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Effectiveness of Eye Movement Desensitization and Reprocessing (EMDR) on Trauma Symptoms and Executive Functions

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ABSTRACT

Purpose: This study aimed to determine the effectiveness of Eye Movement Desensitization and Reprocessing (EMDR) in reducing trauma-related symptoms and improving working memory, attention, and emotional inhibitory control among trauma-exposed adults.

Methods and Materials: This randomized controlled trial employed a pretest-posttest design with two parallel groups and was conducted in 2026 at Pirooz Counseling Clinic in Tehran, Iran. Forty adults with clinically meaningful trauma-related symptoms were purposively recruited and randomly allocated in a 1:1 ratio to an EMDR intervention group (n = 20) or a wait-list control group (n = 20). The intervention group received eight weekly individual EMDR sessions lasting 45–60 minutes. Outcomes were assessed using the PTSD Checklist for DSM-5 (PCL-5), Backward Digit Span, Trail Making Test Part A (TMT-A), and an affective Go/No-Go task. Data were analyzed using 2 × 2 mixed repeated-measures analyses of variance, with Group × Time interactions representing the primary tests of intervention efficacy.

Findings: Significant Group × Time interactions were found for trauma symptoms, $F(1, 38) = 34.62, p < .001, \eta^2 = .477$; working memory, $F(1, 38) = 18.94, p < .001, \eta^2 = .333$; attention/processing speed, $F(1, 38) = 22.17, p < .001, \eta^2 = .368$; and emotional inhibitory control, $F(1, 38) = 16.85, p < .001, \eta^2 = .307$. Bonferroni-adjusted posttest comparisons also demonstrated significantly lower PCL-5 scores ($p < .001$), higher Backward Digit Span scores ($p = .001$), shorter TMT-A completion times ($p = .004$), and fewer commission errors ($p = .001$) in the EMDR group compared with the control group.

Conclusion: Eight sessions of EMDR were effective in reducing trauma-related symptoms and improving multiple domains of executive functioning, including working memory, attention/processing speed, and emotional inhibitory control. These findings suggest that EMDR may provide cognitive as well as clinical benefits for trauma-exposed adults.

Keywords: Eye Movement Desensitization and Reprocessing; EMDR; Trauma Symptoms; Posttraumatic Stress; Working Memory; Attention; Emotional Inhibitory Control; Executive Functions

1. Introduction

Exposure to traumatic events can produce enduring psychological, emotional, cognitive, and behavioral

consequences that extend well beyond the immediate period following the event. Posttraumatic reactions may include intrusive memories, avoidance of trauma-related cues,

persistent negative changes in mood and cognition, hyperarousal, impaired concentration, heightened reactivity, and difficulties regulating emotions and behavior. Although these symptoms are most prominently conceptualized within the framework of posttraumatic stress disorder, the effects of trauma frequently involve broader disturbances in cognitive functioning, particularly in executive processes that support goal-directed behavior, flexible adaptation, working memory, attentional control, and inhibition of prepotent responses. Such disturbances are clinically important because executive functions are central to everyday functioning and influence an individual's capacity to organize behavior, maintain attention, regulate emotional responses, manage competing information, and inhibit maladaptive reactions. Cognitive difficulties may therefore contribute to the persistence of trauma-related impairment even when overt emotional symptoms are the primary focus of treatment. Contemporary cognitive rehabilitation research likewise indicates that higher-order cognitive functions, including memory and cognitive flexibility, are modifiable through targeted psychological interventions, reinforcing the broader proposition that cognitive outcomes should be considered alongside symptomatic improvement when evaluating treatment effectiveness (Pourjaberi et al., 2023).

Eye Movement Desensitization and Reprocessing (EMDR) has emerged as one of the most extensively discussed trauma-focused psychotherapeutic approaches for the treatment of posttraumatic stress and related psychological difficulties. EMDR is a structured intervention in which distressing memories are accessed while the individual simultaneously engages in bilateral stimulation, most commonly through guided eye movements, with the broader therapeutic process incorporating history taking, preparation, assessment, desensitization, installation of adaptive cognitions, body scanning, closure, and reevaluation. Its conceptual foundation is commonly associated with the Adaptive Information Processing framework, which proposes that distressing experiences may remain inadequately processed and stored in maladaptive memory networks, causing present-day triggers to activate the affective, cognitive, sensory, and physiological components of the original experience. Through reprocessing, EMDR is intended to facilitate integration of these experiences into more adaptive memory networks and reduce the intensity of trauma-related distress. Recent summaries of the field describe EMDR as an established and increasingly diversified intervention with applications across different traumatic experiences, age

groups, and clinical settings (de Jongh et al., 2024). Broader conceptual accounts also emphasize the distinctive combination of memory activation, bilateral stimulation, cognitive restructuring, and emotional processing that characterizes the method (Matten & Pausch, 2024; Palade & Goga, 2024). In clinical practice, EMDR has also been incorporated into other therapeutic frameworks, illustrating its potential compatibility with integrative models and its relevance beyond narrowly defined treatment protocols (Walker, 2024).

The empirical literature increasingly supports the use of EMDR across heterogeneous trauma-exposed populations. Studies have extended its application beyond conventional adult outpatient PTSD populations to children, adolescents, individuals with intellectual disabilities, patients with neurological conditions, emergency workers, and those receiving treatment through remote or technology-mediated formats. A multiple-baseline experimental investigation among very young children with PTSD provided preliminary evidence that EMDR may be feasible and potentially efficacious even in children between approximately 1.5 and 8 years of age, thereby expanding the developmental range in which trauma-focused reprocessing may be considered (de Roos et al., 2025). In children with intellectual disabilities, available evidence similarly suggests that EMDR may be adapted for individuals whose cognitive and communicative profiles require modification of conventional therapeutic procedures (Williamson & Rayner, 2023). A scoping review concerning EMDR in relation to child sexual abuse further highlighted the relevance of therapist knowledge, appropriate application, and adaptation of EMDR within highly vulnerable pediatric trauma populations (Montoya & Saunt, 2024). Taken together, these findings suggest that the therapeutic principles of EMDR are not limited to a single diagnostic group or developmental stage and that the approach may retain clinical utility when appropriately modified to individual needs.

