

## The Effectiveness of Emotional Stimulus-based Working Memory Training in Improving the Cognitive Emotion Regulation in Adolescents with Post-Traumatic Stress Disorder

Zobair Samimi, M.A.<sup>1</sup>, Moslem Kord, M.A.<sup>2</sup>, Fatemeh Mirdoraghi, M.A.<sup>3</sup>, Jafar Hasani, Ph.D.<sup>4</sup>

1- Ph.D. Student, Department of Education, Faculty of Education & Psychology, Azarbaijan Shahid Madani, Tabriz, Iran (Corresponding author; E-mail: std\_samimi@khu.ac.ir)

2- Ph.D. Student, PhD Student of Cognitive Psychology, Institute for cognitive and brain science, Shahid Beheshti University

3- Ph.D. Student, Department of Psychology, Faculty of Educational Sciences and Psychology, Ferdowsi University of Mashhad, Mashhad, Iran

4- Associate Professor, Department of clinical Psychology, Faculty of Educational Sciences and Psychology, Kharazmi University of Tehran, Tehran, Iran

Received: 15 April, 2017

Accepted: 3 December, 2017

### ARTICLE INFO

#### Article type:

Original article

#### Keywords:

Post- traumatic Stress Disorder

Cognitive Emotion Regulation Strategies

Emotional Working Memory

### Abstract

**Background:** The aim of this study was to investigate the effectiveness of emotional stimulus-based working memory training in improving the cognitive emotion regulation strategies in adolescents with Post-Traumatic Stress Disorders (PTSD).

**Methods:** Based on the framework of single case and using multiple –baselines, 3 adolescents (2 females, 1 male) were candidates from one of the Labor Child Educational Centers of Karaj, using 2 instruments (SCID-I) and (IES-R). The participants, one by one, participated in 20 sessions of emotional working memory training. All participants were assessed during three stages (pre-training, during training, and 2-month follow-up), using Cognitive Emotion Regulation Questionnaire-Kids form (CERQ-k). Data were analyzed using the indexes for trend changes, gradients and revision of the charts, and the clinical significance was determined using Cohen's index, recovery percent and effect size.

**Results:** The results showed that emotional stimulus-based working memory training is significantly effective in increasing adaptive strategies and reducing maladaptive strategies of cognitive emotion regulation in adolescent with PTSD.

**Conclusion:** According to the results, emotional stimulus-based working memory training can be an effective alternative for improving the cognitive emotion regulation strategies in adolescents with PTSD.

**Copyright:** 2017 The Author(s); Published by Kerman University of Medical Sciences. This is an open-access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

**Citation:** Samimi Z, Kord M, Mirdoraghi F, Hasani J. The Effectiveness of Emotional Stimulus-based Working Memory Training in Improving the Cognitive Emotion Regulation in Adolescents with Post- Traumatic Stress Disorder. Journal of Kerman University of Medical Sciences, 2017; 24(4): 298-311.

### Introduction

Although stress has an important role in preparing individuals to respond to the problems in everyday life, but high levels of stress have destructive and harmful effects on

regular performances and can lead to mental disorders. One of the mental disorders in which stress plays a significant role which is caused by a stressful experience, is post-traumatic stress disorder [PTSD] (1). PTSD is a severe mental disorder

resulted from a stressful event with a very threatening or disastrous nature. It is associated with symptoms such as recalling and returning unwanted memory in the form of intrusive thoughts, nightmare and avoiding trauma-related stimuli. The condition ultimately causes changes in the emotional and cognitive processes such as memory, attention, planning, and problem solving (2,3).

The importance of the effects of exposure to distressing events during adolescence is different when compared with the other life stages as the adolescence is the period that the adolescents acquire their identity. Such the events can potentially prevent a person from having a positive and successful development in adolescence (4). Additionally, adolescence is associated with the onset of puberty and may lead to more emotional and behavioral problems in adolescents (5). The experience of a traumatic event in adolescents creates feelings of guilt, sadness, embarrassment, shame, and, consequently, the inability to regulate these emotions (6).

There are corroborated findings have shown that people with PTSD face with emotional regulation problems (7, 8). Emotional regulation is a goal-oriented process designed to influence the severity, duration, type of excitement experienced and is a process by which individuals can modulate their emotions consciously and unconsciously (9, 10).

One of the most common strategies for management and regulation of emotional experiences and emotional stimulus is the use of strategies that emphasize the cognitive aspects of coping, which are known as cognitive emotion regulation strategies (11). In this regard, nine cognitive emotion regulation strategies have been identified that are generally

classified into adaptive strategies (acceptance, positive refocus, refocus on planning, positive reappraisal and putting into perspective) and maladaptive strategies (self-blame, catastrophizing, rumination, and other-blame) (12, 13).

People with PTSD, repeatedly suppress their emotional states to reduce unpleasant feelings that have experienced in a stressful event (14), but the lack of verbal expression of these emotions causes intense emotional arousal. In fact, they are radically using maladaptive emotion regulation strategies. On the other hand, adaptive emotion regulation strategies, such as cognitive appraisal, are rarely used to cope with a stressful event. The most common problems is that emotion regulation associated with more severity of symptoms in people with PTSD. Whatever the individuals use of maladaptive emotion regulation strategies to regulate their emotions and avoid using adaptive strategies, the severity of PTSD symptoms will be more pronounced (15, 16).

