



Effectiveness of the Therapeutic Reconsolidation Process Model on Executive Functions, Cognitive Flexibility, and Schemas Related to Post-traumatic Stress in Neuropsychiatric Veterans above 25%

ARTICLE INFO

Article Type

Original Research

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How to cite this article

Salmanipour R, Pirkhaefi A, Peymani J, Foroghi A A. Effectiveness of the Therapeutic Reconsolidation Process Model on Executive Functions, Cognitive Flexibility, and Schemas Related to Post-traumatic Stress in Neuropsychiatric Veterans above 25%. Iranian Journal of War & Public Health. 2023;15(2):141-149.

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Article History

Received: April 10, 2023

Accepted: June 12, 2023

ePublished: August 5, 2023

ABSTRACT

Aims Post-traumatic stress disorder in people traumatized by war includes a set of clinical symptoms such as cognitive, emotional, behavioral, and physical symptoms. This study aimed to determine the effectiveness of training the therapeutic reconsolidation process model on improving executive functions, increasing cognitive flexibility, and modifying schemas related to post-traumatic stress disorder in neuropsychiatric veterans above 25%.

Materials & Methods This semi-experimental study in a pre-test, post-test design with a control group and a 45-day follow-up was conducted on the neuropsychiatric veterans above 25%. 40 people were randomly selected and assigned into the experimental (n=20) and control (n=20) groups. The therapeutic reconsolidation process model training was held for the experimental group in 12 sessions (90 minutes once a week). The research tools included the Post-Traumatic Stress Disorder Checklist, Leahy Emotional Schema Scale, Wisconsin Card Sorting Test, Stroop Color and Word Test, and Cognitive Flexibility Questionnaire. Data were analyzed using SPSS 24 software.

Findings In different study stages, there was a significant increase in the mean scores of response inhibition in the Stroop test, subscales of cognitive flexibility, compatible emotional schemas, and correct answers in the Wisconsin test, and a significant decrease in the mean scores of incompatible emotional schemas and incorrect answers in Wisconsin test, in the experimental group compared to the control group (p<0.05).

Conclusion The therapeutic reconsolidation process model is effective in improving executive functions, increasing cognitive flexibility, and modifying schemas related to post-traumatic stress disorder in neuropsychiatric veterans above 25%.

Keywords PTSD; Executive Functions; Neuronal Plasticity; Reconsolidation; Schema

CITATION LINKS

[1] Psychological health in veterans of the Iran-Iraq ... [2] Effectiveness of cognitive-behavioral therapy ... [3] Diagnostic and statistical manual of mental ... [4] Hoping for Grace: Early trauma, PTSD, and ... [5] Kaplan & Sadock's synopsis of psychiatry ... [6] Diagnostic and statistical manual ... [7] A model of emotional ... [8] Introduction: emotional schemas ... [9] Emotional schema ... [10] Predictors of posttraumatic growth in a multiwar ... [11] Tools to explore neuroplasticity in humans ... [12] The structural relationships of self-Compassion ... [13] Correlates of cognitive flexibility in veterans ... [14] Executive ... [15] Reconsolidation: a brief history a ... [16] Memory reconsolidation understood ... [17] Clinical translation of memory ... [18] Guidelines for creating juxtaposition ... [19] Updating memories--the role of prediction ... [20] Memory integration as a challenge to the ... [21] How the science of memory reconsolidation ... [22] Unlocking the emotional brain: Eliminating symptoms ... [23] Neuroscience of enduring change and psychotherapy ... [24] The PTSD Checklist (PCL): Reliability, validity, and diagnostic ... [25] Checking the validity and reliability of the Mississippi ... [26] Studies of interference in serial verbal ... [27] Neuropsychological ... [28] A compendium of neuropsychological tests ... [29] The executive functions in methadone maintenance ... [30] The WCST-64: a standardized short form ... [31] The Cognitive Flexibility Inventory: Instrument ... [32] Executive function and attention deficits in post-traumatic ... [33] Effectiveness of Powell's cognitive rehabilitation ... [34] Comparison of emotional schemes in war veterans ... [35] Synergistic effect of dermatophagoidesfarinae Cognitive flexibility predicts PTSD symptoms: observational ... [36] Some risk factors of asthma in bronchial asthma ... [37] Erasing problematic emotional learnings: Psychotherapeutic ... [38] Reconsolidation and the dynamic nature of ... [39] Sacrificing reward to avoid threat: Characterizing ... [40] Traumatic exposure and psychological ... [41] A chink in the armor: The influence of ... [42] Memory reconsolidation and the crisis of ... [43] AMaladaptive emotional schemas and emotional functioning: evaluation of an integrated ... [44] Emotional deregulation, dissociative experiences ... [45] Trauma cognitions are related to symptoms ...

Introduction

The Iran-Iraq war left devastating effects on soldiers, veterans, and their families for eight years [1]. A significant group of veterans suffer from post-traumatic stress disorder symptoms [2]. Post-Traumatic Stress Disorder (PTSD) includes a series of physical and mental disorders [3].