The growing diversity of EMDR applications is also evident in adult clinical and high-risk populations. Farrell and colleagues evaluated group early-intervention EMDR delivered through videoconferencing among frontline and emergency workers affected by the COVID-19 pandemic, demonstrating that EMDR-based protocols can be implemented in group and remote formats for individuals exposed to intense occupational stress, trauma, and moral injury (Farrell et al., 2023). Similarly, a recent clinical case study reported the use of remotely delivered EMDR for

posttraumatic stress disorder in an adult with congenital heart disease, illustrating the feasibility of delivering trauma-focused reprocessing when face-to-face treatment may be difficult or clinically impractical (Callus, 2025). EMDR has also been explored among individuals with acquired brain injury and co-occurring posttraumatic stress symptoms, with retrospective evidence suggesting that trauma-focused processing may be feasible even in the presence of neurological impairment, provided that treatment is carefully adapted to the patient's cognitive and medical status (Janssen et al., 2023). In adolescent populations, EMDR has also been compared with pharmacological treatment. Research comparing EMDR and sertraline among depressed adolescents with childhood trauma indicates that trauma-focused psychotherapy may influence both emotional symptoms and trauma-related psychological functioning, thereby supporting its consideration as an intervention in complex presentations involving overlapping affective and trauma-related symptoms (Hu et al., 2023). These studies collectively underscore the expanding clinical scope of EMDR while emphasizing the importance of examining not only symptom reduction but also changes in cognitive and behavioral processes that may accompany successful trauma treatment.

Although reduction of trauma-related symptom severity remains the primary therapeutic goal of EMDR, there is increasing interest in understanding its effects on cognitive mechanisms. Trauma can place considerable demands on executive control systems because intrusive memories, hypervigilance, emotional arousal, and threat-related attentional biases compete with resources required for working memory and deliberate behavioral regulation. From this perspective, successful trauma processing may reduce the cognitive burden created by persistent emotional activation and thereby permit more efficient executive functioning. Experimental evidence concerning eye-movement interventions provides support for the possibility that eye movements influence the interaction between perception and memory processing. Wang and colleagues reported that eye movement intervention can facilitate concurrent perceptual and memory processing, suggesting that the cognitive mechanisms involved in bilateral stimulation may extend beyond simple distraction and may affect the allocation and integration of cognitive resources during memory activation (Wang et al., 2024). Such findings are especially relevant to EMDR because the procedure requires the individual to maintain aspects of a distressing memory in mind while simultaneously attending to an

external bilateral task. This dual-attention demand may modify the vividness, accessibility, emotional intensity, or subsequent processing of traumatic material, potentially producing downstream changes in cognitive efficiency.

Executive functioning is a multidimensional construct, and three components are particularly relevant in trauma-related disorders: working memory, attention, and inhibitory control. Working memory enables temporary storage and active manipulation of information and is essential for maintaining goals, integrating ongoing experience, and resisting interference. Attention allows selective allocation of cognitive resources and supports efficient processing of task-relevant information, whereas inhibitory control enables suppression of dominant or automatic responses when they are inappropriate. In trauma-exposed individuals, each of these processes may be compromised by the constant competition generated by intrusive memories and heightened emotional salience. Hypervigilance may draw attention toward perceived threat, intrusive recollections may occupy working-memory resources, and emotionally charged stimuli may reduce the ability to inhibit rapid defensive responses. Consequently, improvements in these executive domains may constitute an important but underexamined outcome of successful trauma-focused psychotherapy. The relevance of this possibility is supported by evidence that EMDR can influence executive domains directly. In veterans with PTSD, EMDR was reported to improve response inhibition and cognitive flexibility, suggesting that the treatment may affect functions associated with top-down cognitive control in addition to reducing trauma-related distress (Bonyadi et al., 2023). This finding is particularly important because inhibitory control is central to regulating impulsive, emotionally driven, or habitual reactions and may contribute substantially to functional recovery.

The potential cognitive effects of EMDR are also consistent with broader models of memory reconsolidation, attentional competition, and dual-task interference. During EMDR, the individual is asked to activate a distressing memory while engaging in bilateral stimulation, creating a condition in which the memory representation competes with an additional cognitive task. This competition may reduce the resources available to sustain the original vividness and emotional intensity of the memory. Over repeated processing cycles, such changes may alter the subjective and cognitive characteristics of the traumatic representation and reduce its capacity to dominate attention. Reviews of the EMDR literature emphasize that the

mechanisms of action remain an active area of investigation and likely involve multiple interacting processes rather than a single explanatory pathway (de Jongh et al., 2024). Contemporary descriptions of EMDR likewise highlight the importance of memory processing, emotional regulation, attentional engagement, and adaptive integration in explaining therapeutic change (Kurniawan et al., 2024). The relevance of such mechanisms is not restricted to PTSD. A recent meta-analysis examining EMDR for craving among individuals with substance use disorders found evidence that EMDR can reduce craving, suggesting that the intervention may influence emotionally salient and motivationally powerful memory networks outside the traditional domain of posttraumatic stress (Martínez-Fernández et al., 2024). These findings broaden the conceptual basis for investigating EMDR-related changes in cognitive control and emotional inhibition.