Since the people with PTSD to experience negative emotions faster and more severe than the others. They face with some problems in modifying and regulation of these emotions, hence to encounter problems in identifying and understanding their emotions. For this reason, emotions are considered as a disturbing and unpleasant source of information rather than a source of information for emotion regulation. As a result, people with PTSD try to avoid or control their emotions (17).

In addition to impaired emotion regulation, people with PTSD (18), to use maladaptive cognitive strategies to eliminate anxiety symptoms and to escape from the experience of negative emotions. Research (15) suggest that people with PTSD, are using significantly higher levels of rumination, self-blame and catastrophizing strategies. Given

that these patients experience negative emotions after reminding their stressful memories, and making use of maladaptive emotion regulation strategies to escape from such a situation leading to continuation of the disorder, it is accepted that they have a negative appraisals of their emotions.

Several studies have shown a strong relationship between cognitive emotion regulation and PTSD and other mental disorders (18, 16). They have suggested that cognitive emotion regulation problems may even remain after recovery (19). For this reason, the increased ability of cognitive emotion regulation can be a great help for these patients and thus it is worthwhile to perform some interventions using specific strategies in patients with PTSD in order to improve their cognitive emotion regulation.

So far, many efforts have been made to increase the emotion regulation strategies; however, most of these methods are costly and have been limited to the therapeutic, neurological and invasive methods of brain surgery, such as deep brain stimulation (DBS) (20, 21, 22). However, recent advances in cognitive neuroscience suggest that emotion regulation can be increased through appropriate computer programs, which are much less costly in terms of human and financial resources, and also can be provided for all people through the Internet (23). According to the study of Schweizer et al., (24), modified working memory training using emotional stimuli can improve cognitive-emotional control and emotion regulation in the short run. Emotional working memory training is a dual (audio-visual) memory training program in which the participant receives emotional training in addition to cognitive training using emotional audio-visual stimuli (16).

People who received emotional working memory training showed better performance in emotional Stroop task than those who received cognitive working memory training. Emotional working memory refers to the ability to identify, understand, and regulate emotions and also to the function of short-term memory in encoding, storing, and retrieving emotional information (25).

Several studies have confirmed the relationship between working memory and emotions. Schmeichel, Volokhov, and Demaree (26) have shown that people with a higher working memory capacity have the ability to manage facial expressions and adopt a non-emotional attitude when face with emotional stimuli. Regarding the theoretical foundations and the results of the research, there seems to be a separate mechanism for storing the emotions in working memory (21). Storing emotions as a specific function of emotional working memory plays a key role in decision making, emotion regulation (27), rumination in depressed people (28), and in the onset of judging past and future experiences (29).

The main feature of emotional working memory training is that the capacity of emotional working memory is a separate process from cognitive abilities, and given the fact that the emotional stimuli associated with disruption are used in the training, one can hope that significant advances to be observed after the emotion regulation processes (30).

Despite the high prevalence of PTSD among adolescents and its problems, as well as its prognosis and the essential role of emotion regulation skills in controlling the emotional state of the patients with PTSD, most of the studies have been conducted on adults and clinical subjects so far. Therefore, it seems necessary to use new methods for research on and treatment of the disorder in adolescents. On the other hand,

due to the importance of emotional working memory in improving the emotion regulation (31), the present study aimed to investigate the effectiveness of emotional stimulus-based working memory training in improving the cognitive emotion regulation in adolescents with post-traumatic stress disorder (PTSD).

## Materials and Methods

The present study is based on a single-subject designs using a step-by-step multiple base lines design. In this study, working memory training was considered as an independent variable and adaptive and maladaptive strategies of emotion cognitive regulation were considered as dependent variables.

The population included all adolescents with PTSD in Karaj. Using convenience sampling, 3 adolescents (2 females, 1 male) with mean age of 16 were selected from Khane Mehr Center (one of the centers affiliated with the Society for Protection of Working and Street Children) in Karaj as patients with PTSD. Patients were selected based on the Impact of Events Scale-revised (IES-R) questionnaire and the results of structured clinical interview. It should be noted that the participants were also evaluated for other mental disorders and the results showed that none of the participants met the other mental disorders diagnostic criteria. It was revealed that all participants met PTSD diagnostic criteria (symptoms such as nightmares, frequently reminding stressful memories, avoidance of stressful situations, physical problems such as transpiration, tremor, irritability and aggression, unconsciousness and selflessness). The participants did not receive any specific medical or psychological treatment during the research process.

Participant I: A 16-year-old boy who was studying at Khane Mehr Center of Karaj. At the age of seven, when he was alone at home, a thief came to their home and beat him. After this event, he constantly experienced PTSD symptoms such as nightmares, fear of darkness, emotional problems, heart palpitations, and transpiration during nightmares.

Participant II: A 16-year-old girl whose father was addicted and hanged himself because of financial, family, and addiction problems, and she was the only witness to the event. It was happened when she was 8-year-old. After this event, she had PTSD symptoms such as fear, anxiety, heart palpitations, nightmares, and social and communicative problems.

Participant III: A 16-year-old girl who had been sexually abused by her cousin 2 years ago. After the event, she had PTSD Symptoms such as fear, nightmare, rumination, heart palpitations, sweating, shortness of breath, and limited social relationships.

## Data Collection Instruments

### 1) Structured Clinical Interview for DSM-IV

This interview is a comprehensive and standard tool designed to evaluate major psychiatric disorders based on the DSM-IV diagnostic criteria and used for clinical and research purposes (32). In a study conducted by Mohammadkhani and colleagues, the validity and reliability of SCID were established for clinical trials, which can be used to confirm a valid and accurate diagnosis (33).

