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An Open-Label Feasibility Trial Examining the Effectiveness of a Cognitive Training Program, Goal Management Training, in Individuals With Posttraumatic Stress Disorder

Jenna E. Boyd[1,2,3], Charlene O'Connor[3,4], Alina Protopopescu[1,2,3], Rakesh Jetly[5,6], Shawn G. Rhind[7], Ruth A. Lanius[3,8,9,10], and Margaret C. McKinnon[1,2,3,11]

Abstract

Background: Posttraumatic stress disorder (PTSD) is associated with dysfunction across multiple cognitive domains including executive functioning, attention, and verbal memory. This dysfunction is associated with negative impacts on functional outcomes (e.g., work or social functioning) and reduced response to psychotherapy for PTSD. Despite this knowledge, little work has investigated the efficacy of cognitive remediation strategies in improving cognition and functional outcomes among individuals with PTSD.

Objective: The current study investigated the efficacy of an established cognitive remediation program, Goal Management Training (GMT), in improving cognitive functioning in a pilot sample of individuals with PTSD symptoms in an inpatient treatment setting.

Method: Thirty-four inpatients with PTSD symptoms participated in either GMT in addition to treatment as usual (TAU; consisting of psychiatric management, group and individual psychotherapy) (TAU+GMT; $n = 18$) or TAU alone ($n = 16$). The TAU+GMT group received neuropsychological assessment at baseline and posttreatment, while both the TAU+GMT and TAU groups received assessment with clinical self-report measures at baseline and posttreatment.

Results: Paired-sample t-tests revealed significant improvements on measures of executive functioning (e.g., response inhibition, cognitive flexibility), processing speed, sustained attention, and verbal memory in the TAU+GMT group. Mixed-design analyses of variance (ANOVAs) revealed a trend toward an interaction effect indicating potentially greater improvements on a measure of the ability to engage in goal-directed behaviors while highly emotional in the TAU+GMT group as compared to the TAU group.

Discussion: The results of this small feasibility investigation of GMT in PTSD point toward the potential efficacy of GMT in ameliorating cognitive difficulties in individuals with PTSD.

Keywords

cognitive dysfunction, cognitive remediation, emotion regulation, Goal Management Training, posttraumatic stress disorder

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[1]Department of Psychology, Neuroscience, and Behaviour, McMaster University, Hamilton, Ontario, Canada
[2]Mood Disorders Program, St. Joseph's Healthcare Hamilton, Ontario, Canada
[3]Homewood Research Institute, Guelph, Ontario, Canada
[4]Program for Traumatic Stress Recovery, Homewood Health Center, Guelph, Ontario, Canada
[5]Directorate of Mental Health, Canadian Forces Health Services Group Headquarters, Department of National Defence, Ottawa, Ontario, Canada
[6]Department of Psychiatry, University of Ottawa, Ontario, Canada
[7]Defence Research and Development Canada, Toronto Research Centre, Ontario, Canada
[8]Department of Psychiatry, Western University, London, Ontario, Canada
[9]Department of Neuroscience, Western University, London, Ontario, Canada
[10]Imaging Division, Lawson Health Research Institute, London, Ontario, Canada
[11]Department of Psychiatry and Behavioural Neurosciences, McMaster University, Hamilton, Ontario, Canada

Corresponding Author:
Margaret C. McKinnon, Department of Psychiatry and Behavioural Neurosciences, McMaster University, 100 West 5th Street, Hamilton, ON, Canada.
Email: mmckinno@stjoes.ca

Introduction

Posttraumatic stress disorder (PTSD) is a debilitating mental health condition that affects a significant proportion of the population, with 8% to 9% of North Americans meeting criteria for this disorder in their lifetime.[1,2] PTSD is associated with significant functional impairment, including reductions in work- and mental health-related quality of life,[3] impaired workplace performance,[4] and high use of medical care services.[5] Importantly, impairments in quality of life may persist following remission of PTSD symptoms.[6] PTSD is also associated with cognitive impairments across a range of domains, with a meta-analytic study indicating that PTSD is associated with medium to large effect size impairments across measures of verbal learning ($d = -0.62$), processing speed ($d = -0.59$), attention and working memory ($d = -0.50$), verbal memory ($d = -0.46$), executive function ($d = -0.45$), and language ($d = -0.43$), and with small effect size impairments across visuospatial functioning ($d = -0.38$), visual learning ($d = -0.32$), and visual memory ($d = -0.29$).[7] Similarly, a more recent meta-analysis identified mild to moderate executive functioning impairment among trauma-exposed individuals with PTSD as compared to trauma-exposed and healthy controls, regardless of the level of PTSD symptom severity, suggesting that cognitive dysfunction may be present even among individuals with milder levels of PTSD symptomatology.[8]

Cognitive dysfunction has been associated with poor functional outcomes among individuals with PTSD.[9,10] For example, among a sample of veterans with PTSD, impairments in verbal memory were associated with worse social and occupational outcomes.[9] Furthermore, the results of another study of veterans with PTSD indicated that heightened executive dysfunction was associated with higher self-reported impairments in occupational functioning (e.g., absenteeism) and poorer physical health-related quality of life.[10] Similarly, perceived cognitive impairment is a predictor of poor quality of life among military members and veterans with PTSD, after accounting for history of traumatic brain injury (TBI), PTSD symptoms, and depressive symptoms.[11]

Cognitive dysfunction has also been related to symptom severity. For example, inhibitory dysfunction (e.g., the ability to inhibit automatic responses, a component of executive function) has been related to re-experiencing and hyperarousal symptoms among individuals with PTSD, which has been thought of as impaired ability to regulate emotional responding.[12] Further, impaired cognitive functioning has been associated with reduced treatment response among individuals with PTSD.[13,14] Specifically, poor verbal memory performance predicted decreased response to cognitive behavioral therapy (CBT) for PTSD.[13] Moreover, among veterans with PTSD and co-morbid mild to moderate TBI, worse pretreatment executive functioning was associated with increased drop-out and poorer response to treatment with cognitive processing therapy.[14] Cognitive dysfunction appears to be stable over time among individuals with PTSD, such that although clinical symptoms fluctuate over time, cognitive and functional impairments demonstrate relative stability.[15] However, one study reported improvements in executive functions following psychotherapy for PTSD in a small sample of 15 individuals.[16]