Another important issue concerns the relationship between symptom improvement and executive-function change. One possibility is that cognitive improvement occurs indirectly because reductions in intrusive recollections, arousal, and emotional distress free cognitive resources that were previously occupied by trauma-related processing. Under this explanation, working memory, attention, and inhibitory control improve as secondary consequences of reduced symptom interference. A second possibility is that components of EMDR directly exercise or modify cognitive processes through repeated dual-attention demands, memory updating, emotional exposure, and behavioral inhibition. These mechanisms are not mutually exclusive and may operate simultaneously. Evidence from different EMDR applications supports the plausibility of both direct and indirect pathways. For example, research in complex clinical populations shows that changes in trauma symptoms can occur alongside improvements in broader psychological functioning (Hu et al., 2023; Janssen et al., 2023), while experimental findings concerning eye movements suggest that the procedures themselves may influence concurrent cognitive processing (Wang et al., 2024). The possibility that EMDR affects both symptom severity and executive control therefore warrants direct examination using behavioral cognitive measures rather than relying solely on self-report indices of emotional distress.

The clinical literature also suggests that the effectiveness and implementation of EMDR may depend on contextual and procedural factors, including therapist training, treatment format, patient characteristics, developmental level, mode of delivery, and the nature of the traumatic

experience. The successful application of EMDR in remote settings, group formats, pediatric populations, and individuals with neurological or developmental difficulties suggests substantial adaptability, but it also highlights the need for carefully specified protocols and outcome measures (Callus, 2025; de Roos et al., 2025; Farrell et al., 2023; Williamson & Rayner, 2023). Similarly, the use of EMDR in child sexual abuse contexts requires sensitivity to developmental, relational, and safeguarding considerations (Montoya & Saunt, 2024), whereas application in acquired brain injury demands consideration of cognitive capacity and neurological limitations (Janssen et al., 2023). These variations reinforce the value of controlled studies employing standardized intervention schedules and clearly defined cognitive and clinical outcomes. A structured eight-session protocol is particularly useful in this respect because it allows the effects of a relatively brief, standardized course of EMDR to be examined under controlled conditions while remaining clinically feasible.

Despite the expanding evidence base, an important gap remains in studies that simultaneously assess trauma-related symptoms and multiple executive-function domains using behavioral tasks within the same randomized controlled design. Much of the EMDR literature has understandably concentrated on symptom reduction, diagnostic status, emotional distress, or trauma-memory characteristics. Studies examining cognitive outcomes frequently focus on a single domain or use specialized populations, making it difficult to determine whether treatment-related gains extend consistently across working memory, attention, and emotional inhibitory control. The available findings concerning response inhibition and cognitive flexibility among veterans suggest that such effects are plausible (Bonyadi et al., 2023), while research on cognitive rehabilitation in other psychological conditions demonstrates that cognitive processes can change meaningfully following structured intervention (Pourjaberi et al., 2023). Theoretical and experimental work on eye-movement procedures further supports the possibility that concurrent memory and perceptual processing may be altered during intervention (Wang et al., 2024). At the same time, the breadth of contemporary EMDR research, ranging from standard trauma treatment to remote delivery, developmental adaptations, neurological populations, and substance-related craving, indicates that its therapeutic effects may operate across multiple psychological systems rather than being restricted to a narrow reduction in PTSD

symptoms (Martínez-Fernández et al., 2024; Matten & Pausch, 2024; Walker, 2024).

Accordingly, examining executive functions alongside trauma symptoms may provide a more comprehensive understanding of the effects of EMDR and clarify whether clinical improvement is accompanied by measurable changes in cognitive performance. Such evidence could have practical implications for treatment planning because improvements in working memory may support everyday problem solving and goal maintenance, enhanced attention may improve concentration and task persistence, and stronger emotional inhibitory control may facilitate more adaptive responses to trauma-related cues. These domains are directly relevant to functional recovery and may influence social, occupational, and interpersonal adjustment after treatment. Furthermore, demonstrating changes across both symptom and behavioral cognitive measures would strengthen the interpretation that successful trauma treatment has effects beyond subjective distress alone. The continuing development and diversification of EMDR research indicates that such multidimensional evaluation is increasingly necessary for understanding how and for whom the intervention works (de Jongh et al., 2024; Palade & Goga, 2024), particularly as EMDR is applied across increasingly varied clinical contexts (Kurniawan et al., 2024). Therefore, the aim of the present study was to determine the effectiveness of an eight-session EMDR intervention in reducing trauma-related symptoms and improving working memory, attention, and emotional inhibitory control among trauma-exposed adults.

2. Methods and Materials

2.1. Study Design and Participants

The present study employed a classical experimental randomized controlled pretest–posttest design with two parallel groups to evaluate the effectiveness of Eye Movement Desensitization and Reprocessing (EMDR) on trauma-related symptoms and selected executive functions. The study was conducted in 2026 at Pirooz Counseling Clinic in Tehran, Iran, and all screening, assessment, and intervention procedures were carried out at this clinical setting. Participants were recruited purposively from individuals referred to psychological clinics because of trauma-related symptoms as well as through community advertisements. Following initial screening for eligibility and completion of baseline assessments, eligible participants were randomly allocated in a 1:1 ratio to either the EMDR

intervention group or the wait-list control group using a computer-generated random allocation sequence. The allocation process was conducted by a researcher who was not involved in outcome assessment in order to reduce the possibility of allocation-related bias. Because the intervention consisted of face-to-face psychotherapy, blinding of participants and therapists was not feasible; however, assessors responsible for administering the neuropsychological measures were kept unaware of participants' group assignments whenever practically possible. The analytic sample consisted of 40 adults, with 20 participants assigned to the EMDR group and 20 to the wait-list control group. Eligibility criteria included an age range of 18 to 60 years, a history of exposure to at least one potentially traumatic event, clinically meaningful trauma-related symptoms as indicated by the PTSD Checklist for DSM-5, sufficient ability to read and understand Persian, and willingness to refrain from initiating another trauma-focused psychological intervention during the study period. Exclusion criteria included current psychotic symptoms, manic episodes, severe cognitive impairment, acute suicidal risk requiring a higher level of clinical care, neurological disorders likely to substantially affect neuropsychological test performance, and changes in psychotropic medication during the intervention period. Participants who withdrew from the study, attended fewer than six EMDR sessions, or initiated another trauma-focused treatment during the intervention period were excluded from the per-protocol analysis. After enrollment, all participants completed informed consent procedures, demographic information, the clinical symptom measure, and the executive-function assessments at baseline. Following the intervention period, posttest assessments were administered within one week after completion of the eighth EMDR session. The wait-list control group did not receive a trauma-focused psychological intervention during the corresponding study period and was offered an appropriate clinical referral or delayed intervention after completion of posttest assessment, subject to the approved study protocol.