Regarding post-traumatic stress disorder, the American Psychological Association defines trauma as an emotional reaction to a horrific event such as an accident, sexual assault, or natural disaster, followed by shock and denial immediately after the event. There can also be long-term reactions, including unpredictable emotions, flashbacks, strained relationships, and even physical symptoms such as headaches or nausea. Some people face many problems for the rest of their lives, such as behavioral, emotional, cognitive, and interpersonal problems [4].

According to the definition of the Diagnostic and Statistical Manual of Mental Disorders - Fifth Edition (DSM-5), PTSD includes intrusive memories of the accident, persistent avoidance of stimuli reminiscent of the traumatic event, persistent negative changes in mood and cognition, and changes in arousal that are mainly excessive arousal and irritability following the traumatic event. These symptoms must exist for at least one month. PTSD symptoms and the relative predominance of different symptoms may change over time. The duration of symptoms also varies. In addition, symptom relapse and exacerbation may occur in response to reminders of the original injury, current life stressors, or recently experienced traumatic events [5, 6].

One of the cognitive problems of PTSD patients is their emotional schemas. According to Leahy, emotional schemas are defined as a set of organized principles or intellectual content of a person, which are tied to emotions, goals, memories, and behavioral tendencies and arise from the interaction of a person's early learning history and his natural temperament. And when they are activated, they have a significant impact on how life events are interpreted and reacted to. People may differ in the structure and evaluation of their emotional experiences (emotional schemas). On the other hand, maladaptive emotional schemas may cause the use of ineffective coping strategies such as avoidance, rumination, and worry [7, 8]. Leahy classified emotional schemas into 14 types, which are duration, need for control, shame/guilt, tolerance of mixed emotions, acceptance, normality, understandability, blame, rumination, expression, validation, numbing, the need for rationality, and connection with higher values [9].

The research results show the relationship between emotional schemas and cognitive flexibility in PTSD sufferers. In a research, Hijazi *et al.* found that

cognitive flexibility is related to more positive emotional schemas [10].

In the definition of cognitive flexibility, it can be said that "cognitive flexibility is the capacity of the central nervous system to reorganize structurally and functionally in response to the environment, afferent stimuli, and efferent demands" [11], which is one of the explanatory passages related to self-compassion in post-traumatic symptoms [12]. Therefore, people exposed to trauma with high cognitive flexibility, compared to people with weaker cognitive flexibility, reduce PTSD symptoms better and show optimistic expectations for the future and greater satisfaction with life. Hence, interventions designed to increase cognitive flexibility in veterans may be a valuable adjunct to the treatment of PTSD [12, 13].

On the other hand, one of the cognitive defects of veterans is the disturbance in their executive functions. Executive Functions (EFs), also called executive control or cognitive control, refer to a family of top-down mental processes that act as an umbrella to encompass a set of higher-order cognitive abilities required to study and achieve a goal [14]. Higher-order cognitive abilities include working memory, inhibitory control, cognitive flexibility, planning, reasoning, and problem-solving, which enable humans to achieve goals, adapt to everyday life situations, and manage social interactions. Executive functions have traditionally been associated with frontal lobe function. More recent evidence suggests that posterior and subcortical areas also play an important role in executive function processing, especially in the integration of sensory information and emotions [14]. One of the therapeutic approaches to eliminating PTSD symptoms that is supported by scientific research is the therapeutic model of Memory Reconsolidation (MR). According to the review conducted by Riccio *et al.*, memory reconsolidation was discovered during the years 1997 to 2000 and was introduced as an inherent and natural mechanism of the brain to change the content of memory [15]. The results of a century of study show that memories are not a fixed effect of past experience but dynamic entities that enable us to predict the results of future situations and choose appropriate behaviors [16]. The storage of information in memory takes place in two ways: First, the memory of specific personal experiences or episodic memory, which is not simply the cognitive and real memory of what happened, but the living memory of the learned mental experience of the event about the nature and behavior of the world (including people and self).

Second, semantic memory that produces symptoms includes nonverbal but clearly defined mental patterns that operate outside of awareness to create problematic behavior, mental states, and physical

conditions [17].

The cause of the problem or symptom in the patient is this unconscious emotional knowledge, which is related to at least one of the adaptive schemas or emotional reality structures of the person and includes an unconscious and non-verbal but completely coherent set of personal themes, goals, knowledge, meanings, and structures [16]. These things are the special structure of a person's emotional reality that is stored in the emotional implicit memory systems of the brain (limbic system and right hemisphere of the brain) [18]. Therefore, one of the main characteristics of working memory is flexibility, that is, its ability to integrate new information. This flexibility extends from a short period before reactivation to a short period after reactivation [19].

The Therapeutic Reconsolidation Process (TRP) model was developed and introduced by Ecker as a meta-method that is entirely determined based on the intrinsic function of the brain. Through experimental processes, this model can completely and permanently remove an acquired behavior, emotional learning, or emotional response and make changes in different types of memory. The implementation of this model is relatively simple in its nature, but its clinical implementation is complex and nuanced depending on personality, tolerance of emotional experience, extent and depth of repressed emotional distress, readiness to trust the therapist, and other variables among clients. Through the TRP model, the patient consciously examines the original problem as it was initially interpreted and the strategy that was formed as a solution to it to create a strategy that causes deep extinction and revision of the nature of the problem, a solution to deal with it, or both, which leads to the disappearance of symptoms [20-22].