Taken together, these findings indicate that cognitive dysfunction in PTSD may interfere with functional recovery and treatment response, even after controlling for TBI. The mechanisms for this are not yet fully understood; however, it has been hypothesized that executive dysfunction may be related to increased difficulty in coping with PTSD symptoms and thus increased emotional distress leading to reduced functioning in social and occupational roles.[10,14] Furthermore, difficulty encoding and recalling meaningful information (e.g., verbal memory deficits) may impact directly, response to psychotherapies such as CBT, where there is a significant component of encoding, recalling, and applying verbal information.[13] These findings indicate that treatment of cognitive dysfunction among individuals with PTSD who are experiencing cognitive difficulties is essential in achieving functional recovery from PTSD and in promoting symptomatic recovery by allowing these individuals to better respond to psychological interventions.

Despite findings of impaired cognitive functioning and associated functional impairment and reduced treatment response, only a handful of studies to date have examined the impact of structured cognitive remediation interventions, aimed at improving cognitive functioning, among individuals with PTSD.[17–19] These studies suggest that cognitive dysfunction in PTSD may respond to treatment intervention. For example, a nonstandardized intervention protocol aimed at improving cognitive functioning in PTSD found clinically effective (but not statistically significant) improvements on measures of cognitive functioning following implementation of a bottom-up executive training approach used in conjunction with transcranial direct current stimulation in a pilot sample of four patients.[17] Another recent study of individuals with PTSD examined the effectiveness of an eight-session computerized cognitive training program in reducing proactive interference, or the inability to inhibit irrelevant or unwanted information from intruding into working memory.[18] Compared to patients enrolled in a control condition (involving training using low levels of proactive interference), participants who received the active treatment reported lower re-experiencing symptoms and performed better on a working memory task at posttreatment.[18] Finally, Fine et al.[19] plan to investigate a web-based program that will provide computerized cognitive training to recent trauma survivors with the aim of

preventing the onset of PTSD symptoms by targeting executive functioning, emotion regulation, and emotional reactivity.

Notably, these studies have employed ''bottom-up,'' restitution-based approaches that begin with remediation of basic skills, such as attention (e.g., skill-drill exercises), advancing to more complex skills.[20] These approaches contrast with top-down approaches that begin with remediation of complex skills (e.g., executive functioning, problem-solving) and have the overall aim of improving basic skills via downstream effects and generalization to real-world functioning.[20] Notably, a recent meta-analysis of computerized cognitive training (bottom-up approach) in the treatment of cognitive dysfunction in major depressive disorder found no significant effects on executive functioning,[21] a key component of cognitive dysfunction among individuals with PTSD.[12]

Goal Management Training (GMT) is a cognitive remediation approach that employs ''top-down'' strategies taught in a staged manor, with the aim of reducing executive dysfunction and improving the ability to carry out goal-directed behaviors.[22] GMT provides patients with strategies that facilitate the resumption of supervisory control of cognitive processes and allow individuals to improve monitoring and execution of daily functions. GMT has demonstrated efficacy as a stand-alone approach and when used in conjunction with psychotherapy among populations characterized by cognitive difficulties, including older adults,[23,24] TBI,[22,25,26] attention deficit hyperactivity disorder,[27] polysubstance abuse,[28] and spina bifida[29] and was recently identified as an evidence-based strategy for the remediation of executive functioning difficulties for military members and veterans with TBI.[30] A recent meta-analysis of 21 treatment studies investigating GMT reported small-medium effect size improvements on measures of executive functioning, working memory, and long-term memory, as well as self- and other- (e.g., caregiver or therapist) reported executive difficulties, mental health status, and functional outcomes (e.g., instrumental activities of daily living).[31] The standard GMT protocol includes 9 sessions, and GMT has been found to be effective at varying lengths (6–24 sessions); however, greater number of treatment hours is associated with greater reduction in executive dysfunction.[31] Critically, with the exception of improvements in self- and other-rated executive functioning, these results were maintained at follow-up.[31]

Given the previous success of this intervention in remediating cognitive dysfunction across a host of clinical populations, we hypothesize that GMT has the potential to remediate a similar pattern of cognitive dysfunction observed among individuals suffering from PTSD. Accordingly, the aim of the current open-label feasibility study was to evaluate the effectiveness of GMT in reducing cognitive dysfunction in PTSD. Specifically, our primary aim was to determine whether a six-session program of GMT would result in improvements in cognitive domains impaired in PTSD and previously shown to be targeted by GMT. In particular, as noted in a recent meta-analysis of GMT across various populations (e.g., TBI, aging, polysubstance abuse), small-to-moderate effects across a wide range of executive function, working memory and long-term memory tasks have been found. Hence, it was within these domains we expected to see the most improvement. A secondary aim was to explore whether, relative to treatment as usual (TAU), augmentative participation in GMT, along with treatment as usual (TAU+GMT), would be associated with heightened functional improvement and greater reductions in clinical symptoms associated with executive dysfunction (e.g., emotion regulation).

Method

This study was approved by the Homewood Health Centre Research Ethics Board.