2.2. Data Collection Tools

The PTSD Checklist for DSM-5 (PCL-5) was used to assess the severity of trauma-related symptoms and served as the primary clinical outcome measure. The PCL-5 is a 20-item self-report questionnaire designed to assess posttraumatic stress symptoms corresponding to the diagnostic criteria of the fifth edition of the Diagnostic and

Statistical Manual of Mental Disorders. Each item is scored on a five-point Likert-type scale ranging from 0, indicating “not at all,” to 4, indicating “extremely,” resulting in a total score ranging from 0 to 80. Higher total scores represent greater severity of posttraumatic stress symptoms. The original psychometric evaluation of the instrument demonstrated excellent internal consistency, with a Cronbach’s alpha coefficient of .94, as well as strong test–retest reliability of $r = .82$ and satisfactory evidence of convergent and discriminant validity. The psychometric properties of the Persian version have also been supported, with a reported Cronbach’s alpha coefficient of .92, evidence of a five-factor structure, convergent validity of .74, and an inverse association of approximately .46 with resilience. In the present study, the PCL-5 was administered at both pretest and posttest to evaluate changes in trauma-related symptom severity. Although the instrument provides a standardized measure of symptom burden, it was used as a self-report outcome measure rather than as a substitute for a clinician-administered diagnostic interview.

Working memory was assessed using the backward condition of the Digit Span task. In this task, the examiner presented sequences of digits orally at a standardized rate, and participants were required to repeat each sequence in the reverse order. This procedure requires the temporary retention and active manipulation of verbal information and is therefore commonly used as an indicator of auditory working memory and attentional control. The score was based on the number of digit sequences correctly reproduced in reverse order, with higher scores representing better working-memory performance. The backward condition was selected because it places greater demands on manipulation and executive control than simple forward repetition. Digit Span tasks have been widely used in neuropsychological assessment, and Iranian normative data have highlighted the importance of considering demographic variables such as age, sex, and educational level when interpreting performance. In the current study, the Backward Digit Span was administered at both pretest and posttest, allowing comparison of changes in working-memory performance between participants receiving EMDR and those assigned to the control condition.

Attention and processing speed were evaluated using the Trail Making Test Part A (TMT-A), a commonly used neuropsychological task assessing visual scanning, sustained attention, psychomotor speed, and efficient sequencing. During administration, participants were instructed to connect a series of numbered targets in

ascending numerical order as rapidly and accurately as possible. Completion time, recorded in seconds, was considered the primary performance index, with shorter completion times indicating better attentional efficiency and faster information processing. Errors occurring during performance were corrected as part of the standardized administration procedure and recorded separately. Although TMT-A is frequently interpreted as an indicator of attention and processing speed, task performance may also be influenced by visual scanning ability, motor speed, familiarity with numerical sequencing, and test-related anxiety. Iranian normative data stratified by age, sex, and education have been reported and can provide an appropriate contextual framework for interpreting performance in Iranian samples. In the present study, TMT-A was administered before and after the intervention to assess whether EMDR was associated with improvements in attentional performance relative to the wait-list control condition.

Emotional inhibitory control was assessed using an affective Go/No-Go task. In this computerized behavioral paradigm, participants were required to respond rapidly to designated Go stimuli while withholding responses to No-Go stimuli presented in an emotionally salient context involving affective or emotional visual stimuli. The primary outcome variable was the number of commission errors occurring on No-Go trials, which represented failures to inhibit an inappropriate or prepotent response. Lower numbers of commission errors therefore indicated better inhibitory control. Additional performance indicators included omission errors and reaction time for correct responses to Go trials. The affective Go/No-Go task was particularly relevant to the objectives of the present study because trauma-related symptoms may interfere with the ability to regulate rapid behavioral responses when emotionally salient information is present. Trauma-related hyperarousal, heightened threat sensitivity, and emotional interference may increase competition between automatic affective responses and deliberate top-down cognitive control. Accordingly, changes in commission errors from pretest to posttest were used as the principal indicator of intervention-related improvement in emotional response inhibition, while the secondary indices provided supplementary information regarding response accuracy and processing speed.

2.3. Intervention

The experimental group received an eight-session individual Eye Movement Desensitization and Reprocessing intervention based on the standard eight-phase EMDR framework. Sessions were delivered once per week by a trained clinician familiar with EMDR procedures, and each session lasted approximately 45 to 60 minutes. The intervention was implemented flexibly according to each participant's level of emotional tolerance, with stabilization and resource-development procedures prioritized whenever distress exceeded the participant's capacity for effective processing. The first session focused on assessment and preparation and included clinical history taking, identification of relevant traumatic experiences and treatment targets, psychoeducation regarding trauma responses and EMDR, and instruction in safe-place imagery and basic stabilization strategies. The second session emphasized preparation and target planning through development of psychological resources, enhancement of affect tolerance, construction of a hierarchy of target memories, and establishment of baseline Subjective Units of Disturbance and Validity of Cognition ratings. During the third session, active target reprocessing began by identifying the disturbing image, associated negative cognition, emotional response, and relevant bodily sensations, followed by bilateral stimulation. The fourth session continued desensitization procedures, with attention to reducing subjective disturbance and strengthening a more adaptive cognition. The fifth session extended reprocessing to current triggers and included further bilateral stimulation, body scanning, and structured closure. The sixth session focused on development of a future template, in which participants mentally rehearsed adaptive responses to anticipated situations while bilateral stimulation was used to consolidate more functional patterns of responding. The seventh session emphasized integration and reevaluation through review of previously processed targets, identification of residual disturbance, and additional processing where required. The eighth and final session consisted of comprehensive reevaluation, review of changes in symptoms and functioning, closure of unresolved material when possible, relapse-prevention planning, and provision of further referral recommendations when clinically indicated. Across all sessions, the clinician monitored participants' emotional responses and adjusted the pacing of reprocessing according to individual tolerance in order to maintain safety and therapeutic engagement.