### 2) Impact of Event Scale

In this study, this questionnaire was used to determine the severity of post-traumatic stress disorder.

This scale has been designed to measure common mental discomfort after a life-threatening incident in life, and consists of 22 items, 8 of which measure avoidance, 8 to measure intrusive thoughts and images, and 6 to measure hyperarousal. The highest score was 88 (34). In the Iranian population, the pre-test reliability coefficient for avoidance (.89), intrusive thoughts and images (.94) and arousal (.92) was determined (35).

### 3) Cognitive Emotion Regulation Questionnaire

This questionnaire was designed by Garnefski (1999) to assess the cognitive strategies of individuals in response to life-threatening and stressful experiences (35). The questionnaire is a 36-item self-report instrument (36), which measures 9 different subscales (self-blame, other-blame, acceptance, rumination, positive refocus, refocus on planning, positive reappraisal, and catastrophizing and putting into perspective) (37). Scores range from 1 (almost never) to 5 (almost always). The obtained Cronbach's alpha (ranging from .68 to .82) showed that the Persian version of the questionnaire was valid, and analysis of the main component explained the variance (75%) and confirmed the questionnaire. High correlation between the subscales has been reported (38).

### 4) Emotional Stimulus-based Working Memory Training Program

In this study, emotional working memory training program was employed to train the emotional working memory according to the original version of the protocol by Schweizer and colleagues (30, 39). This program was designed in the C# programming environment and included

an emotional N-back task that simultaneously displays a four-by-four-inch face within 500-milliseconds, 1 matrix on the monitor and a word repeats for 500-milliseconds in the headphones. The participants were asked to match each pair of images/words presented for 250-milliseconds by pressing a button and responding to one or both stimuli simultaneously. 60% of the words such as sexual abuse and death and faces such as fears, sadness, and anger were emotionally negative in accordance with the trauma of the samples, and 40% were emotionally neutral (such as a wardrobe and chair).

Auditory words from Self-assessment Mankin test were selected from 2000 common Persian words that were standardized by Nazari et al., (40). For emotional faces, the Emotional Face Foundation provided by Department of Clinical Neuroscience, Karolinska Institute in Sweden, was also used while all rights were reserved (41). The task had audiovisual feedback, so that giving wrong or no answer to the target's audio stimulus leading to hear an unpleasant sound and correct answer to the target's stimulus leading to hear a pleasant sound. In addition, giving wrong or no answer to the target's stimulus was presented by a sad face in red color and giving correct answer, presented by a smiley face in green colour (Fig. 1). The software started with one step back by default.

In order for the subjects to have the highest level of performance, the lower threshold was proposed 20 and the upper threshold, 60. If the number of correct answers of the participants was higher than 60%, one stage would be added to the test, and if the number of correct answers was lower than 20%, one stage of the test would be reduced. The program was displayed on Lenovo laptop 15.5-inches screen which was directly 55 cm away from the participant.

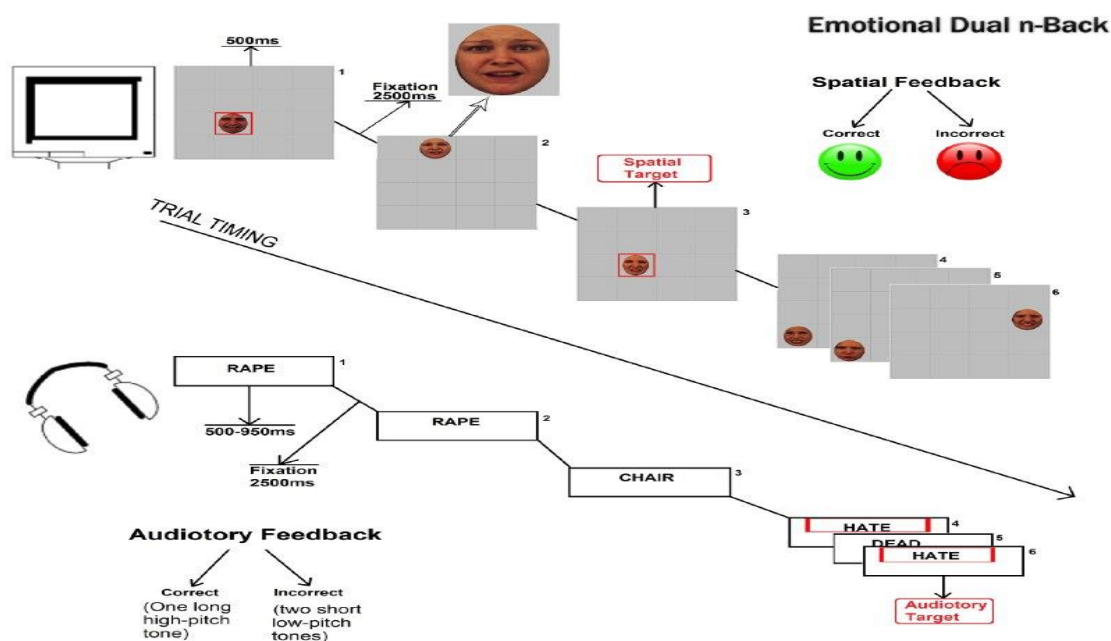


Fig 1. Schematic design of emotional working memory program

In the first stage, the participants were identified based on the inclusion criteria, and in order to preserve the research ethics, the purpose of the research and training method was explained to the participants and their possible questions were answered. Then, an informed consent form was signed by the participants, their parents and authorities of the center. It should be noted that this study was based on a study with larger population approved by the Ethics and Research Committee of Kharazmi University in Tehran.