Participants

Sixty-five ($n = 65$) participants who met criteria for a probable diagnosis of Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) PTSD (e.g., assessed via structured interview of self-report assessment) were invited to participate in this study. Participants were included in the study if they (a) were between the ages of 18 and 65 years; (b) had a diagnosis of PTSD based on clinical interview with the Clinician-Administered PTSD Scale for DSM-5 (CAPS-5)[32] or scored above the proposed cut-point for a diagnosis of PTSD based on the PTSD Checklist for DSM-5 (PCL-5) (score of 33);[33] (c) were able to provide written, informed consent; and (d) were able to read and write in English. Exclusion criteria were evaluated for participants in the TAU+GMT group and included (a) treatment with antipsychotic medications known to adversely affect cognition; (b) electroconvulsive therapy within the past year; (c) history of a medical disorder known to adversely affect cognition in the past year (e.g., heart disease); and (d) history of TBI. Thirty-seven ($n = 37$) individuals elected to participate in TAU+GMT, and $n = 28$ individuals elected to participate in TAU. Within the TAU+GMT group, $n = 6$ individuals dropped out from the GMT group but not from TAU, and $n = 3$ individuals were discharged early or dropped out of the full treatment program. Two ($n = 2$) individuals were discharged early or dropped out of the treatment program in the TAU condition. Five ($n = 5$) individuals in the TAU+GMT group and $n = 2$ individuals in the TAU group did not complete follow-up assessment. Five ($n = 5$) individuals in the TAU+GMT group and $n = 8$

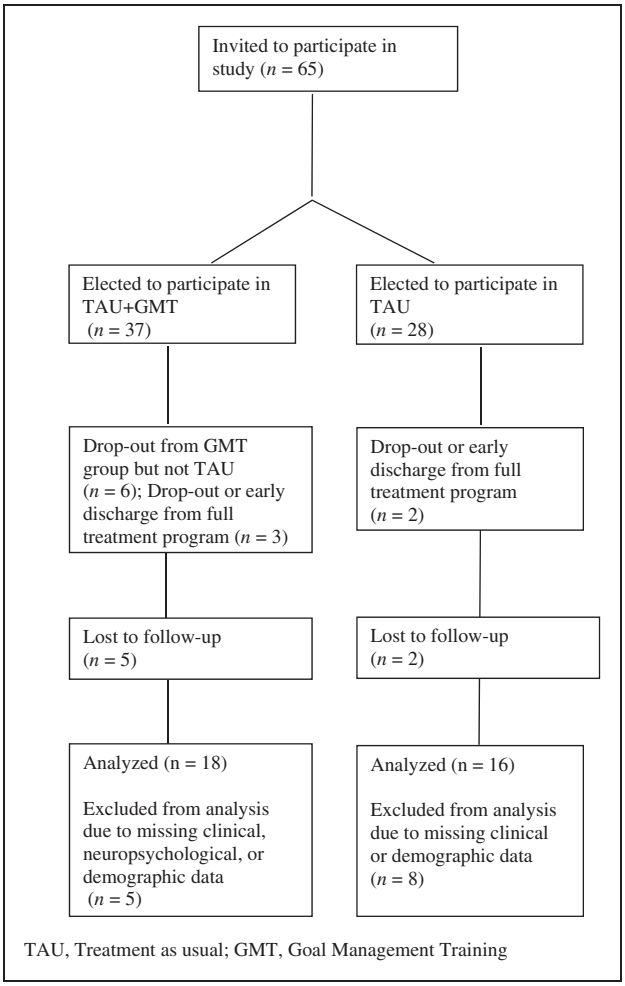

Figure 1. Consort diagram depicting recruitment, drop-out, and follow-up of study participants.

Table 1. Demographic and clinical characteristics of study sample.

	TAU+GMT ($n = 18$)	TAU ($n = 16$)
Demographic characteristics	*M* (*SD*)	
Sex (female:male)	5:13	9:7
Age	45.1 (8.0)	45.2(9.4)
Education	% of sample	
Some high school	0	5.5
High school	31	11
Technical or trade school	0	5.5
Some college or university	12.5	27.8
Diploma or bachelor's degree	56.2	27.8
Graduate degree	0	22
Military or first responder status	% of sample	
Military or veteran	33.3	50
First responder	18.9	25
Both	0	6.3
Clinical characteristics	*M* (*SD*)	
PCL-5 total score (baseline)	54.8(11.7)	62.9(10.1)*
CAPS-5 total score (baseline)	40.7(9.2)	n/a
IQ		
Premorbid IQ (WTAR)	103.9(9.4)	n/a
Estimated IQ (WASI-II)	109.9(27.6)	n/a
Additional M.I.N.I. 7.0 diagnoses	% of sample	
Major depressive disorder	77.8	n/a
Panic disorder	22.2	n/a
Agoraphobia	16.7	n/a
Social anxiety disorder	22.2	n/a
Generalized anxiety disorder	22.2	n/a
Obsessive compulsive disorder	0	n/a
Alcohol use disorder	5.6	n/a
Substance use disorder	5.6	n/a

TAU: treatment as usual; GMT: Goal Management Training; PCL-5: PTSD Checklist for Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition; CAPS-5: Clinician-Administered PTSD Scale for Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition; WTAR: Wechsler Test of Adult Reading; WASI-II: Wechsler Abbreviated Scale of Intelligence – II; M.I.N.I. 7.0: Mini International Neuropsychiatric Interview 7.0.
*$p < .05$, indicating a significant difference between the TAU + GMT and TAU groups.

individuals in the TAU group were excluded from the final analysis due to missing or incomplete neuropsychological, clinical, or demographic data, leaving a final sample of $n = 18$ TAU+GMT and $n = 16$ TAU participants. See figure 1 for a CONSORT diagram of dropout or loss to follow-up. Clinical and demographic characteristics of the study sample are provided in Table 1.

Experimental Design and Procedure

This study used an open-label feasibility trial design with the aims of (a) examining the feasibility of utilizing GMT among individuals with PTSD and (b) determining whether a subsequent randomized controlled trial should be conducted (e.g., does GMT lead to significant improvements on measures of neuropsychological and psychological functioning and functional outcomes, thereby warranting further investigation of this approach?). Participants were not randomly assigned to treatment groups but had the option to participate in TAU+GMT or TAU. Clinical assessors were aware of the treatment conditions in which participants were enrolled.

Participants were those receiving treatment on an inpatient psychological trauma treatment unit in Guelph, Ontario, Canada. All new patients admitted in the three weeks prior to the group commencing were invited to participate in the GMT program and research study. Patients who did not wish to participate in the GMT program, but who wanted to contribute to research, were asked to have their de-identified clinical data included in the study for comparison purposes.

Table 2. Description of GMT sessions.