2.4. Data Analysis

Statistical analyses were conducted using two-sided significance tests with the alpha level set at .05. Descriptive statistics were first calculated to summarize demographic and clinical characteristics of the participants and to describe the distributions of the primary study variables at pretest and posttest. Baseline equivalence between the EMDR and wait-list control groups was evaluated using independent-samples *t* tests for normally distributed continuous variables and Mann–Whitney *U* tests when distributional assumptions were not adequately satisfied. Categorical variables were compared using chi-square tests or Fisher's exact tests, as appropriate. Prior to inferential analyses, the assumptions underlying parametric statistical procedures were examined. The normality of continuous outcome variables was assessed using Shapiro–Wilk tests in conjunction with visual inspection of Q–Q plots, while homogeneity of variance between groups was examined using Levene's test. The principal inferential analysis consisted of a 2×2 mixed repeated-measures analysis of variance conducted separately for each outcome variable. In these models, Group, consisting of the EMDR and wait-list control conditions, was treated as the between-subjects factor, whereas Time, consisting of pretest and posttest assessments, was treated as the within-subjects factor. The Group $\times$ Time interaction constituted the primary statistical test of intervention effectiveness because a significant interaction indicated that changes over time differed between participants receiving EMDR and those in the control condition. Separate models were evaluated for trauma symptoms measured by the PCL-5, working memory assessed through Backward Digit Span, attention and processing speed measured by TMT-A completion time, and emotional inhibitory control represented by commission errors in the affective Go/No-Go task. Effect sizes were quantified using partial eta squared (η^2), and 95% confidence intervals were considered where applicable. When statistically significant interaction effects were identified, Bonferroni-adjusted pairwise comparisons were used to further examine between-group differences and changes across assessment occasions while controlling for multiple comparisons. The analytic framework was designed to distinguish intervention-related change from general time-related variation and to provide both statistical significance and effect-size estimates for the clinical and executive-function outcomes.

3. Findings and Results

A total of 40 participants were included in the study and were equally allocated to the Eye Movement Desensitization and Reprocessing (EMDR) group ($n = 20$) and the wait-list control group ($n = 20$). All participants included in the per-protocol analysis completed both the pretest and posttest assessments. The mean age of participants was 34.10 years ($SD = 8.21$) in the EMDR group and 35.25 years ($SD = 7.88$) in the control group, with no statistically significant difference between the two groups, $t(38) = -0.45$, $p = .655$. Women constituted 60.0% of the EMDR group and 55.0%

of the control group, and the difference in sex distribution was not statistically significant, $\chi^2(1) = 0.10$, $p = .752$. University education was reported by 65.0% of participants in the EMDR group and 60.0% of those in the control group, with no significant between-group difference, $\chi^2(1) = 0.11$, $p = .743$. Furthermore, no statistically significant baseline differences were observed between the groups in PCL-5 scores, Backward Digit Span performance, TMT-A completion time, or Go/No-Go commission errors (all $ps > .05$), indicating satisfactory comparability of the two groups before implementation of the intervention.

Table 1

Pretest and Posttest Descriptive Statistics for Study Outcomes by Group

Outcome	Group	Pretest M (SD)	Posttest M (SD)	Change
PCL-5 total	EMDR	48.70 (7.04)	28.15 (8.11)	-20.55
	Control	47.95 (7.51)	45.80 (8.02)	-2.15
Backward Digit Span	EMDR	4.15 (0.93)	5.65 (1.04)	+1.50
	Control	4.25 (0.97)	4.40 (1.01)	+0.15
TMT-A time (s)	EMDR	78.40 (15.12)	62.10 (13.21)	-16.30
	Control	76.95 (14.81)	75.10 (14.35)	-1.85
Commission errors	EMDR	18.10 (4.22)	11.20 (3.81)	-6.90
	Control	17.75 (4.09)	16.95 (4.17)	-0.80

As shown in Table 1, the descriptive pattern of scores indicated considerably greater improvement in the EMDR group than in the wait-list control group across all study outcomes. Mean PCL-5 scores in the EMDR group decreased from 48.70 ($SD = 7.04$) at pretest to 28.15 ($SD = 8.11$) at posttest, representing a reduction of 20.55 points, whereas the control group demonstrated a considerably smaller reduction of 2.15 points. Working-memory performance, as measured by the Backward Digit Span, increased by 1.50 points in the EMDR group, compared with an increase of only 0.15 points in the control group. Similarly, TMT-A completion time decreased by 16.30 seconds in the EMDR group, compared with a reduction of 1.85 seconds in the control group, suggesting greater improvement in attention and processing speed following EMDR. Commission errors on the affective Go/No-Go task decreased by 6.90 errors in the intervention group, whereas the corresponding reduction in the control group was only 0.80 errors. Thus, the descriptive findings consistently

avored the EMDR intervention across trauma symptoms, working memory, attention and processing speed, and emotional inhibitory control.

Prior to conducting the inferential analyses, the assumptions underlying the mixed repeated-measures analysis of variance were evaluated. The planned analytical procedure included assessment of the normality of outcome distributions through Shapiro–Wilk tests and inspection of Q–Q plots, together with evaluation of homogeneity of variance using Levene’s test. Baseline comparisons also indicated that the EMDR and control groups did not differ significantly on any of the outcome variables before the intervention, supporting baseline comparability. Because the study included only two measurement occasions, pretest and posttest, the assumption of sphericity was not applicable to the within-subjects factor. However, the manuscript does not provide numerical results for the Shapiro–Wilk or Levene tests; therefore, exact assumption-test statistics cannot be reported without the original analysis output.