Before the onset of the process of emotional stimulus-based working memory training, participants were asked to complete Cognitive Emotion Regulation Questionnaire-Kids form (CERQ-k) for assessing cognitive emotion regulation strategies. Then the people participated in the emotional working memory training sessions.

Before the onset of training sessions, and in order to being familiarized with training software, participants were asked to

read the written instructions for completing the test. In addition, once again the researcher has explained them verbally how to implement the training software. Then, training sessions were held in 20 consecutive days except Thursday and Friday and in the 30-45 minute sessions. During the training process, the participants completed the questionnaire on sessions 4, 8, 12, 16, and 20. At the end of the sessions, and while the participants had received no treatment, they were asked to complete the questionnaire again to ensure that the effect of emotional stimulus-based working memory training was stable. At the end of the study, a gift was donated to the participants to appreciate them for participation in the research.

In order to analyze and interpret the collected data according to single-subject experimental design, changing trend, gradients and clinical significance percent or the effect sizes were calculated for each participant. The scores of

adaptive and maladaptive strategies during the training sessions were separately presented on the charts for each participant (figures 1-3).

## Results

**Table 1.** Score variations of adaptive and maladaptive strategies in emotional cognitive regulation for the three participants during twenty training sessions

Participants	Strategies	Base line	Session 4	Session 8	Session 12	Session 16	Session 20	Follow-up
The first	Adaptive	55	58	62	62	69	70	75
	Maladaptive	37	32	31	28	28	24	21
The second	Adaptive	54	55	54	59	65	69	73
	Maladaptive	35	30	28	27	23	22	18
The third	Adaptive	35	37	43	46	52	57	61
	Maladaptive	42	42	38	35	34	32	29

According to Table 1, all participants showed changes in the scores of adaptive and maladaptive strategies so that adaptive strategies score, from baseline stage to follow-up, has been increased but the score of maladaptive strategies, from the baseline stage to follow-up, has been decreased. To analyze the performance of the participants, indicators of process change, gradients, and effect size of the participants' scores were evaluated using the following formulas (Table 1):

$$\text{MPI} = \frac{[(\text{Baseline Mean} - \text{Treatment Phase Mean}) / \text{Baseline Mean}] \times 100$$

$$\text{MPR} = \frac{[(\text{Baseline Mean} - \text{Treatment Phase Mean}) / \text{Treatment Phase Mean}] \times 100$$

$$\text{Cohen's } d = M1 - M2 / \sigma \text{ pooled}$$

$$\text{Where } \sigma \text{ pooled} = \sqrt{[(\sigma_1^2 + \sigma_2^2) / 2]}$$

Table 1 shows changes in the scores of adaptive and maladaptive strategies in the emotional cognitive regulation questionnaire for all three participants during the baseline, in 5 sessions during the intervention and at a two-month follow-up period.

In these formulas, MPI represents recovery percent; MPR, percent of grades reduction; and Cohen's d, the effect size. These indicators show process change, gradients and effect size, respectively (16).

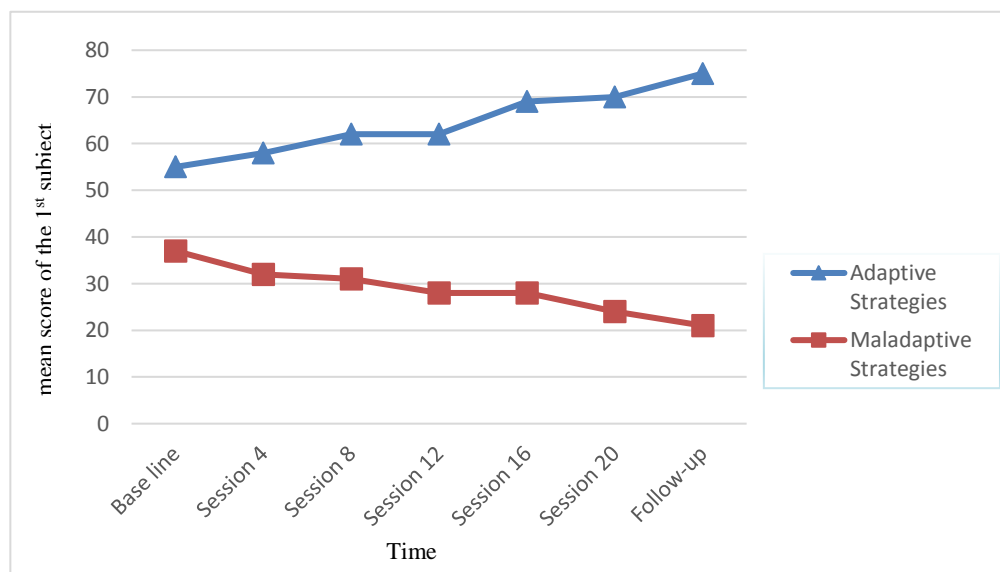
The effect size, MPR, and MPI were significant for all participants. The highest significance and effect size were found in the adaptive strategies of the first participant ( $d_1=0.78$ ) during the intervention period and  $d_2=-0.99$  in the follow-up period) and the least significance and effect size were found in the adaptive strategies of the second participant ( $d_1=-0.56$  in the intervention period). Also, the highest significance and effect size were found in the maladaptive strategies of the first and second participants ( $d_1=0.87$  during the intervention period and  $d_2=0.99$  in the follow-up period) (Table 2).