The TRP model is done in three phases and seven stages. The first phase is preparation, which includes steps A, B, and C. Step A is the symptom identification, step B involves the retrieval of target learning, and step C is the identification of disconfirming knowledge. The second phase is transformation (Empirically Confirmed Process of Erasure, ECPE), which consists of steps 1, 2, and 3. Stage 1 is the reactivation of target learning, stage 2 is the Activation of disconfirming knowledge, and stage 3 is cross-learning by repeating the opposite symmetry. The third phase is Verification (V), which is the verification of the erasure of the target memory material and includes the step of observing and documenting the signs of erasure [19-21].

Two issues seem to be new in coherence therapy: in the first stage, the further development of this concept as the central principle of mental activity and self-organization, and in the second stage, the systematic use of coherence for quick and accurate recovery and dissolution of emotions that generate symptoms of schemas, which as a natural and

neurological process of the brain can lead to the complete and permanent removal of an acquired behavior or emotional reaction [23].

Many therapeutic approaches aimed at reducing the clinical effects of psychiatric disorders have been carried out by researchers and therapists over the years to relieve the mental and psychological pain of veterans, each of whom has achieved success in this field, but these treatments have not completely eliminated the disorder, and the symptoms of the disorder still remain in the memory and cause harassment to the veterans. The approach to solving this vacuum of treatment seems more necessary than ever. This research aimed to determine the effectiveness of the therapeutic reconsolidation process model on improving executive functions, increasing neurological flexibility, and modifying schemas related to post-traumatic stress disorder in neuropsychiatric veterans above 25%.

Materials and Methods

This study is applied research with a quasi-experimental method with a pre-test, post-test, and follow-up design (45 days) with a control group. The statistical population of the research was neuropsychological veterans above 25% with a diagnosis of PTSD, under the support of the Foundation of Martyrs and Veterans Affairs, who referred to the Sadr and Niayesh Hospitals in Tehran from 2021 to 2022. After setting the list, among 50 people, 40 people were selected by random sampling method and using Krejcie & Morgan table and were assigned to experimental (n=20) and control (n=20) groups. The tools used in the research are as follows:

1) PTSD Checklist for DSM-5 (PCL-5): This self-report scale is used to assess the extent of the disorder and to screen patients from normal individuals and other patients as a diagnostic aid. This checklist was developed by Weathers *et al.* [24] based on the DSM diagnostic criteria for the US National Center for PTSD. It contains 17 items, 5 of which are related to the signs and symptoms of re-experiencing the traumatic event, 7 of which are related to the signs and symptoms of emotional numbness and avoidance, and 5 of which are related to the signs and symptoms of intense arousal. This list has three versions as follows: Military version (PCL-M), which is the main version, Civilian version (PCL-C), and Specific version (PCL-S). By implementing this checklist on 117 people at Shiraz University, Goodarzi [25] determined the validity and reliability of this scale in Iran. The reliability of this checklist was obtained at 93% with Cronbach's alpha coefficient and 87% with the halving method (based on whether items are even or odd). To determine the validity of this scale, its correlation with the life events checklist was calculated. The obtained correlation coefficient was equal to 37%, which indicates the simultaneous validity of the scale.

2) Leahy Emotional Schemas Scale (LESS): This scale was made to measure emotional schemas. Its 28-question form was used in this research, which measures 14 subscales in the field of emotional schema on a six-point Likert scale. The scoring in this scale is as follows: completely correct = 6, almost correct = 5, slightly correct = 4, slightly incorrect = 3, almost incorrect = 2, and completely incorrect = 1. In some questions, the scoring is reversed. After summing up the scores for each subscale, the higher the person's score, the more the person goes towards negative emotions and is known to be more emotional. Its validity and reliability have been investigated in different groups. In his research, Leahy investigated the validity of the scale of emotional schemas using the correlation analysis of the items with each other and the correlation with Millon Clinical Multiaxial Inventory-III (MCMI-III), Beck's Depression Inventory (BDI), Beck Anxiety Inventory (BAI), and Cartwright-Houghton & Wells Metacognitions Questionnaire (MCQ) on 53 psychiatric patients. The results of this research showed that the majority of the 14 dimensions of this scale have significant correlations with anxiety and depression. Also, the results of the correlation between the dimensions indicated the acceptable validity of this scale. In addition, Leahy has reported the reliability of this scale using Cronbach's alpha coefficient as 0.81 [17].

3) Wisconsin Card Sorting Test: The Wisconsin Card Sorting Test is a useful tool for studying cognitive deficits following brain injuries and was applied as a standard neuropsychological test for measuring cognitive flexibility skills related to the function of the frontal lobe, especially the prefrontal lobe. This test is designed to measure cognitive flexibility and the ability to change cognitive sets based on abstract thinking. This test is used to measure executive function, which requires strategic planning, organized research, using environmental feedback to change cognitive sets, orienting behavior to achieve a goal and to moderate impulsive responses [26]. Lezak mentioned the validity of this test to measure cognitive deficits after brain damage above 0.86. The validity of this test is reported as 0.83 based on the agreement coefficient of evaluators in the study of Spreen & Strauss. Abidizadegan *et al.* mentioned the validity of this test in the Iranian population with the retest method as 0.85 [27-29].