Table 2

Mixed Repeated-Measures ANOVA Results for Group $\times$ Time Interactions

Outcome	F(1, 38)	p	ηp^2
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PCL-5 total	34.62	< .001	.477
Backward Digit Span	18.94	< .001	.333
TMT-A time	22.17	< .001	.368
Commission errors	16.85	< .001	.307

The results of the mixed repeated-measures ANOVA demonstrated statistically significant Group $\times$ Time interaction effects for all four outcome variables. For trauma-related symptoms, the interaction effect was statistically significant, $F(1, 38) = 34.62$, $p < .001$, $\eta^2 = .477$, indicating that the decrease in PCL-5 scores across time was significantly greater in the EMDR group than in the control group. A significant interaction was also observed for working memory, $F(1, 38) = 18.94$, $p < .001$, $\eta^2 = .333$, demonstrating a greater improvement in Backward Digit Span performance among participants who received EMDR. For attention and processing speed, the

Group $\times$ Time interaction for TMT-A completion time was significant, $F(1, 38) = 22.17$, $p < .001$, $\eta^2 = .368$, indicating a substantially greater reduction in completion time in the EMDR group. Emotional inhibitory control also showed a significant Group $\times$ Time interaction, $F(1, 38) = 16.85$, $p < .001$, $\eta^2 = .307$, demonstrating that commission errors decreased significantly more in the EMDR group than in the control group. The partial eta-squared values ranged from .307 to .477, indicating substantial intervention effects across all four outcomes, with the largest effect observed for trauma-related symptoms.

Table 3

Bonferroni-Adjusted Posttest Comparisons Between the EMDR and Control Groups

Outcome	EMDR Adjusted M	Control Adjusted M	Mean Difference	95% CI	p
PCL-5 total	28.15	45.80	-17.65	[-23.12, -12.18]	< .001
Backward Digit Span	5.65	4.40	+1.25	[0.56, 1.94]	.001
TMT-A time (s)	62.10	75.10	-13.00	[-21.47, -4.53]	.004
Commission errors	11.20	16.95	-5.75	[-9.02, -2.48]	.001

The Bonferroni-adjusted pairwise comparisons further confirmed significant posttest differences between the two groups across all study outcomes. The adjusted mean PCL-5 score was significantly lower in the EMDR group than in the control group, with a mean difference of -17.65 points, 95% CI [-23.12, -12.18], $p < .001$, indicating substantially lower trauma-related symptom severity following the intervention. The EMDR group also demonstrated significantly better working-memory performance, with an adjusted Backward Digit Span mean difference of 1.25 points relative to the control group, 95% CI [0.56, 1.94], $p = .001$. TMT-A completion time was significantly shorter in the EMDR group, with a between-group mean difference of -13.00 seconds, 95% CI [-21.47, -4.53], $p = .004$, reflecting superior post-intervention attention and processing-speed performance. Finally, participants in the EMDR group made significantly fewer commission errors on the affective Go/No-Go task than participants in the control group, with a mean difference of -5.75 errors, 95% CI [-9.02, -2.48], $p = .001$. Because none of the confidence intervals included zero, the post-hoc comparisons consistently supported a significant advantage of EMDR over the wait-list condition

across clinical symptoms and all three domains of executive functioning.

4. Discussion and Conclusion

The present study examined the effectiveness of Eye Movement Desensitization and Reprocessing (EMDR) in reducing trauma-related symptoms and improving executive functions among trauma-exposed adults. The findings showed that participants who received eight sessions of EMDR demonstrated significantly greater reductions in posttraumatic stress symptoms than those in the wait-list control condition. In addition to this clinical improvement, the EMDR group showed significantly greater gains in working memory, faster performance on the Trail Making Test Part A, and fewer commission errors on the affective Go/No-Go task. The significant Group $\times$ Time interactions across all four outcomes, together with moderate-to-large effect sizes, suggest that the intervention was associated not only with symptom reduction but also with measurable improvement in cognitive processes related to active information maintenance, attentional efficiency, processing speed, and inhibition of emotionally salient responses. The

pattern of results is consistent with contemporary conceptualizations of EMDR as a trauma-focused psychotherapy that may influence both emotional processing and broader cognitive functioning. Current reviews describe EMDR as an established intervention for trauma-related psychopathology and emphasize that its therapeutic effects may extend beyond the attenuation of subjective distress to changes in memory processing, affect regulation, and adaptive cognitive integration (de Jongh et al., 2024; Matten & Pausch, 2024; Palade & Goga, 2024). The present findings therefore contribute to a growing body of evidence suggesting that successful trauma processing may be accompanied by improvements in domains of executive functioning that are frequently compromised by chronic hyperarousal, intrusive recollection, and attentional capture by trauma-related material.

The first major finding was that EMDR produced a substantial reduction in trauma-related symptoms compared with the wait-list control condition. The interaction effect for PCL-5 scores was the largest among the study outcomes, indicating that participants receiving EMDR experienced a markedly greater decline in posttraumatic symptom severity over time. This finding accords with the broader literature showing that EMDR is effective in reducing intrusive recollections, avoidance, negative emotional responses, and hyperarousal associated with traumatic experiences. The therapeutic logic of EMDR assumes that traumatic memories may remain insufficiently integrated within adaptive memory networks and may consequently retain high levels of sensory vividness, affective intensity, and physiological activation. Reprocessing such memories under conditions of bilateral stimulation and dual attention may reduce their emotional charge and facilitate more adaptive meaning-making. Reviews of the current state of EMDR science have similarly emphasized its capacity to modify maladaptively stored trauma-related information and reduce the clinical expression of posttraumatic stress (de Jongh et al., 2024). The effectiveness observed in the present study is also compatible with evidence from diverse trauma-exposed populations, including children with PTSD, adults receiving remote EMDR, individuals with acquired brain injury, and frontline or emergency personnel exposed to pandemic-related traumatic stress (Callus, 2025; de Roos et al., 2025; Farrell et al., 2023; Janssen et al., 2023). Although these studies differ in population, treatment context, and delivery format, their findings collectively support the view that EMDR can reduce trauma-related distress across a range of clinical circumstances.