**Table 2.** Indicators of process changes, gradients, and effect size of participants' scores

Participants	The First Participants		The Second Participants		The Third Participants	
	Adaptive Strategies	Maladaptive Strategies	Adaptive Strategies	Maladaptive Strategies	Adaptive Strategies	Maladaptive Strategies
Base line	55	37	54	35	35	42
Average intervention	64.20	28.60	60.40	26	47	36.2
Standard deviation	5.11	3.13	6.46	3.39	7.77	3.89
Recovery percent)MPI(	-16.72	22.70	-11.85	25.71	-34.28	13.80
Percent of grades reduction (MPR)	-14.33	29.37	-10.59	34.61	-25.53	16.02
Effect size (d1)	-0.78	0.87	-0.56	0.87	-0.73	0.71
Follow-up	75	21	73	18	61	29
Recovery percent (MPI)	-36.36	43.24	-35.18	48.57	-74.28	30.95
Percent of grades reduction (MPR)	-26.66	76.19	-29.37	94.44	-42.62	44.82
Effect size (d2)	-0.99	0.99	-0.99	0.99	-0.99	0.98

The least significance effect size was also found in maladaptive strategies of the third participant ( $d_1=0.71$  during the intervention period and  $d_2=0.98$  in the follow-up period) (Table 2). The first participant showed the highest significance, MPI, and effect size. The findings show that

emotional working memory training improves adaptive and maladaptive strategies in all participants from baseline to follow-up (Table 2). In figures 1-3, changes in the scores of adaptive and maladaptive cognitive emotion regulation strategies for each participant were represented.

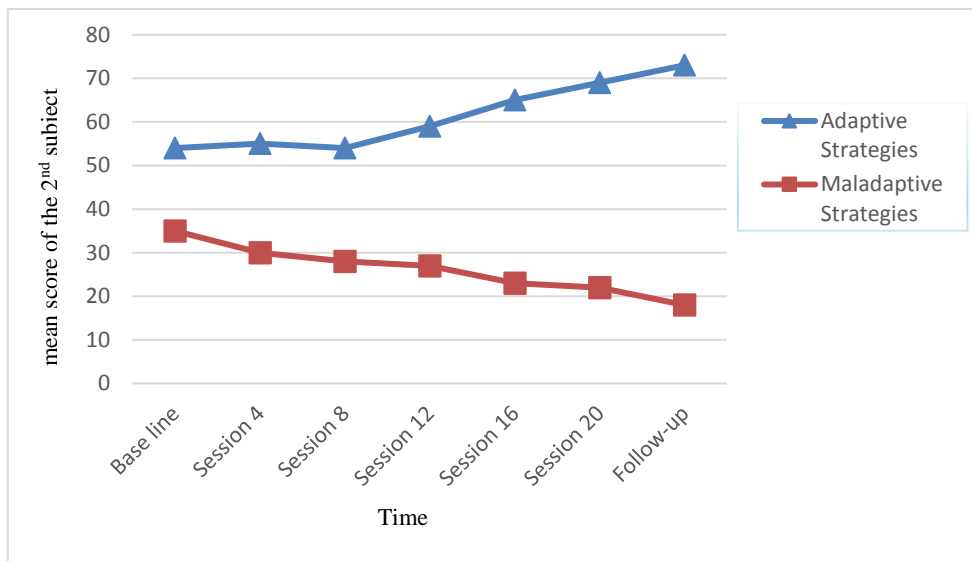


**FIG 1.** Changes in the scores of adaptive and maladaptive cognitive emotion regulation strategies for the first participant

As shown in figure 1, the first participant showed a significant increase in the scores of adaptive strategies from baseline to follow-up. Changes in the scores shows a significant decrease in the scores of maladaptive strategies

from baseline to follow-up. Therefore, the emotional working memory training was effective in improving the adaptive and maladaptive strategies in this participant from the baseline to follow-up stage.

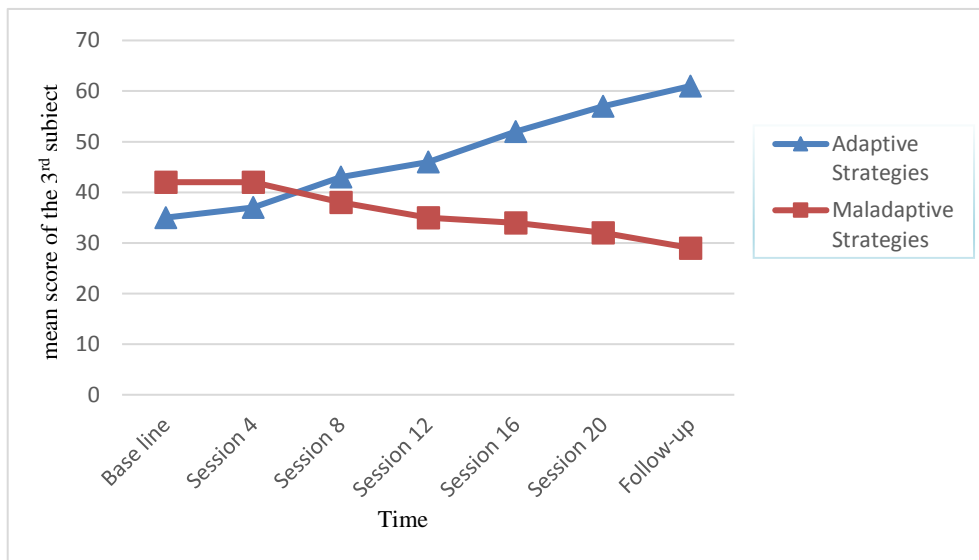




**FIG 2.** Changes in the scores of adaptive and maladaptive cognitive emotion regulation strategies for the second participant

