robust.

Table 4: Repeated Measures ANOVA showing comparison of attention bias score: pretest to post test and follow-up score in experimental group and control group.

Group	Time points	Mean (SD)	F value	p-value
Experimental group	Pre-test	21/048 (4/063)	390316	0.001*
	Post-test	13/985 (1/828)		
	Follow-up	14/868 (1/849)		
Control group	Pre-test	22/162 (4/011)	3.52	0.34
	Post-test	22.408 (4/059)		
	Follow-up	21/659 (4/216)		

Note: *significant at the 0.05 level

Table 5: Attentional bias post hoc test.

Three points time	Group	MD	SE	p-value
Pre-test-Post-test	Experiment	7.063*	0.87	0
	Control	-0.246	0.135	0.86
Pre-test follow-up	Experiment	6.180*	0.64	0
	Control	0.503	0.342	0.051
Post-test follow-up	Experiment	-0.883	0.089	0
	Control	0.749	0.531	0.34

Note: *significant at the 0.05 level, MD: Mean Differences; SE: Standard Error

Table 6: Repeated measures ANOVA showing comparison of interpretation bias score: Pre-test to post-test and follow-up score in experimental group and control group.

Group	Time points	Mean (SD)	F value	p-value
Experimental group	Pre-test	9/850 (2/641)	18.898	0.001*
	Post-test	12/800 (2/067)		
	Follow-up	12/150 (2/345)		
Control group	Pre-test	10.300 (1.838)	4.41	0.86
	Post-test	10.350 (1.926)		

Follow-up	11.200 (1.765)			

Note: *significant at the 0.05 level

Table 7: Interpretation bias post hoc test.

Three points time	Group	MD	SD	p-value
Pre-test-Post-test	Experiment	-2.95*	0.509	0.001
	Control	-0.05	0.447	0.86
Pre-test follow-up	Experiment	-2.30*	0.458	0
	Control	0.1	0.324	0.056
Post-test follow-up	Experiment	0.65	0.464	0
	Control	0.15	0.435	0.41

Note: *significant at the 0.05 level, MD: Mean Differences; SE: Standard Error

RESULTS AND DISCUSSION

One of the findings of this study showed that the attention bias towards emotional stimuli in individuals with generalized anxiety disorder can be improved through a mindfulness-based stress reduction program. In explaining the above finding, it can be said that Bishop et al. proposed that the operational definition of mindfulness is self-regulation of attention and orientation towards experience and they introduced cognitive flexibility as one of the important components of attention self-regulation. Mindfulness-based approaches, by encouraging individuals to fully experience their bodily sensations, emotions and thoughts without changing or avoiding them, gradually enable individuals to accept their experiences.

Furthermore, in the research by Philip Goldin and colleagues, it was found that mindfulness-based training can be effective in reducing attention bias in anxious individuals. In the study by Zaniel et al., it was found that training in mindfulness-based remedial programs can lead to the enhancement of executive functions, including attention, inhibition accuracy and shifting accuracy. Additionally, in the study by Lian Zhou et al., it was found that short-term mindfulness training can have a significant effect in reducing attention bias towards unpleasant anxiety-provoking events [7]. Moreover, in the review study by Alberto Chiesa, Raffaella Calati and Alessandro Serretti, the overall conclusion was that mindfulness training can generally improve the cognitive abilities of individuals. In the study by Stefan Hofmann and Angelina Gómez, it was found that mindfulness-based interventions can lead to the improvement of anxiety and depression, which is likely due to the effect of this program on strengthening one of the strategies for cognitive modulation of emotional situations, which will be discussed further and is also the central focus of the current research.

Studies have shown that when a person is exposed to negative emotional stimuli, the corresponding emotional centers become activated and if the person does not want to change the expression of their emotions, the cognitive centers do not show much activity. However, if the person wants to voluntarily change the expression of their emotions, cognitive strategies come into play. One of these strategies is the reappraisal (re-evaluation) behavior, which aims to reduce negative emotions. It seems that in line with the findings of the current research, the training of the mindfulness-based stress reduction program, with attention as its core component, as well as the mindful cognitive style of attention and non-judgment, has been able to create a capacity for attentional control by training individuals to change their mindful and intentional attention to the present moment and consequently lead to a reduction in the bias towards emotional stimuli.

Another finding of the study was that the training of the mindfulness-based stress reduction program can improve the accuracy of stimulus detection and generally reduce the bias in interpretation. Consistent with the findings of the current study, Hoge et al. in a study on individuals with generalized anxiety disorder found that the mindfulness-based stress reduction program significantly reduced the individual's anxiety level [8].

Pablo Roca et al. concluded in a study that mindfulness-based programs improve well-being and mental health through the modification of attentional processing of emotional stimuli.

Mindfulness has been defined as a type of bias-free processing and a type of beginner's mind, paying attention to what is currently happening without trying to change it (acceptance) and the absence of any kind of filter or sieve in the way of cognitive operations as well as reality-based/reality-congruent evaluation instead of evaluation based on expectations and

beliefs, therefore it may be expected that if individuals can learn mindfulness skills well, they are less likely to be subject to interpretation bias [9].

CONCLUSION

In their research, Brigitta Meyer and colleagues came to the conclusion that the more mindfulness skills, the more likely it is to reduce interpretation bias and lower the level of anxiety and depression. The interesting point of this research is that interpretation bias seems to play the role of a kind of mediator in the relationship between mindfulness and acceptance with the symptoms of anxiety and depression. Philip Mimin and E. Langer put forward the view that mindfulness may be associated with less negative cognitive biases and consequently, mindfulness can reduce an individual's vulnerability to cognitive biases. Based on these studies, it can be concluded that with the reduction of interpretation bias, we may witness an improvement in anxiety symptoms in individuals. Also, Elizabeth Hoge and colleagues in their research found that the mindfulness-based stress reduction program can reduce the bias of negative interpretation. It is worth noting that in 2018, Audrey Gibb and colleagues concluded that mindfulness is less associated with negative interpretation bias.

COMPLIANCE WITH ETHICAL STANDARDS

No pharmacological intervention was administered in this study and it was conducted in accordance with the ethical guidelines outlined in the Declaration of Helsinki.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no conflict of interest.

REFERENCES

1. Foa EB. Treatment of anxiety disorders: Implications for psychology. 1985.

2. Clark D, Wells A. A cognitive model of social phobia. 1995; 69-93.

3. Beck AT, Clark DA. An information processing model of anxiety: Automatic and strategic processes. Behav Res Ther. 1997;35:49-58.

4. Beck AT, Emery G, Greenberg RL. Anxiety disorders and phobias: A cognitive perspective. 1985.

5. Mogg K, Bradley B. Attentional bias in generalized anxiety disorder versus depressive disorder. Cogn Ther Res. 2005;29:29-45.

6. Mathews A, Mackintosh B. A cognitive model of selective processing in anxiety. Cogn Ther Res. 1998;22(6):539-560.

7. Bar-Haim Y, Lamy D, Pergamin L, Bakermans-Kranenburg MJ, van IJzendoorn MH. Threat-related attentional bias in anxious and non-anxious individuals: A meta-analytic study. Psychol Bull. 2007;133: 1–24.

8. Robinson OJ, Krimsky M, Grillon C. The impact of induced anxiety on response inhibition. Front Hum Neurosci. 2013;7:69.

9. Valadez EA, Pine DS, Fox NA, Bar-Haim Y. Attentional biases in human anxiety. Neurosci Biobehav Rev. 2022;142:104917.