4) The Stroop Color and Word Test (SCWT): The Stroop test was first developed in 1935 by Ridley Stroop to measure selective attention and cognitive flexibility. This test has been used in various researches in many clinical groups to measure response inhibition ability, selective attention, cognitive variability and cognitive flexibility. Researchers believe that the word color task measures response flexibility and inhibition. The amount of inhibition with interference is obtained by subtracting the score of the correct number of

inconsonant from the score of the correct number of consonants. Also, the longer average response time to inconsonant stimuli is another indicator to evaluate the interference. Validation of this test has been done with the help of experts in psychology and cognitive ergonomics. Reliability of the Stroop test has been reported in the range of 80% to 91% using retest [30].

5) Cognitive Flexibility Questionnaire: This questionnaire, which was created by Dennis and Vander Wal in 2010, is a short self-report tool with 20 questions, and its scoring is based on a 7-point Likert scale. This questionnaire tries to measure three aspects of cognitive flexibility, including 1) the tendency to perceive difficult situations as controllable, 2) the ability to perceive multiple alternative explanations for life occurrences and human behavior; and 3) the ability to generate multiple alternative solutions to difficult situations. The concurrent validity of this questionnaire with the Beck Depression Inventory was equal to 39%, and its convergent validity with Martin & Rubin's cognitive flexibility scale was 75%. These researchers obtained reliability by Cronbach's alpha method for the whole scale, perception of controllability, perception of multiple alternative solutions, and perception of multiple alternative explanations, respectively 91%, 91%, and 84%, and by retest method, respectively 81%, 75%, and 77%. In Iran, the test-retest reliability coefficient for the whole scale was reported as 71%, and for the subscales of perception of controllability, perception of multiple alternative solutions, and perception of multiple alternative explanations, it was reported as 72%, 55%, and 57%, respectively. These researchers reported Cronbach's alpha coefficient of the whole scale to be 90% [31].

From May to August 2022, intervention sessions were held for the experimental group. At the beginning of the first session, it was clearly explained to the participants what their responsibility is in this research, and in simple and clear language, the scientific and theoretical importance of the research topic, as well as the principle of confidentiality and the value of intervention sessions were clarified. Then, written consent and contract were drawn up to commit to participating in all meetings, and they were asked to answer the research questionnaires honestly and carefully. For the experimental group, training intervention therapy (TRP) was held for 12 sessions of 90 minutes once a week at Niayesh Hospital. The control group did not receive the treatment protocol. After the end of the sessions, to measure the effectiveness of the independent variable on the dependent variables, a post-test was conducted on both the experimental and control groups. To study the research subject more deeply and to strengthen the initial result, in the context that the influence of the independent variable on the dependent variables cannot be reversed, a follow-up test was conducted for the experimental group after 45 days.

Data analysis

Collected data were presented as frequency and percentage for qualitative variables and as mean and Standard Deviation (SD) for quantitative variables. To check the main hypothesis of the research and its subscales, the statistical test of mixed analysis of variance and analysis of variance with repeated measures was used. According to the Shapiro-Wilk test, all three variables of executive functions, cognitive flexibility and emotional schemas had normal distribution. Also, according to Levine's test, the assumption of equality of variances was established ($p>0.05$). Data was analyzed in SPSS 24.

Findings

A total of 40 people participated in the study, 20 people in the experimental group and 20 people in the control group.

In both groups, the majority of people were in the age group of 55-59 years with a diploma degree, and the percentage of veterans was between 25% and 30%. There was no significant difference between the experimental and the control groups in terms of age, education level, occupation, percentage of veterans, and hospitalization period before the intervention, and the two groups were almost homogeneous ($p>0.05$).

Table 1) Mean scores of variables of executive functions, cognitive flexibility, and emotional schemas of two groups in different stages