According to figure 2, the second participant showed a significant increase in the scores of adaptive strategies from the baseline to follow-up stage; this increase was slow until session 8 but after that, a more rapid increase was reported. This participant also showed significant decrease in the scores

of maladaptive strategies, which have reached the lowest score and highest improvement until the follow-up stage. Changes in the scores indicate that emotional working memory training was effective in improving the adaptive and maladaptive cognitive emotion regulation strategies in this participant.



**FIG 3.** Changes in the scores of adaptive and maladaptive cognitive emotion regulation strategies in the third participant

The third participant showed significant changes in the scores of adaptive and maladaptive strategies. In other words,

this participant showed a significant increase in the scores of adaptive strategies from the baseline to follow-up stage, and

also a significant decrease in the scores of maladaptive strategies from the baseline to follow-up stage. The results showed that emotional working memory training was effective in improving adaptive and maladaptive cognitive emotion regulation strategies (figure 3).

Finally, in addition to analyzing the data individually, the changes in the scores of adaptive and maladaptive strategies for all three participants were compared. For this purpose, a

repeated measurement Anova was used; however, before performing this test, sphericity was evaluated for the mean scores of adaptive and maladaptive strategies separately by using Mauchly's sphericity test. The results of this test were not significant for both strategies, which shows that the assumption of homogeneity of covariance of adaptive and maladaptive strategies was not different at different stages of the assessment and sphericity was observed (Table 3).

**Table 3.** Results of repeated measurement test for adaptive and maladaptive strategies

Variables	Sources of Changes	Sum of Squares	Degree of Freedom	Average Squares	F	Significance (P-value)
Adaptive variables	Evaluation process	1198.66	6	199.77	48.03	0.001
	Error	49.90	12	4.15		
Maladaptive variables	Evaluation process	489.61	6	81.60	66.76	0.001
	Error	14.66	12	1.22		

As shown in Table 3, there is a significant difference between mean scores of adaptive strategies at different stages of the assessment (baseline, session 4, 8, 12, 16, 20, and follow-up) ( $P < 0.001$ ,  $F_{(12,6)} = 48.03$ ). Due to the significance of this result and for pairwise comparisons of different stages of the evaluation, Bonferroni test was used. The results showed that there is a significant difference between the mean scores of adaptive strategies at stage 4 and follow-up ( $P < 0.05$ ); however, the mean scores at follow-up (69.66) were higher than those at session 4 (50).

In other words, emotional working memory training increased adaptive strategies among participants. As shown in Table 3, there is a significant difference between the mean scores at different stages of the assessment ( $P < 0.001$ ). The results of Benfrown's test also showed a significant difference between mean scores of maladaptive strategies at session 4 and follow-up ( $P < 0.05$ ), and those at session 8 and follow-up ( $P < 0.05$ ), so that the mean scores at follow-up stage (22.66)

were lower than those at session 4 (34.66) and 8 (32.33). In other words, emotional working memory training reduced maladaptive strategies in participants.

## Discussion

The purpose of this study was to investigate the effectiveness of emotional stimulus-based working memory training on cognitive emotion regulation in adolescents with PTSD. The results of this study showed that emotional stimulus-based working memory training led to an increase in the adaptive strategies (acceptance, positive refocus, refocus on planning, positive reappraisal and putting into perspective) and a decrease in the maladaptive cognitive emotion regulation strategies (self-blame, catastrophizing, rumination, and other-blame) in all three participants, which is consistent with the results of other studies (23, 39).

In addition, a positive relationship was observed between working memory capacity and cognitive emotion regulation strategies (26). According to theoretical foundations, by

increase of the working memory capacity, at any rate, emotion regulation strategies also change. In other words, this increase lead to increase of adaptive strategies and reduction of maladaptive strategies. People with a higher working memory capacity are more capable of suppressing facial expressions and are being able to adopt a non-emotional attitude when they are exposed to an emotional stimulus (26). Accordingly, the results of a study indicated that emotional stimulus-based working memory training in adolescents with social and emotional problems improved cognitive emotion regulation strategies (42).

To explain this result, it can be said that the main potential for cognitive emotion regulation in most people relies on the neurological regions (43) and neural circuits, including prefrontal, posterior, and lateral cortex, lower wall and anterior cortical cortex (44), which play a key role in the good performance of working memory assignments (45,46,47). In addition, malfunction of these regions causes emotional disorders such as PTSD which are associated with poor cognitive emotion regulation (48).

It is worth mentioning that cognitive emotion regulation strategies must be verbalized in the brain so that individuals can control emotions by themselves; individuals need continuity and repetition for verbalization of their emotions (49). Therefore, according to the findings of this study, 20 training sessions based on emotional stimuli provided a good opportunity for the participants to internalize cognitive emotion regulation strategies by practice, repetition and feedback. Therefore, as it was expected, working memory training makes people to use more internal capacities associated with nervous systems, and subsequently new skills will be provided (50). In addition, functional reorganization

makes individuals to adhere to adaptive and maladaptive cognitive emotion regulation strategies. Therefore, it can be concluded that success in verbal internalization along with increase of emotional working memory capacity improves cognitive emotion regulation in adolescents with PTSD.