GMT session	Description
Session 1: Absentminded slips	Introduce the concept of absentmindedness and absentminded slips, and discuss emotional and practical consequences.
Session 2: The automatic pilot	Describe "automatic pilot" as being a habitual mechanism which can lead to inappropriate responses or actions if not monitored.
Session 3: STOP the automatic pilot	Participants are introduced to the "STOP!" technique as a method of bringing one's attention to the present to monitor current behavior.
Session 4: The mental blackboard	The construct of working memory as a "mental blackboard," which can be erased or oversaturated with information, is explained. Participants are taught to check "the mental blackboard" to keep current goals in mind.
Session 5: State your goal and making decisions	Describe how goals can become entangled when attempting to multitask. Introduce the concept of stating one's goal as a way to aid encoding and recall of that goal. Introduce the concept of conflicting goals and detail strategies for how to make decisions.
Session 6: Check!	Review the material covered across previous sessions and underscore the importance of goal monitoring (the "STOP!" technique).

GMT: Goal Management Training.

Participants elected to participate in either (a) a 6-session structured cognitive remediation program, TAU+GMT group ($n = 18$) or (b) TAU group ($n = 16$). All participants were abstinent from alcohol or illicit drug use for the study period as per the policy of the inpatient treatment unit.

As part of routine clinical care, all participants (TAU+GMT and TAU) completed a self-report assessment battery on admission and discharge from the treatment unit. De-identified assessments from this battery (Measures and Materials section) were included in this study. At baseline (within the three weeks prior to the GMT group commencing), participants in the TAU+GMT group underwent assessment with the Mini International Neuropsychiatric Interview for DSM-5 to determine additional DSM-5 diagnoses and the CAPS-5 to confirm a diagnosis of PTSD.[32] They also received a battery of clinician-administered and self-report clinical, neuropsychological, and functional outcome measures at baseline and posttreatment (within two weeks after completion of GMT). Trained clinical researchers at the graduate level or higher administered all assessments.

Study Conditions

GMT. GMT is a structured, short-term cognitive remediation program with an emphasis on practicing skills to regain executive and self-regulatory control.[22] A shortened version of GMT was administered over a three-week period with 6 2-hour sessions. A 6-session version of GMT has been demonstrated to be effective[31] and was utilized due to logistical reasons (e.g., length of time on the inpatient unit, accommodation within other program elements). Over the course of the 6 sessions, participants were introduced to concepts including absentmindedness and automatic pilot errors and the usefulness of monitoring these errors in order to gain awareness of individual factors associated with executive functioning difficulties, including PTSD-related symptoms (e.g., flashbacks, hypervigilance). See Table 2 for details of information covered in each treatment session. GMT was administered by a registered occupational therapist highly experienced in the provision of GMT. Participants were provided with encouragement and support during and between sessions to encourage engagement with GMT.

TAU. TAU consisted of an eight-week inpatient treatment program for trauma-related psychological difficulties consisting of various components, including group treatment (e.g., emotion regulation skills training, mindfulness), individual treatment with a primary therapist using various approaches such as CBT, and medication management and consultation with an attending psychiatrist. No components of TAU focus specifically on cognitive functioning or remediation.

Measures and Materials

Symptom Measures. The PCL-5[34] is a 20-item self-report questionnaire that assesses symptoms of PTSD as per DSM-5 criteria with good test–retest reliability, convergent validity, and sensitivity (e.g., ability to detect clinical levels of PTSD symptomatology).[33,35,36] The PCL-5 assesses intrusive symptoms (PCL intrusions), avoidance (PCL avoidance), negative alterations in mood and cognition (PCL mood and cognition), and alterations in arousal and reactivity (PCL arousal and reactivity),

with the total PCL-5 score demonstrating good–high internal consistency (Cronbach's alpha (α) = 0.91–0.95).[36] A cut-off score of 33 has been found to be optimally efficient to detect PTSD cases according to DSM-5 criteria.[33]

The *Difficulties in Emotion Regulation Scale* (DERS)[37] assesses emotion regulation difficulties across six dimensions, including lack of awareness of emotional responses (awareness), lack of clarity of emotional responses (clarity), nonacceptance of emotional responses (nonacceptance), limited access to emotion regulation strategies (strategies), difficulties controlling impulsive behavior when experiencing negative emotions (impulsivity), and difficulty engaging in goal-directed behavior when experiencing negative emotions (goals).[37]

The Depression Anxiety and Stress Scale – 21-item version (DASS-21)[38] measures symptoms of depression (DASS depression) (low mood, motivation and self-esteem), anxiety (DASS anxiety) (physiological arousal, panic, and fear), and stress (DASS stress) (tension and irritability).[38]

Patient Health Questionnaire-9 (PHQ-9)[39]—The TAU+GMT group only completed the PHQ-9, a self-report questionnaire measuring symptoms of depression over the past week, and the degree to which participant's symptoms of depression have impacted their day-to-day activities over the past two weeks.[39]

Subjective Cognition. The TAU+GMT and TAU groups completed a brief self-report measure assessing subjective cognitive functioning, the *Cognitive Failure Questionnaire* (CFQ).[40] The CFQ assesses daily errors in distractibility, blunders, names, and memory with good internal consistency (α = 0.76–0.86).[41]

The TAU+GMT group only completed the *Dysexecutive Questionnaire-Self* (DEX),[42] a self-report questionnaire assessing four factors of executive functioning difficulties in nonneurological populations: inhibition, intention, social regulation, and problem-solving.[43]

Functional Outcomes. The TAU+GMT and TAU groups completed *The World Health Organization Disability Assessment Schedule 2.0* (WHODAS),[44] 12-item version to assess functional disability.