Variables	Pre-test		Post-test		Follow-up	
	Experimental	Control	Experimental	Control	Experimental	Control
The Stroop Color and Word Test						
Response inhibition	44.85±36.25	40.00±28.22	47.50±31.55	40.60±29.58	53.75±36.95	40.18±28.95
Wisconsin Card Sorting Test						
Correct answer	27.90±5.72	28.38±4.78	28.50±5.30	29.08±4.99	27.25±5.49	28.85±4.67
Wrong answer	18.15±4.52	19.83±7.61	15.20±3.91	18.63±4.10	13.95±2.76	18.68±4.13
Executive functions						
Alternatives	26.20±3.74	25.65±3.25	54.45±3.63	24.00±2.50	55.75±2.94	24.45±3.08
Control	19.50±2.68	17.93±2.42	80.42±2.78	18.03±1.99	45.15±2.89	18.18±2.30
Alternative for human behavior	5.20±0.95	5.53±1.30	10.60±0.99	5.28±1.13	11.05±0.83	5.53±1.22
Compatible emotional schemas						
Distrust	4.70±0.66	4.65±0.81	9.35±1.09	4.45±1.76	9.25±0.95	4.95±1.61
Lack of understanding	3.95±0.69	4.40±0.94	9.38±0.98	4.55±1.73	9.15±1.09	4.20±0.41
Lack of evaluation	9.30±1.17	9.25±0.84	4.65±1.69	8.60±1.34	4.20±0.77	9.13±0.76
Lack of control	4.65±0.81	4.45±0.94	9.75±0.85	4.65±0.81	9.30±0.85	5.05±1.43
Weak consciousness	4.40±0.82	4.20±0.41	9.25±0.97	4.50±0.76	9.33±0.73	4.10±0.31
Rejection	4.50±0.83	3.60±0.99	9.68±0.69	4.40±0.82	9.45±0.76	4.80±1.47
Poor expression	4.45±1.05	4.60±0.50	9.25±0.72	4.80±0.62	9.10±0.84	4.70±0.92
Incompatible emotional schemas						
Feel guilty	9.50±1.00	9.65±0.77	4.45±1.76	8.78±1.56	4.50±0.83	9.53±0.68
Simplicity of excitement	9.15±0.93	9.50±0.87	4.95±1.70	8.75±1.56	4.45±0.60	9.48±0.85
Lack of rationality	9.10±1.07	9.35±0.77	5.35±1.84	8.55±1.48	4.40±0.68	9.15±0.83
Numbness	9.35±0.81	9.18±0.87	4.40±0.88	9.08±0.66	4.80±1.32	8.60±1.30
Continuity of feeling	9.65±1.09	9.33±0.83	4.75±1.59	8.55±1.43	4.45±0.76	9.13±0.88
Rumination	9.75±1.02	9.58±0.96	4.90±1.37	8.80±1.57	4.70±0.92	9.45±1.01
Feeling ashamed	9.75±0.79	9.40±0.74	5.15±1.53	8.68±1.47	4.35±0.99	9.10±0.84

Table 2) Results of mixed variance analysis to examine the mean scores of components of executive functions and cognitive flexibility in PTSD with the Greenhouse-Geisser criterion

Variables	Factors	F	Sig.	Eta coefficient
The Stroop Color and Word Test				
Response inhibition	Test stage	3.92	0.03	0.08
	Experimental group	1.11	0.30	0.02
Wisconsin Card Sorting Test				
Correct answer	Test stage	90.88	0.001	0.61
	Experimental group	20.44	0.001	0.26
Wrong answer	Test stage	8.36	0.001	0.13
	Experimental group	8.44	0.01	0.13
Executive functions				
Alternatives	Test stage	695.48	0.001	0.92
	Experimental group	935.47	0.001	0.94
Control	Test stage	795.32	0.001	0.93
	Experimental group	1160.92	0.001	0.95
Alternative for human behavior	Test stage	242.47	0.001	0.81
	Experimental group	180.99	0.001	0.76

In the colored Stroop test, the average response inhibition score in the experimental group increased compared to the control group. The Wisconsin test

also showed an increase in scores in the post-test, and this score remained stable in the follow-up phase. In the post-test and follow-up phases, the

mean scores of incorrect answers in the experimental group decreased. In the cognitive flexibility test, the mean scores of the three subscales of alternatives, control, and Alternative for human behavior in the post-test and follow-up phases showed an increase in the experimental group compared to the control group. Also, in the test of emotional schemas, the mean scores of compatible emotional schemas increased in the post-test and follow-up, and the

mean scores of incompatible emotional schemas decreased (Table 1). The F value calculated for the effect of stages (pre-test, post-test, and follow-up) for the components of executive functions and cognitive flexibility in PTSD was significant ($p < 0.05$; Table 2). The F value calculated for the effect of stages (pre-test, post-test, and follow-up) for the components of schemas related to PTSD was significant ($p < 0.05$; Table 3).

Table 3) Results of mixed variance analysis to examine the mean scores of components of schemas related to PTSD with the Greenhouse-Geisser criterion

Variables	Factors	F	Sig.	Eta coefficient
Compatible emotional schemas				
Distrust	Test stage	78.34	0.001	0.58
	Experimental group	233.81	0.001	0.80
Lack of understanding	Test stage	101.18	0.001	0.64
	Experimental group	198.34	0.001	0.77
Lack of evaluation	Test stage	109.08	0.001	0.65
	Experimental group	249.36	0.001	0.81
Lack of control	Test stage	122.28	0.001	0.68
	Experimental group	212.00	0.001	0.79
Weak consciousness	Test stage	115.69	0.001	0.67
	Experimental group	303.13	0.001	0.84
Rejection	Test stage	80.97	0.001	0.58
	Experimental group	195.18	0.001	0.77
Poor expression	Test stage	91.57	0.001	0.61
	Experimental group	238.19	0.001	0.80
Incompatible emotional schemas				
Feel guilty	Test stage	105.59	0.001	0.65
	Experimental group	307.66	0.001	0.84
Simplicity of excitement	Test stage	91.35	0.001	0.61
	Experimental group	231.73	0.001	0.80
Numbness	Test stage	125.89	0.001	0.69
	Experimental group	266.31	0.001	0.82
Lack of rationality	Test stage	81.91	0.001	0.59
	Experimental group	192.27	0.001	0.77
Continuity of feeling	Test stage	122.98	0.001	0.68
	Experimental group	191.27	0.001	0.77
Rumination	Test stage	117.71	0.001	0.67
	Experimental group	160.38	0.001	0.73
Feeling ashamed	Test stage	122.52	0.001	0.68
	Experimental group	201.10	0.001	0.78

Discussion

This research aimed to determine the effectiveness of the therapeutic reconsolidation process model on improving executive functions, increasing neurological flexibility, and modifying schemas related to PTSD in neuropsychiatric veterans.