The improvement in working-memory performance represents an important extension of the clinical symptom findings. Participants in the EMDR group showed a substantially greater increase in Backward Digit Span scores than participants in the control group. Working memory depends on the capacity to temporarily maintain and manipulate information while resisting distraction from competing internal and external stimuli. Trauma-related intrusions, hypervigilance, repetitive negative thought, and physiological arousal can consume limited cognitive resources, thereby reducing the efficiency with which information is actively held and transformed. From this perspective, improvement in working memory after EMDR may partly reflect a reduction in the cognitive burden imposed by intrusive trauma memories. When traumatic material becomes less vivid, emotionally disruptive, and attentionally dominant, more cognitive capacity may become available for goal-directed processing. Experimental evidence indicating that eye movements interact with concurrent memory and perceptual processing provides a plausible cognitive framework for this interpretation (Wang et al., 2024). The dual-task characteristics of EMDR require individuals to maintain traumatic material in mind while simultaneously engaging in bilateral stimulation, a process that may alter the vividness, accessibility, and emotional impact of the recalled material. The present findings also fit with broader evidence that cognitive functioning can be responsive to targeted psychological intervention. For example, cognitive rehabilitation research has demonstrated that memory-related and executive capacities such as prospective memory and cognitive flexibility can improve following structured intervention among individuals experiencing psychological difficulties (Pourjaberi et al., 2023). Although cognitive rehabilitation and EMDR operate through different mechanisms, both lines of evidence underscore the modifiability of executive processes in populations affected by emotional and cognitive dysfunction.

The significant improvement in attention and processing speed, reflected in reduced TMT-A completion time, further suggests that the benefits of EMDR may extend to the efficiency of basic executive-attentional functioning. Trauma-related symptoms frequently involve excessive monitoring of threat, difficulty disengaging from emotionally salient information, concentration problems, and reduced task persistence. Such processes may interfere with visual scanning, sustained attention, and efficient information processing. The substantial decrease in

completion time observed in the EMDR group may therefore indicate that symptom reduction was accompanied by improved allocation of attentional resources and reduced interference from trauma-related cognitive activity. This interpretation is consistent with work suggesting that EMDR involves complex coordination between perceptual processing, memory activation, and attentional engagement (Wang et al., 2024). It is also consistent with contemporary descriptions of EMDR that emphasize the interaction between emotional processing and cognitive reorganization rather than viewing treatment as solely a reduction of subjective distress (Kurniawan et al., 2024; Walker, 2024). As traumatic memories become less emotionally dominant, individuals may become better able to sustain attention on neutral task demands without being disrupted by intrusive thoughts, autonomic arousal, or anticipatory threat monitoring. Nevertheless, because TMT-A is influenced by several processes, including psychomotor speed and visual search, the observed effect should be interpreted as improvement in attentional-processing efficiency rather than as evidence of change in a single isolated cognitive mechanism.

The reduction in commission errors on the affective Go/No-Go task provides additional evidence that EMDR may enhance inhibitory control in emotionally demanding contexts. Participants receiving EMDR were significantly better able to suppress inappropriate responses to No-Go stimuli at posttest than participants in the control group. Emotional inhibitory control is particularly relevant in trauma because trauma-related cues can rapidly activate defensive responses, emotional arousal, and habitual patterns of reacting that may occur before deliberate regulatory processes are fully engaged. Improvement in this domain may therefore indicate greater top-down control over behavior in the presence of emotionally salient information. The present finding closely aligns with previous evidence showing that EMDR can improve response inhibition and cognitive flexibility among individuals with posttraumatic stress disorder (Bonyadi et al., 2023). Such convergence is especially important because it suggests that executive improvements following EMDR are not limited to subjective reports but can also be detected in behavioral measures requiring active response regulation. The findings may reflect decreased emotional interference, greater cognitive flexibility, improved regulatory control, or some combination of these processes. As the emotional intensity of trauma-related memory networks diminishes, participants may become less vulnerable to automatic

response activation and better able to pause, evaluate, and inhibit prepotent responses when situational demands require restraint.

The combined pattern of improvement across symptoms, working memory, attention, and inhibitory control supports a broader interpretation in which trauma treatment and executive functioning are functionally interconnected. Trauma does not operate only at the level of emotional distress; it can also disrupt cognitive systems involved in maintaining goals, shifting attention, suppressing irrelevant responses, and regulating behavior in emotionally challenging situations. Accordingly, successful trauma-focused therapy may produce cognitive benefits indirectly by reducing the amount of executive capacity consumed by intrusive recollection and hyperarousal. It is also possible that repeated engagement in the structured attentional and memory-processing demands of EMDR contributes more directly to changes in cognitive regulation. The current literature increasingly recognizes that EMDR may influence multiple interacting systems rather than a single mechanism (de Jongh et al., 2024). Research examining eye-movement interventions has likewise suggested that eye movements can influence the interaction between concurrent perception and memory processing, supporting the possibility that the procedure affects the way emotionally charged information competes for cognitive resources (Wang et al., 2024). The results of the present study therefore fit a model in which reduction of trauma-related memory interference allows executive processes to operate more efficiently, while the structured reprocessing procedures of EMDR may simultaneously strengthen adaptive cognitive engagement with previously distressing material.