Neuropsychological Assessment. A battery of standardized and experimental neuropsychological measures aimed at measuring executive functioning, attention, and memory was administered to the TAU+GMT group only. *Current and premorbid intellectual functioning* (administered at baseline only): (a) Wechsler Test of Adult Reading:[45] estimate of premorbid IQ; (b) Wechsler Abbreviated Scale of Intelligence – II:[46] one subtest from the performance index (matrix reasoning) and one subtest from the verbal index (vocabulary) were administered to calculate current two-subtest full-scale IQ. *Declarative memory*: (a) California Verbal Learning Test-Second Edition (CVLT-II; standard form administered pretraining and alternate form administered posttraining):[47] word list learning task providing assessment of immediate and delayed memory, interference learning, and recognition. *Executive functioning*: (a) Controlled Oral Word Association Task:[48] a measure of verbal fluency, including phonemic (FAS) and semantic (animals) fluency; (b) Stroop Color and Word Test:[48] a measure of processing speed and sensitivity to suppress habitual responses; (c) Trail Making Test Part A & B:[48] measure of attention, speed, and mental flexibility, including the ability to sequence two stimulus sets while alternating between them; (d) Delis–Kaplan Executive Function System (DKEFS) Tower Test:[49] requires participants to place disks on dowels to match increasingly complex models while following "rules" constraining the movement of these disks. DKEFS Tower Test measures planning, rule learning, response inhibition, and perseveration. *Attention*: (a) Conner's Continuous Performance Test – Third Edition (CPT), a measure of sustained attention and response inhibition.[50]

Data Analysis

All analyses were completed using SPSS version 25.0. Analysis of the distribution of variables assessed in the current study revealed nonnormality of several variables (Shapiro–Wilk > .05). Parametric analyses were reported for clarity and ease of interpretation; however, nonparametric tests (not reported) revealed consistent results across analyses.

Independent samples t-tests or chi-square tests were used to analyze differences in demographic variables between the TAU+GMT and TAU groups at baseline. Repeated measures t-tests were used to analyze neuropsychological data within the TAU+GMT group in order to determine differences from baseline to posttreatment in performance on measures of neuropsychological functioning, with estimates of Cohen's *d* for effect size (interpreted conservatively as small = .20, medium = .50, and large = .80). Mixed-design 2 × 2 ANOVAs were used to determine differences from baseline to posttreatment on clinical variables between the TAU+GMT and TAU groups, with estimates of partial-eta squared for effect size (interpreted conservatively as small = .01, medium = .09, and large = .25).

In order to determine the extent to which individual participants improved across measures, we calculated the number of measures that each individual participant achieved an improvement of 1 standard deviation (SD) or higher, representing a rough estimate of clinically significant improvement as per the SD method (although this approach has been criticized as potentially

overestimating level of clinically significant improvement).[51] This was conducted for only those measures that demonstrated statistically significant improvement in the entire TAU+GMT sample. For each measure that demonstrated statistically significant improvement in the sample, we also calculated the number of individual participants who demonstrated slight worsening or no change (0 SD or less), a change of 0 to 0.5 SD, a change of 0.6 to 1.0 SD, a change of 1.1 to 1.5 SD, and a change of 1.6 SD or greater.

Results

No adverse effects of participation in TAU+GMT group were reported.

No differences emerged between the TAU+GMT and TAU groups on any demographic variables at baseline.

Neuropsychological Functioning in the TAU+GMT Group

Significant improvements were found from baseline to posttreatment on the Stroop Word T Score ($t(17) = -2.73$, $p = .014$, $d = -0.64$) and Color–Word T Score ($t(17) = -2.52$, $p = .022$, $d = -0.59$), the WAIS-IV Coding Scaled Score ($t(17) = -3.69$, $p = .002$, $d = -0.87$), the DKEFS Tower Time Per Move Scaled Score ($t(17) = -4.11$, $p = .001$, $d = -0.97$) and Rule Violations ($t(17) = 3.07$, $p = .007$, $d = 0.72$), the Short Delay Free Recall Z Score ($t(17) = -2.64$, $p = .017$, $d = -0.62$) and the Long Delay Cued Recall Z Score ($t(17) = -2.36$, $p = .030$, $d = -0.56$) on the CVLT-II and on the CPT 3.0 Omissions T Score ($t(17) = 2.76$, $p = .013$, $d = 0.65$), Commissions T Score ($t(17) = 2.87$, $p = .011$, $d = 0.68$), and the Detectability T Score ($t(17) = 3.04$, $p = .007$, $d = 0.72$). The results of paired-sample t-tests comparing pre- versus postneuropsychological and psychological performance in the TAU+GMT group only are presented in Table 3.

It was found that 72.2% of the sample improved by 1 SD or greater on at least one measure that demonstrated statistically significant improvement within the entire TAU+GMT sample; 5.6% of the sample improved on 1 measure, 38.9% of the sample improved on 2 measures, 5.6% of the sample improved on 3 measures, 5.6% of the sample improved on 4 measures, and 16.7% of the sample improved on 5 measures. 27.8% of the sample demonstrated no such improvement. The extent to which the sample improved on each statistically significant measure is reported in Table 4.

Psychological Functioning in the TAU+GMT Group

Within the TAU+GMT group, significant improvements were found from pre- to posttreatment for the PHQ-9 depression ($t(14) = 3.19$, $p = .007$, $d = 0.82$) and impairment scores ($t(14) = 5.13$, $p = .000$, $d = 1.32$). There was a trend toward a significant improvement on the DEX within the TAU+GMT group ($t(15) = 2.94$, $p = .010$, $d = 0.76$).

Comparison of Psychological Functioning in the TAU Versus TAU+GMT Groups

Main effects of time were found across all psychological measures and measure subscales administered (all $p < .05$; $\eta^2_p = .21$–$.71$), suggesting that the TAU+GMT group and the TAU group improved on total and subscale scores of the PCL-5, DASS, DERS, CFQ, and WHODAS.

Main effects of group were found for PCL-5 total and subscale scores (all $p < .05$; $\eta^2_p = .13$–$.26$), with the exception of the arousal and reactivity subscale, where the TAU group demonstrated higher scores at pre- and posttesting in comparison to the TAU+GMT group, suggesting a higher level of PTSD symptom severity in the TAU group. A main effect of group was found for the DERS awareness subscale ($F(1,32) = 12.23$, $p = .001$, $\eta^2_p = .28$), such that the TAU+GMT group demonstrated higher scores at pre- and posttesting, in comparison to the TAU group, suggesting greater levels of difficulty in awareness of emotions in the TAU+GMT group.