The research findings show an increase in response inhibition in the colored Stroop test, an increase in correct answers, and a decrease in incorrect answers in the Wisconsin test in the experimental group. The results indicate that the training of the TRP model has successfully been able to improve or eliminate previous traumatic emotional learning and lead to an increase in concentration, accuracy, and understanding of complex or abstract concepts, which ultimately leads to the acquisition of targeted skills based on the future, such as planning, improving cognitive performance, improving executive functions, and increasing cognitive flexibility, in PTSD patients. The findings of the present study are in agreement with the results of previous studies that stated that the executive

functions, memory, and attention of veterans with PTSD are improved by cognitive rehabilitation, and coping flexibility acts as a protective factor for post-traumatic stress in adults exposed to trauma and improves cognitive function and reduces PTSD symptoms [32-36].

Ecker showed in his research that the TRP model can be used for all symptoms caused by memory contents. This model can lead to a complete and sustained cessation of long-term core symptoms by neutralizing or eliminating lifelong, complex, and intense goal learning and emotional learning [37, 38]. Based on our findings, the scores of cognitive flexibility components, including subscales of alternatives, control, and human behavior alternatives, in the experimental group compared to the control group increased significantly ($p < 0.05$). The results show that the TRP model has been able to increase flexibility and reduce PTSD symptoms by creating self-conscious adaptation to new conditions, changing thoughts between multiple concepts, updating beliefs and thoughts, and thinking about

several elements at the same time. The results of this research are in line with the findings of researchers who stated that cognitive flexibility is associated with lower levels of PTSD symptoms, less guilt feeling, positive post-traumatic growth, and optimistic expectations for the future [12, 39, 40].

Haim-Nachum & Levy-Gigi, in their research, concluded that cognitive flexibility moderates the relationship between trauma and psychological well-being and that improving generalization learning may affect the recovery process of people from trauma [41]. Also, Ecker & Vaz stated that by identifying the basic mechanisms in the brain, reconsolidation of memory can lead to the change of target learning, the invalidation of subcortical emotional learning and behaviors and mental states [42].

In the variable of emotional schemas, the findings of the research showed a significant decrease in the scores in the incompatible subscales and a significant increase in the scores in the compatible subscales in the experimental group compared to the control group in the three stages of the study. This change is caused by the intervention of the TRP model, which has been able to correct dysfunctional emotional schemas such as feeling guilt, simplicity of excitement, lack of rationality, numbness, continuity of feeling, rumination, and feeling ashamed on the one hand, and on the other hand by using compatible strategies in the schemas of distrust, lack of understanding, lack of evaluation, lack of control, weak consciousness, rejection, and poor expression cause a change in how to interpret life events and react to them. This process ultimately led to the modification of schemas related to post-traumatic stress. The findings of this research are in line with the results of the research of Edwards *et al.* [43] and Kiamarsi *et al.* [44], who showed that emotional schema has a basic function and a key role in guiding emotional processes, emotional experience and performance, and correcting dissociative experiences and cognitive deficiencies, and strengthening emotion regulation skills may help reduce PTSD symptoms.

Zare *et al.* [34], in their study to compare emotional schemes in war veterans suffering PTSD with depression symptoms, anxiety symptoms, and without signs of depression and anxiety, concluded that emotional schemas in veterans with depression and anxiety and lack of symptoms are different. Therefore, in the treatment of these patients, attention should be paid to the role and replacement of compatible emotional schemas in the recovery of the disease.

In a study, Scher *et al.* [45] examined the relationships between trauma-related cognitions and PTSD symptoms before treatment and a long-term period after treatment. Findings showed that beliefs related to the reliability and trustworthiness of others, self-worth and judgment, threat of harm, and guilt were

associated with PTSD symptoms during follow-up. These data suggest that trauma-related cognitions are a potential mechanism for long-term maintenance of treatment gains for PTSD [45].

In the end, it should be mentioned that the training of TRP model has been effective in the study group, in the first stage, by correcting or removing previous traumatic emotional learnings, and changing beliefs, as well as correcting dysfunctional emotional schemas, and in the second stage, by creating self-conscious adaptability to new conditions, and applying adaptive strategies in PTSD patients in how they interpret life events and react to them. This model ultimately led to a reduction of clinical symptoms of post-traumatic stress disorder, such as intrusive thoughts, avoidance, intense arousal, and mood and cognitive changes in neuropsychiatric veterans above 25%.

Limitations

Veterans' entry into old age, lack of access to female veterans in the study group, availability of the studied sample during office hours, and limited entry and exit of the researcher during non-office hours were some of the limitations of this study.

Suggestions

It is suggested to conduct similar studies as well as longitudinal studies in the groups of female veterans and free men and in other cities.