In addition, given the fact that these people had traumas such as robbery, sexual abuse and hanging in their family, words and images related to these traumas such as hanging, robbery, and sexual abuse were used in this study. It was supposed that the use of these words in the research program would make the participants to reduce their fears gradually by hearing the words and looking at the images related to these topics and also by daily regular and systemic desensitization, which was confirmed by the results of this study. Daily recalling of these memories and simultaneous strengthening of the brain systems associated with storing of these memories, reduced fears and anxieties in these people during the research.

## Conclusion

According to the results, it can be claimed that emotional stimulus-based working memory training can be a good alternative for improving cognitive emotion regulation strategies in adolescents with post-traumatic stress disorder; however, lack of access to neurological tools such as magnetic resonance imaging (MRI) was one of the limitations of this study, which makes it impossible to completely generalize these results. Since these tools make it possible to observe brain and neurological changes during the intervention, further studies are suggested to use these tools and emotional stimulus-based working memory training in adolescents with ADHD and OCD.

## References

- Hayes JP, VanElzaker MB, Shin LM. Emotion and cognition interactions in PTSD: a review of neurocognitive and neuroimaging studies. *Front Integr Neurosci* 2012; 6(89):1-14.
- Blake DD, Weathers FW, Nagy LM, Kaloupek DG, Gusman FD, Charney DS, et al. The development of a Clinician-Administered PTSD Scale. *J Trauma Stress* 1995; 8 (1):75-90.
- American Psychiatry Association. The revised passage of the statistical and recognition guide of mental disorders. Translated by Nikkhoo MR. Tehran, Iran, Sokhan Publication, 2010 [In Persian].
- Li Y, Zhang W, Liu J, Arbeit MR, Schwartz SJ, Bowers EP, Lerner RM. The role of school engagement in preventing adolescent delinquency and substance use: A survival analysis. *Journal of Adolescence* 2011; 34 (6):1181-92.
- Crane PA, Clements PT. Psychological responses to disasters: Focus on adolescents. *J Psychosoc Nurs* 2005; 43(8): 31-38.
- Villalba JA, Lewis LD. Children, adolescents, and isolated traumatic events: Counseling considerations for couples and family counselors. *Fam J* 2007; 15(1):31-5.
- Liberzon I, Sripada CS. The functional neuroanatomy of PTSD: a critical review. *Prog Cardiovasc Dis* 2007; 167:151-69.
- Lanius RA, Williamson PC, Densmore M, Boksman K, Gupta MA, Neufeld R, et al. Neural correlates of traumatic memories in posttraumatic stress disorder: a functional MRI investigation. *Am J Psychiatry* 2001; 158(11):1920-2.
- Gross JJ (editor). Handbook of emotion regulation. New York, Guilford pub; 2013; pp 322-325.
- Hopp H, Troy AS, Mauss IB. The unconscious pursuit of emotion regulation: Implications for psychological health. *Cogn Emot*. 2011;25(3):532-45.
- Garnefski N, Teerds J, Kraaij V, Legerstee J, van den Kommer T. Cognitive emotion regulation strategies and depressive symptoms: Differences between males and females. *Pers Individ Dif*. 2004; 36(2):267-76.
- Garnefski N, Kraaij V, Spinhoven P. Negative life events, cognitive emotion regulation and emotional problems. *Pers Individ Dif* 2001; 30(8):1311-27.
- Garnefski N, Boon S, Kraaij V. Relationships between cognitive strategies of adolescents and depressive symptomatology across different types of life event. *J Youth Adolesc* 2003; 32(6):401-8.
- Gross JJ, Levenson RW. Hiding feelings: the acute effects of inhibiting negative and positive emotion. *J Abnorm Psychol* 1997; 106(1):95-103.
- Bonn-Miller MO, Vujanovic AA, Boden MT, Gross JJ. Posttraumatic stress, difficulties in emotion regulation and coping-oriented marijuana use. *Cogn Behav Ther* 2011; 40(1):34-44.
- Samimi Z, Hasani J, Moradi A. The Effectiveness of Emotional Working Memory Training on Affective Control Ability in Adolescents with Post-Traumatic Stress Disorder. *Develop Psychol* 2016; 12 (47): 307-320 [In Persian].
- Gross JJ, John OP. Individual differences in two emotion regulation processes: implications for affect, relationships, and well-being. *J Pers Soc Psychol* 2003; 85(2):348-62.
- Gross JJ. Emotion regulation: taking stock and moving forward. *Emotion* 2013; 13(3):359-65.