No significant Group × Time interaction effects emerged. However, there was a trend toward a Group × Time interaction effect for the DERS goals subscale ($F(1,32) = 2.92$, $p = .097$, $\eta^2_p = .08$) assessing the ability to engage in goal-directed behavior when experiencing negative emotions. Simple main effect analysis revealed a significant reduction on DERS goals in the TAU+GMT group ($F(1,32) = 19.29$, $p = .000$, $\eta^2_p = .38$). A smaller, nonsignificant reduction emerged on the DERS goals in the TAU group ($F(1,32) = 3.21$, $p = .083$, $\eta^2_p = .09$), suggesting greater improvement on this subscale in the TAU+GMT group. Results of the mixed-design ANOVAs comparing pre- and posttreatment outcomes in the TAU and TAU+GMT groups are presented in Table 5.

Discussion

The results of this study point to the possibility that GMT may serve as an effective cognitive intervention for individuals with PTSD. In particular, our results demonstrate that it is possible to conduct GMT within an inpatient PTSD sample and that GMT is associated with improvements on measures of neuropsychological functioning. In addition, 72.2% of the sample demonstrated potentially clinically significant improvement on at least one measure where clinically significant improvements were found within the entire TAU+GMT sample.

Table 3. Neuropsychological outcomes of patents who received GMT+TAU ($n = 18$).

Test	Assessment time		Effect size (Cohen's *d*)
	Baseline *M* (*SD*)	Posttreatment *M* (*SD*)	
Stroop Color and Word Test			
Word T Score	40.67 (14.62)	46.28 (13.68)*	−0.64
Color T Score	41.50 (11.34)	45.94 (13.26)	−0.29
Color–Word T Score	44.33 (8.07)	49.00 (8.25)*	−0.59
Interference T Score	47.39 (8.20)	49.94 (6.13)	−0.33
WAIS-IV Coding Scaled Score	9.22 (1.90)	10.56 (2.28)**	−0.87
COWAT			
FAS T Score	48.61 (10.15)	49.89 (7.99)	−0.16
Animals T Score	49.06 (11.66)	50.78 (10.39)	−0.22
Trail Making Test			
Trails A T Score	54.17 (12.99)	58.89 (12.07)	−0.37
Trails B T Score	45.78 (12.80)	50.22 (14.43)	−0.36
DKEFS Tower Test			
Total Score Scaled Score	10.83 (2.57)	10.94 (2.21)	−0.04
First Move Time Scaled Score	11.06 (1.89)	11.50 (2.09)	−0.19
Time Per Move Scaled Score	11.00 (1.03)	12.28 (1.23)**	−0.97
Move Accuracy Scaled Score	9.06 (2.62)	9.00 (2.45)	0.03
Rule Violations	1.33 (1.57)	0.39 (0.61)**	0.72
CVLT-II			
Trial 1 Z Score	−0.53 (1.09)	−0.72 (0.94)	0.13
Trials 5 Z Score	0.00 (0.75)	0.25 (0.79)	−0.30
Trial 1-5 T Score	50.67 (8.27)	52.39 (6.90)	−0.21
Trial B Z Score	−0.28 (1.05)	−0.89 (0.76)	0.49
Short Delay Free Recall Z Score	0.06 (0.77)	0.47 (0.85)*	−0.62
Short Delay Cued Recall Z Score	0.08 (0.77)	0.42 (0.82)	−0.39
Long Delay Free Recall Z Score	−0.11 (0.70)	0.11 (0.81)	−0.36
Long Delay Cued Recall Z Score	−0.06 (0.68)	0.33 (0.64)*	−0.56
Repetitions Z Score	0.08 (0.90)	−0.19 (0.94)	0.26
Intrusions Z Score	0.86 (1.04)	0.64 (1.26)	0.16
Discriminability Z Score	0.06 (0.78)	0.25 (0.84)	−0.23
CPT 3.0			
Ommissions T Score	45.83 (1.47)	44.94 (0.64)*	0.65
Commissions T Score	48.83 (7.37)	43.17 (6.67)*	0.68
Detectability T Score	46.06 (6.65)	39.72 (8.10)**	0.72
Hit Rate T Score	45.06 (8.05)	48.61 (8.21)	−0.45
Variability T Score	47.11 (6.32)	47.44 (7.00)	−0.04
Perseveration T Score	47.28 (4.07)	48.39 (6.54)	−0.14

GMT: Goal Management Training; TAU: treatment as usual;WAIS-IV: Wechsler Adult Intelligence Scale Fourth Edition; COWAT: Controlled Oral Word Association Task; DKEFS: Delis–Kaplan Executive Function System; CVLT-II: California Verbal Learning Test-Second Edition; CPT: Conner's Continuous Performance Test – Third Edition.

*$p < .05$; **$p < .01$

Note: FAS is a subtests for the COWAT that stands for the letters F A and S.

However, with respect to the exploratory analyses on clinical variables, while one trend-level interaction effect was found, it remains unclear the extent to which GMT may impact clinical symptoms relative to TAU.

The results of our analyses revealed significant, focused gains on tasks assessing cognitive domains commonly affected in PTSD, including executive processes, processing speed, response inhibition, sustained attention, and verbal short-term memory (on select measures only). Specifically, participation in GMT was associated with significant posttreatment improvements on an executive functioning measure, and on measures assessing

Table 4. Percent of sample achieving different levels of change for neuropsychological measures with statistically significant change in the TAU+GMT group.