Conclusion

The Therapeutic Reconsolidation Process (TRP) model is effective in improving executive functions, increasing cognitive flexibility, and modifying schemas related to post-traumatic stress disorder in neuropsychiatric veterans above 25%.

Acknowledgements: We hereby thank and appreciate all the dear ones who cooperated and assisted in this research, as well as all the precious veterans who are the pride of Iran and participated in this research.

Ethical Permission: This research was carried out with the permission of the Institute of Engineering and Medical Sciences of Veterans with the code IR.ISAAR.REC.1401.003. All the people who participated in the study were assured that all their information will be completely confidential both during the study and during the treatment.

Conflict of Interests: Nothing reported by the authors.

Authors' Contribution: Salmanipour R (First Author), Introduction Writer/Main Researcher/Statistical Analyst/Discussion Writer (40%); Pirkhaefi A (Second Author), Methodologist/Discussion Writer (30%); Peymani J (Third Author), Methodologist/Discussion Writer (15%); Foroghi AA (Fourth Author), Methodologist/Discussion Writer (15%)

Funding/Support: This article is extracted from the doctoral thesis of the first author.

References

- 1- Zarkar F, Forozandeh A, Mohammadi A, Bagerayan Sararodi R, Habibi M. Psychological health in veterans of the Iran-Iraq imposed war, 22 years after the war ended. *J Res Behav Sci.* 2013;10(6):544-53. [Persian]