The generalizability of the current results is also supported by the breadth of populations in which EMDR has been examined. Although the present study involved trauma-exposed adults in a clinical setting, prior research has reported potential benefits of EMDR among children, adolescents, individuals with intellectual disabilities, adults with acquired brain injury, people with chronic medical conditions, and individuals with substance-related problems (Callus, 2025; Hu et al., 2023; Janssen et al., 2023; Martínez-Fernández et al., 2024; Williamson & Rayner, 2023). The application of EMDR to children exposed to trauma has received particular attention, with recent research suggesting therapeutic benefit even in very young children with PTSD (de Roos et al., 2025). Reviews focused on populations affected by child sexual abuse have likewise emphasized increasing interest in the applicability of EMDR to trauma

resulting from severe interpersonal experiences (Montoya & Saunt, 2024). These findings are important because they indicate that the underlying therapeutic principles of EMDR may have relevance across developmental stages and clinical contexts. At the same time, variation in treatment response across populations suggests that intervention pacing, preparation, stabilization, and target selection should be adapted to individual needs rather than implemented mechanically.

The present findings are also compatible with studies demonstrating the adaptability of EMDR across different modes of delivery and therapeutic contexts. Remote and video-conference applications have shown that core EMDR procedures may remain clinically useful even when treatment is delivered outside conventional face-to-face settings (Callus, 2025; Farrell et al., 2023). Similarly, the integration of EMDR with broader psychotherapy frameworks has been discussed as a means of addressing complex trauma presentations that involve both emotional and cognitive difficulties (Walker, 2024). Such evidence strengthens the relevance of the current findings by suggesting that the observed benefits may reflect robust therapeutic processes rather than effects confined to a narrowly defined delivery format. EMDR has also been examined in relation to symptoms beyond conventional PTSD, including depression associated with childhood trauma and craving in substance use disorders (Hu et al., 2023; Martínez-Fernández et al., 2024). These applications support the proposition that maladaptively processed emotionally salient memories may contribute to several forms of psychopathology and that reprocessing them can potentially influence both affective symptoms and self-regulatory functioning.

Nevertheless, the cognitive findings should not be interpreted as establishing a direct neurocognitive mechanism of EMDR. Improvements in Backward Digit Span, TMT-A performance, and affective response inhibition could arise through several pathways, including reduction of anxiety, decreased intrusive thinking, improved sleep or arousal regulation, increased task engagement, expectancy effects, or repeated exposure to the assessment tasks. Research on EMDR mechanisms remains active, and no single explanatory model fully accounts for all observed treatment effects (de Jongh et al., 2024; Palade & Goga, 2024). Nevertheless, the present findings provide clinically meaningful behavioral evidence that symptom improvement can co-occur with enhanced cognitive performance. This is consistent with descriptions of EMDR as a structured

method that combines memory activation, attentional engagement, bilateral stimulation, cognitive reassessment, and emotional regulation within a unified intervention framework (Kurniawan et al., 2024; Matten & Pausch, 2024). Taken together, the results suggest that EMDR may have value not only for reducing distress associated with traumatic memories but also for improving the cognitive control processes required for everyday functioning.

A number of limitations should be considered when interpreting the findings. The sample was relatively small and recruited purposively from a clinical population, which limits statistical precision and reduces the extent to which the findings can be generalized to broader trauma-exposed populations. The use of a wait-list control condition also means that the study could not fully distinguish the specific effects of EMDR from nonspecific therapeutic influences such as therapist attention, expectancy, perceived support, or engagement in a structured treatment process. In addition, outcomes were measured only immediately before and after the intervention, and no follow-up assessment was conducted to determine whether symptom reduction and executive-function improvements were maintained over time. The selected executive-function tasks also do not represent process-pure measures; Backward Digit Span, TMT-A, and affective Go/No-Go performance can each be influenced by several cognitive and situational factors. Practice effects associated with repeated testing may also have contributed to performance changes, although the substantially greater improvement in the EMDR group reduces the likelihood that practice alone accounts for the findings. Finally, the absence of physiological, neuroimaging, or process-level measures prevents conclusions regarding the precise mechanisms responsible for the observed cognitive changes.

Future research should replicate these findings using larger, more diverse samples and multicenter designs to improve statistical power and external validity. Studies should include active comparison conditions, such as trauma-focused cognitive behavioral therapy or another structured psychotherapy, in order to determine whether the observed executive-function improvements are specific to EMDR or reflect broader consequences of successful trauma treatment. Longer follow-up periods are needed to evaluate the durability of changes in trauma symptoms and cognitive functioning. Future investigations should also employ multiple measures within each executive-function domain, thereby reducing reliance on single-task indicators and permitting latent-variable approaches to working memory,

attention, and inhibitory control. Mediation analyses could examine whether cognitive improvement is explained by reductions in trauma symptoms or whether changes in executive functioning independently contribute to clinical recovery. Neurophysiological, eye-tracking, electrophysiological, or neuroimaging measures may further clarify how bilateral stimulation and memory reprocessing alter cognitive-emotional networks. It would also be valuable to examine potential moderators of response, including trauma type, chronicity, baseline symptom severity, age, medication use, comorbidity, and previous treatment exposure.

From a clinical perspective, the findings suggest that practitioners may benefit from considering cognitive functioning as an important component of trauma assessment and treatment evaluation rather than focusing exclusively on symptom severity. When clinically appropriate, EMDR may be incorporated into trauma-focused care for individuals who present with both posttraumatic symptoms and difficulties involving concentration, working memory, distractibility, or emotional response control. Clinicians should assess cognitive complaints before treatment and monitor whether improvements in trauma symptoms are accompanied by changes in everyday executive functioning. Particular attention should be given to stabilization, pacing, and preparation for participants who demonstrate high emotional reactivity or limited tolerance for trauma processing. Behavioral measures of cognitive functioning may also provide useful supplementary indicators of treatment progress, especially when subjective symptom reports do not fully capture functional change. Treatment planning should remain individualized, with careful consideration of comorbid conditions, medication changes, neurological history, and the participant's capacity to engage safely in trauma reprocessing.

Authors' Contributions

All authors significantly contributed to this study.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

In this study, to observe ethical considerations, participants were informed about the goals and importance of the research before the start of the interview and participated in the research with informed consent.

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