	Less than 0 *SD*	0–0.4 *SD*	0.5–0.9 *SD*	1.0–1.4 *SD*	1.5 *SD* or greater
Test	% of sample				
Stroop Color and Word Test					
Word T Score	22.2	33.3	22.2	11.1	11.1
Color–Word T Score	22.2	38.9	22.2	0	16.7
WAIS-IV Coding Scaled Score	16.7	33.3	16.7	33.3	0
DKEFS Tower Test					
Time Per Move Scaled Score	5.6	50	27.8	16.7	0
Rule Violations	11.1	83.3	5.6	0	0
CVLT-II					
Short Delay Free Recall Z Score	16.7	27.8	27.8	11.1	16.7
Long Delay Cued Recall Z Score	16.7	27.8	22.2	22.2	11.1
CPT 3.0					
Ommissions T Score	11.1	88.9	0	0	0
Commissions T Score	22.2	27.8	22.2	11.1	16.7
Detectability T Score	22.2	22.2	22.2	16.7	16.7

GMT: Goal Management Training; TAU: treatment as usual; SD: standard deviation; WAIS-IV: Wechsler Adult Intelligence Scale Fourth Edition; DKEFS: Delis–Kaplan Executive Function System; CVLT-II: California Verbal Learning Test-Second Edition; CPT 3.0: Conner's Continuous Performance Test – Third Edition.

processing speed, response, sustained attention, and verbal short-term memory.

These findings support the use of a ''top-down'' approach to cognitive remediation among individuals with PTSD, where higher-order cognitive processes (i.e., executive functioning) are targeted with the aim of achieving improvement in these areas and in downstream cognitive functions including attention and short-term memory. Critically, ''bottom-up'' approaches involving remediation of basic skills (e.g., processing speed and attention) that aim to improve more complex skills (e.g., executive functioning) through repetitive ''drill and practice'' have been criticized for their limited generalizability to day-to-day functioning,[52] where, for example, approaches have limited effects on executive functioning among individuals with depression.[21] Critically, GMT aims specifically to instill skills that can be generalized to solve issues in daily functioning.[22,26,31] The present study is in keeping with previous meta-analytic findings of improvements on tasks tapping executive processes, including response inhibition, rule learning, and sustained attention, following treatment with GMT.

Although we did not observe a significant difference between the TAU+GMT and TAU groups on improvements on functional outcomes or in self-reported cognitive difficulties in the present study, these findings may stem, in part, from the limited opportunity for inpatients to experience functional improvements in day-to-day life. Further, both the TAU+GMT and the TAU groups reported a significant reduction in subjective cognitive and functional impairment following treatment. Here, the first several sessions of GMT focus on increasing awareness of cognitive and functional difficulties via monitoring absentmindedness or cognitive failures. This may have increased patients' awareness of cognitive difficulties and thus heightened reporting of daily functioning difficulties, leading to the absence of differences between groups.

No significant interaction effects were found between participants in the TAU+GMT and TAU groups from pre- and posttreatment. Notably, however, a trend-level interaction effect was found between the TAU+GMT and TAU group, such that participation in the TAU+GMT as opposed to TAU group was associated with a larger improvement in patients' self-reported ability to engage in goal-directed behavior when highly emotional, a behavioral indicator of executive control. This finding is in keeping with the objective reduction in executive dysfunction observed in the TAU+GMT group.

We did observe significant improvements in clinical symptoms across both the TAU+GMT and TAU groups (large effect sizes). In addition, there was a significant effect of group on several clinical measures, including the PCL-5 total and subscale scores (with the exception of the arousal and reactivity subscale). Given the nonrandomized nature of the current study, it is possible that individuals with higher baseline symptom severity chose not to participate in the TAU+GMT group.

Table 5. Clinical outcome data.

Assessment	Group	Baseline *M* (*SD*)	Posttreatment *M* (*SD*)	*F*, (*df*) main effect of group	*F*, (*df*) main effect of time	*F*, (*df*) interaction effect
PTSD Checklist for Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (PCL-5)						
Total score	GMT ($n = 18$)	54.83 (11.72)	34.06 (16.01)	7.28 (1, 30)*	51.31 (1, 30)**	0.51 (1, 30)
	TAU ($n = 14$)	62.71 (9.21)	45.71 (11.35)			
Intrusions	GMT	12.83 (4.87)	8.67 (4.93)	4.61 (1, 30)*	19.57 (1, 30)**	1.51 (1, 30)
	TAU	15.00 (3.96)	12.64 (3.93)			
Avoidance	GMT	5.83 (1.92)	3.67 (2.30)	10.43 (1, 30)*	22.39 (1, 30)**	0.01 (1, 30)
	TAU	7.36 (1.15)	5.29 (1.59)			
Cognitions and mood	GMT	20.50 (3.83)	11.28 (5.24)	5.48 (1, 30)*	75.98 (1, 30)**	0.60 (1, 30)
	TAU	22.50 (2.62)	14.79 (4.74)			
Arousal and reactivity	GMT	15.67 (3.96)	10.44 (5.32)	3.62 (1, 30)	27.50 (1, 30)**	0.36 (1, 30)
	TAU	17.86 (4.29)	13.00 (3.76)			
Depression Anxiety Stress Scale (DASS)						
Depression	GMT ($n = 18$)	22.89 (10.12)	12.11 (8.58)	1.14 (1, 32)	34.39 (1, 32)**	0.79 (1, 32)
	TAU ($n = 16$)	27.75 (10.04)	13.13 (12.00)			
Anxiety	GMT	22.22 (9.17)	13.89 (9.37)	0.37 (1, 32)	22.04 (1, 32)**	0.29 (1, 32)
	TAU	23.12 (10.50)	16.50 (9.59)			
Stress	GMT	27.89 (7.98)	15.35 (7.73)	0.11 (1, 32)	31.66 (1, 32)**	0.36 (1, 32)
	TAU	27.38 (9.46)	17.25 (8.48)			
Difficulties in Emotion Regulation Scale (DERS)						
Total score	GMT ($n = 18$)	124.17 (20.50)	95.21 (24.22)	0.35 (1, 32)	29.62 (1, 32)**	0.06 (1, 32)
	TAU ($n = 16$)	119.72 (18.56)	93.22 (23.09)			
Nonacceptance of emotions	GMT	20.89 (6.62)	15.83 (6.44)	0.31 (1, 32)	15.19 (1, 32)**	0.21 (1, 32)
	TAU	21.44 (7.09)	17.44 (6.12)			
Goal-directed behavior	GMT	20.72 (3.20)	16.28 (4.42)	0.11 (1, 32)	18.62 (1, 32)**	2.92 (1, 32)^{T}
	TAU	19.05 (4.45)	17.13 (4.90)			
Impulsivity	GMT	16.56 (4.80)	13.61 (6.12)	0.19 (1, 32)	10.31 (1, 32)**	0.14 (1, 32)
	TAU	17.55 (5.17)	13.84 (3.88)			
Awareness	GMT	23.39 (4.04)	20.00 (4.28)	12.23 (1, 32)**	8.65 (1, 32)**	0.29 (1, 32)
	TAU	18.75 (4.27)	16.41 (5.12)			
Strategies	GMT	25.28 (6.39)	19.99 (7.41)	0.48 (1, 32)	12.27 (1, 32)**	0.01 (1, 32)
	TAU	26.75 (7.23)	20.57 (7.55)			
Cognitive Failures Questionnaire (CFQ)						
Total	GMT ($n = 15$)	60.67 (11.38)	40.53 (19.65)	1.42 (1, 25)	33.75 (1, 25)**	0.57 (1, 25)
	TAU ($n = 12$)	70.04 (14.32)	44.00 (22.58)			
World Health Organization Disability Assessment Schedule 2.0 – 12 Item Version (WHODAS 2.0)						
Total	GMT ($n = 18$)	43.06 (18.91)	36.23 (17.15)	0.21 (1, 31)	9.37 (1, 31)**	1.36 (1, 31)
	TAU ($n = 15$)	44.72 (18.71)	29.51 (20.18)			