- 2- Ramezani S, Mohammadi N, Sadri Damirchi E, Rahmani S. Effectiveness of cognitive- behavioral therapy on emotional control and signs of suicide in veterans with PTSD. *Iran J War Public Health*. 2018;10(1):1-7.
- 3- American Psychiatric Association. Diagnostic and statistical manual of mental disorders (DSM). Arlington: American Psychiatric Association. 2013.
- 4- Fidler, W. A. Hoping for Grace: Early trauma, PTSD, and complex PTSD in the military [Dissertation]. Carpinteria, CA: Pacifica Graduate Institute; 2021.
- 5- Sadok BJ, Sadock VA, Ruiz P. Kaplan & Sadock's synopsis of psychiatry: behavioral sciences. 11th Edition. Rezaei F, translator. Tehran: Arjmand Publications; 2015.
- 6- American Psychiatric Association. Diagnostic and statistical manual of mental disorders: DSM-5. Seyed Mohammadi Y, translator. Tehran: Ravan; 2013. [Persian]
- 7- Leahy RL. A model of emotional schemas. *Cogn Behav Pract*. 2002;9(3): 177-90.
- 8- Leahy RL. Introduction: emotional schemas, emotion regulation, and psychopathology. *Int J Cogn Ther*. 2012;5(4):359-61.
- 9- Leahy R L. Emotional schema therapy. *Couns Psychol Psychother*. 2021;29(3):45-57.
- 10- Hijazi AM, Keith JA, O'Brien C. Predictors of posttraumatic growth in a multiwar sample of U.S. Combat veterans. *Peace Confl J Peace Psychol*. 2015;21(3):395-408.
- 11- Christiansen L, Siebner HR. Tools to explore neuroplasticity in humans: Combining interventional neurophysiology with functional and structural magnetic resonance imaging and spectroscopy. *Handb Clin Neurol*. 2022;184:105-19.
- 12- Shafiei M, Mirdarivand F, Heidarirad H. The structural relationships of self-Compassion, cognitive flexibility and symptoms of post-traumatic stress disorder in victims of trauma in West of Iran. *J Res Psychol Health*. 2018;12(2):14-29. [Persian]
- 13- Keith J, Velezmore R, O'Brien C. Correlates of cognitive flexibility in veterans seeking treatment for posttraumatic stress disorder. *J Nerv Ment Dis*. 2015;203(4):287-93.
- 14- Cristofori I, Cohen-Zimmerman S, Grafman J. Executive functions. *Handb Clin Neurol*. 2019;163:197-219.
- 15- Riccio DC, Millin PM, Bogart AR. Reconsolidation: a brief history a retrieval view, and some recent Issues. *Learn Mem*. 2006;13(5):536-44.
- 16- Ecker B. Memory reconsolidation understood and misunderstood. *Int J Neuropsychother*. 2015;3(1):2-46.
- 17- Ecker B. Clinical translation of memory reconsolidation research: Therapeutic methodology for transformational change by erasing implicit emotional learnings driving symptom production. *Int J Neuropsychother*. 2018;6(1):1-92.
- 18- Ecker B. Guidelines for creating juxtaposition experiences. Clinical notes [Internet]. Coherence Therapy Clinical; 2016 [cited 2022 May 23]. Available from: <http://www.coherencetherapy.org/resources/notes.htm>
- 19- Exton-McGuinness MTJ, Lee JLC, Reichelt AC. Updating memories--the role of prediction errors in memory reconsolidation. *Behav Brain Res*. 2015;278: 375-84.
- 20- Gisquet-Verrier P, Riccio DC. Memory integration as a challenge to the consolidation/reconsolidation hypothesis: Similarities, differences and perspectives. *Front Syst Neurosci*. 2019;12:71.
- 21- Ecker B, Bridges SK. How the science of memory reconsolidation advances the effectiveness and unification of psychotherapy. *Clin Soc Work J*. 2020;48(3):287-300.
- 22- Ecker B, Ticic R, Hulley L. Unlocking the emotional brain: Eliminating symptoms at their roots using memory reconsolidation. 1st Edition. New York: Routledge; 2012.
- 23- Nadel L, Lane RD. Neuroscience of enduring change and psychotherapy: an introduction. In: Lane RD, Nadel L, editors. Neuroscience of enduring change. New York: Oxford University Press; 2020.
- 24- Weathers FW, Litz BT, Herman DS, Huska JA, Keane TM. The PTSD Checklist (PCL): Reliability, validity, and diagnostic utility. In: the 9th Annual Meeting of the International Society for Traumatic Stress Studies. San Antonio, TX: 1993.
- 25- Goodarzi MA. Checking the validity and reliability of the Mississippi Post-Traumatic Stress Disorder Scale. *J Psychol*. 2003;7(2):153-78. [Persian]
- 26- Stroop JR. Studies of interference in serial verbal reactions. *J Experimen Psychol*. 1935;18(6):643-62.
- 27- Lezak MD. Neuropsychological assessment. 3rd Edition. New York: Oxford University Press; 1995.
- 28- Spreen O, Strauss E. A compendium of neuropsychological tests: Administration, norms, and commentary. New York: Oxford University Press; 1991.
- 29- Abidizadegan A, Moradi A, Farnam R. The executive functions in methadone maintenance patients. *Adv Cogn Sci*. 2009;10(3):75-81. [Persian]
- 30- Greve KW. The WCST-64: a standardized short form of the Wisconsin card sorting test. *Clin Neuropsychol*. 2001;15(2):228-34.
- 31- Dennis JP, Vander Wal JS. The Cognitive Flexibility Inventory: Instrument development and estimates of reliability and validity. *Cogn Ther Res*. 2010;34(3):241-53.
- 32- Samadi R, Mohammad Razaghi Kashani E, Kami M, Rezaei O. Executive function and attention deficits in post-traumatic stress disorder: a study on Iranian war veterans. *Iran Rehabil J*. 2018;16(1):17-24.
- 33- Sahragard M, Alipour A, Zare H, Roshan R, Moudi M. Effectiveness of Powell's cognitive rehabilitation with neurofeedback in executive functions, memory, and attention to veterans with post-traumatic stress disorder. *Iran J War Public Health*. 2018;10(4):187-93.
- 34- Zare MM, Bagooli H, Kazemi SA, Javidi HA. Comparison of emotional schemes in war veterans suffering post-traumatic stress disorder with depression symptoms, anxiety symptoms and without signs of depression and anxiety. *Iran J War Public Health*. 2020;12(1):53-61.
- 35- Ben-Zion Z, Fine NB, Keynan NJ, Admon R, Green N, Halevi M, et al. Cognitive flexibility predicts PTSD symptoms: observational and interventional studies. *Front Psychiatry*. 2018;9:477.
- 36- Park M, Chang ER, You S. Protective role of coping flexibility in PTSD and depressive symptoms following trauma. *Pers Individ Differ*. 2015;82:102-6.
- 37- Ecker B. Erasing problematic emotional learnings: Psychotherapeutic use of memory reconsolidation research. In: Lane RD, Nadel L, editors. Neuroscience of enduring change: Implications for psychotherapy. New York: Oxford University Press; 2020.
- 38- Nader K. Reconsolidation and the dynamic nature of memory. *Cold Spring Harb Perspect Biol*. 2015;7(10):a021782.
- 39- Weaver S, Kroska EB, Ross MC, Sartin TA, Sellnow KA, Schaumberg K, et al. Sacrificing reward to avoid threat: Characterizing PTSD in the context of a trauma-related approach-avoidance conflict task. *J Abnorm Psychol*. 2020;129(5):457-68.

- 40- Fu F, Chow A. Traumatic exposure and psychological well-being: The moderating role of cognitive flexibility. *J Loss Trauma*. 2017;22(1):24-35.
- 41- Haim-Nachum S, Levy-Gigi E. A chink in the armor: The influence of training on generalization learning impairments after viewing traumatic stimuli. *Cognition*. 2019;193:104021.
- 42- Ecker B, Vaz A. Memory reconsolidation and the crisis of mechanism in psychotherapy. *New Ideas Psychol*. 2022;66(2):100945.
- 43- Edwards ER, Liu Y, Ruiz D, Brosowsky NP, Wupperman P. Maladaptive emotional schemas and emotional

- functioning: evaluation of an integrated model across two independent samples. *J Ration Emot Cogn Behav Ther*. 2021;39:428-55.
- 44- Kiamarsi A, Abolghasemi A, Taherifard M, Alian B. Emotional deregulation, dissociative experiences and cognitive failures in patients with and without posttraumatic stress symptoms. *Iran J Health Psychol*. 2020;3(1):31-42.
- 45- Scher CD, Suvak MK, Resick PA. Trauma cognitions are related to symptoms up to 10 years after cognitive behavioral treatment for posttraumatic stress disorder. *Psychol Trauma*. 2017;9(6):750-7.