19. Kanske P, Heissler J, Schönfelder S, Wessa M. Neural correlates of emotion regulation deficits in remitted depression: the influence of regulation strategy, habitual regulation use, and emotional valence. *NeuroImage* 2012; 61(3):686-93.
20. Harmer CJ, Hill SA, Taylor MJ, Cowen PJ, and Goodwin GM. Toward a neuropsychological theory of antidepressant drug action: increase in positive emotional bias after potentiation of norepinephrine activity. *Am J Psychiatry* 2003; 160(5):990-2.
21. Baddeley A. Working memory, thought, and action. Oxford :OUP; 2007;pp 210-211.
22. DeRubeis RJ, Siegle GJ, Hollon SD. Cognitive therapy versus medications for depression: treatment outcomes and neural mechanisms. *Nat Rev Neurosci* 2008; 9(10):788-96.
23. Engen H, Kanske P. How working memory training improves emotion regulation: neural efficiency, effort, and transfer effects. *J Neurosci* 2013; 33(30):12152-3.
24. Schweizer S, Hampshire A, Dalgleish T. Extending brain-training to the affective domain: increasing cognitive and affective executive control through emotional working memory training. *PLoS One* 2011; 6(9):e24372.
25. Mammarella N. Is Emotional Working Memory Training a New Avenue of AD Treatment? A review. *Aging Dis* 2014; 5(1):35-40.
26. Schmeichel BJ, Volokhov RN, Demaree HA. Working memory capacity and the self-regulation of emotional expression and experience. *J Pers Soc Psychol* 2008; 95(6): 1526-40.
27. Houben K, Dassen FC, Jansen A. Taking control: Working memory training in overweight individuals increases self-regulation of food intake. *Appetite*. 2016; 105:567-74.
28. Leone de Voogd E, Wiers RW, Zwitser RJ, Salemink E. Emotional working memory training as an online intervention for adolescent anxiety and depression: A randomised controlled trial. *Aust J Psychol* 2016; 68(3):228-38.
29. Schweizer S, Dalgleish T. The impact of affective contexts on working memory capacity in healthy populations and in individuals with PTSD. *Emotion* 2016; 16(1):16-23.
30. Schweizer S, Dalgleish T. Emotional working memory capacity in posttraumatic stress disorder (PTSD). *Behav Res Ther* 2011; 49(8): 498-504.
31. Xiu L, Zhou R, Jiang Y. Working memory training improves emotion regulation ability: Evidence from HRV. *Physiol Behav* 2016; 155 (1):25-9.
32. First MB, Spitzer RL, Gibbon M, Williams JB. User's guide for the structured clinical interview for DSM-IV axis I disorders SCID-I: clinician version. Virginia, American Psychiatric Pub, 1997; pp 29-35.
33. Mohammadkhani P, Jahani A, Tamanaeifar SH. Structured clinical interview for DSM-IV disorders, 4<sup>th</sup> ed., Tehran: Press Fradyd; 2007; pp 68-71 [In Persian].
34. Creamer M, Bell R, Failla S. Psychometric properties of the impact of event scale revised. *Behav Res Ther* 2003; 41(12):1489-96.
35. Vakili Y, Fata L, Habibi M. Effectiveness of Metacognitive Therapy in Patients with Post-Traumatic Stress Disorder: Three Case Studies. *J Clinic Psychol* 2014; 5(4): 99-108 [In Persian].
36. Garnefski N, Kraaij V, Spinhoven P. Manual for the use of the Cognitive Emotion Regulation Questionnaire. Leiderdorp, the Netherlands: DATEC, 2002; p 33.

37. Garnefski N, Kraaij V. Cognitive emotion regulation questionnaire—development of a short 18-item version (CERQ-short). *Pers Individ Dif* 2006; 41(6):1045-53.
38. Hasani J. The Psychometric Properties of the Cognitive Emotion Regulation Questionnaire (CERQ). *J Clinic Psychol* 2007; 3(7):73-85 [In Persian].
39. Schweizer S, Grahn J, Hampshire A, Mobbs D, Dalgleish T. Training the emotional brain: improving affective control through emotional working memory training. *J Neurosci* 2013; 33(12): 5301-5311.
40. Nazari MA, Khayati F, Poursharifi H, Hakimi A, Shojaee Z. Providing basic norm emotional Persian. *Psychol Applied Research* 2012; 4(4): 41-71 [In Persian].
41. Lundqvist D, Flykt A, Öhman A. The Karolinska directed emotional faces (KDEF). CD ROM from Department of Clinical Neuroscience, Psychology section, KI. 1998:91-630.
42. Roughan L, Hadwin JA. The impact of working memory training in young people with social, emotional and behavioural difficulties. *Learn Individ Differ* 2011; 21(6):759-64.
43. Duncan J. The multiple-demand (MD) system of the primate brain: mental programs for intelligent behaviour. *Trends Cogn Sci* 2010; 14(4):172-9.
44. Banich MT, Mackiewicz KL, Depue BE, Whitmer AJ, Miller GA, Heller W. Cognitive control mechanisms, emotion and memory: a neural perspective with implications for psychopathology. *Neurosci Biobehav Rev* 2009; 33(5):613-30.
45. Miller EK. The prefrontal cortex and cognitive control. *Nat Rev Neurosci* 2000; 1(1):59-65.
46. Brass M, Ullsperger M, Knoesche TR, von Cramon DY, Phillips NA. Who comes first? The role of the prefrontal and parietal cortex in cognitive control. *J Cogn Neurosci* 2005; 17(9):1367-75.
47. Owen AM, McMillan KM, Laird AR, Bullmore E. N-back working memory paradigm: a meta-analysis of normative functional neuroimaging studies. *Hum Brain Mapp* 2005; 25(1):46-59.
48. Price JL, Drevets WC. Neural circuits underlying the pathophysiology of mood disorders. *Trends Cogn Sci* 2012; 16(1):61-71.
49. Matejka MM, Kazzner P, Seehausen M, Bajbouj M, Klann-Delius G, Menninghaus W, et al. Talking about emotion: prosody and skin conductance indicate emotion regulation. *Front Psychol* 2013; 4:1-11.
50. Kelly AM, Garavan H. Human functional neuroimaging of brain changes associated with practice. *Cereb Cortex* 2005; 15(8):1089-102.