GMT: Goal Management Training group; TAU: treatment as usual group; PTSD posttraumatic stress disorder; SD: standard deviation.
*$p < .05$; **$p < .01$; $^{T}p < .10$

As stated above, GMT aims to reduce executive dysfunction and improving the ability to carry out goal-directed behaviors[22] by providing patients with strategies that facilitate the resumption of supervisory control of cognitive processes and allow individuals to improve monitoring and execution of daily functions. For example, as patients learn to attend to their environment and current behavior (e.g., via the STOP technique), they are better able to evaluate their behavior in order to determine if it is in line with their current goals. The concept of monitoring current goals and behaviors is similar to strategies utilized in mindfulness-based therapies, where such interventions have been associated with improvements in attention among individuals with PTSD[53]. General memory strategies such as stating and re-stating goals in order to enhance encoding into memory are also incorporated. The suggestion that GMT leads to improvements in executive control via

increased monitoring and evaluation are supported by the current findings of improvements on measures of response inhibition (e.g., Stroop Color–Word T Score; DKEFS rule violations) and sustained attention (e.g., CPT 3.0 Omissions and Commissions) as well as trend-level improvements on the ability to pursue goals despite high emotionality relative to the TAU group.

Although the current findings provide support for the use of GMT as a cognitive remediation intervention for PTSD, the results should be interpreted with caution. In the absence of a control group with pre- and post-treatment neuropsychological data, we cannot exclude the possibility that improvements in neuropsychological functioning observed in the TAU+GMT group occurred as a result of overall treatment (e.g., TAU), the passage of time, or practice effects, rather than a specific effect of participation in GMT. However, a study investigating practice effects for the CVLT found small, potentially negligible effects of practice, when alternate forms were employed, similar to the approach here.[54] The CPT 3.0 is also thought to be robust to the effects of practice.[50] Practice effects on the Stroop task are also small.[55] Limited research has examined the effect of practice on the Tower Test; however, tests measuring executive functioning may be particularly susceptible to practice due to learned strategies; thus, our findings of performance improvements on the DKEFS Tower Test time per move score and rule violations should be interpreted with caution.[49] Finally, one study reported an improvement on the WAIS-IV coding task similar to that observed here over a 3- to 6-month period.[56]

Participants in the present study had the option of participating in the TAU+GMT group or TAU and were not randomized; thus, patients who chose to participate in TAU+GMT may have differed from those who chose to participate in TAU. To illustrate, we were unable to control for the fact that patients who opted not to participate in TAU+GMT group had greater symptom severity (and potentially lower levels of treatment engagement). They may also have opted not to participate due to increased demands and anticipated stress such as being asked to participate in additional treatment and assessments. A randomized design would aid in eliminating these confounds. Further, only individuals who participated in the TAU+GMT group were assessed for specific exclusion criteria, which may have led to differences between groups. Similarly, only those in the TAU+GMT group received structured clinical interviews to confirm a diagnosis of PTSD; thus, while participants in the TAU group reported symptoms above the proposed threshold for a diagnosis of PTSD on the PCL-5, a diagnosis of PTSD was not confirmed.

Future work should assess the durability of these effects. The current study did not include a follow-up assessment. Previous studies, however, suggest that GMT confers durable improvements in neuropsychological and functional outcomes.[22–24,26–28,57,58] It will be necessary for future studies to employ a randomized controlled design in order to account for the confounding factors associated with the current nonrandomized design. Future studies may also investigate the impact of GMT or similar intervention on the hypothesized neurobiological mechanisms of cognitive dysfunction in PTSD, as has been previously suggested.[59] In the current study, we investigated GMT delivered simultaneously with TAU. Given that cognitive dysfunction in PTSD has been found to negatively impact treatment outcome,[13,14] it would be interesting to investigate the differential impact of GMT on treatment outcome if it was administered prior to, as compared to being delivered in conjunction with, other psychological treatments for PTSD. Future research should aim to investigate this question.

The results of this study provide preliminary but promising evidence for the effectiveness of GMT as a cognitive remediation intervention for PTSD and is among the very few studies investigating interventions aimed at improving cognitive dysfunction in this population. These findings are particularly important given the critical impact of cognitive dysfunction on functioning and on treatment outcomes among individuals with PTSD.[6,9,10,13,14,59] On balance, remediation of cognitive dysfunction is expected to allow patients with PTSD to achieve greater benefit from cognitively demanding treatments (e.g., CBT),[13,14] to reduce deficits in day-to-day functioning that persist beyond PTSD symptom recovery[6] and to reduce the overall economic and societal burden of this disorder.[9–11]

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ORCID iD

Jenna E. Boyd http://orcid.org/0000-0001-8710-2066
Alina Protopopescu http://orcid.org/0000-0001-6610-9365

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