RISK FACTORS OF MORAL INJURY & COGNITIVE REMEDIATION IN PTSD

EXAMINING RISK FACTORS OF MORAL INJURY AND COGNITIVE REMEDIATION AMONG MILITARY PERSONNEL, VETERANS, AND PUBLIC SAFETY PERSONNEL WITH POSTTRAUMATIC STRESS DISORDER

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Title: Examining risk factors of moral injury and cognitive remediation among military personnel, veterans, and public safety personnel with posttraumatic stress disorder

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Lay Abstract

Moral injury (MI) is an emerging area of research among military personnel, veterans (MPV), and public safety personnel (PSP). It refers to the distress associated with either oneself or another person betraying one's morals or values through action or inaction. MI is associated with several mental health conditions, including posttraumatic stress disorder (PTSD). This thesis examines whether risk factors associated with PTSD, including adverse childhood experiences and difficulties managing emotions, are also associated with MI among a sample of MPV. Another understudied area of research among MPV and PSP with PTSD includes the investigation and treatment of difficulties with cognitive functioning. This thesis investigates whether the intervention, Goal Management Training (GMT), can assist with improving cognitive, emotional, and functional difficulties. By examining risk factors of MI and whether GMT can assist with difficulties with cognition, emotions, and functioning, we hope to improve the lives of MPV and PSP with PTSD.

Abstract

Military personnel, veterans (MPV), and public safety personnel (PSP) are at an increased risk for developing posttraumatic stress disorder (PTSD). A risk factor for developing PTSD may include adverse childhood experiences (ACEs). Difficulties with emotion regulation (ER), a factor associated with the onset, development, and severity of PTSD, is a proposed mechanism to explain this relation. A burgeoning area of research among MPV includes moral injury (MI). MI is the distress associated with transgressing or betraying one's morals or values through action or inaction by oneself or others. Existing research has found that MI is associated with PTSD; however, little research has investigated potential risk factors of MI. Given the associations between MI and PTSD, this thesis investigates whether risk factors associated with PTSD are also associated with MI. Studies one and two are the first investigations to examine whether ACEs and difficulties with ER, respectively, are associated with MI among a sample of MPV. It was found that childhood emotional abuse was significantly associated with MI, while the association between difficulties with ER and MI were not significant. Another understudied area of research among MPV and PSP is the treatment of cognitive difficulties associated with PTSD. Notably, cognitive dysfunction has associations with difficulties with ER and impaired functioning. In study three, we conducted a randomized controlled trial investigating whether Goal Management Training (GMT), a skills-based, top-down cognitive remediation intervention, would assist with cognitive dysfunction, difficulties with ER, functioning, symptoms of PTSD, and symptoms associated with PTSD among a sample of MPV and PSP. It was found that GMT significantly improved

areas of cognitive functioning, daily functioning, ER, symptoms of PTSD, and symptoms associated with PTSD when compared to a waitlist condition. Together, these studies further our knowledge of MI and PTSD among MPV and PSP.

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List of Abbreviations

ACEs	Adverse Childhood Experiences
ACE-Q	Adverse Childhood Experiences Questionnaire
AD	Adaptive Disclosure
ADHD	Attention Deficit Hyperactivity Disorder
ANOVA	Analysis of Variance
APA	American Psychiatric Association
BAI	Beck Anxiety Inventory
BDI-II	Beck Depression Inventory – II
CAF	Canadian Armed Forces
CAPS-5	Clinician-Administered PTSD Scale for DSM-5
CEN	Central Executive Network
CFQ	Cognitive Failures Questionnaire
COWAT	Controlled Oral Word Association Task
COVID-19	Coronavirus Disease
CPT 3.0	Conners' Continuous Performance Test – Third Edition
CVLT-II	California Verbal Learning Test II
DASS-21	Depression Anxiety Stress Scale
DERS	Difficulties in Emotion Regulation Scale
DKEFS	Delis-Kaplan Executive Function System
DMN	Default Mode Network
DRTE	Deployment-Related Traumatic Experiences
DSM-5	Diagnostic and Statistical Manual for Mental Health Disorders, Fifth Edition
EI	Employment Insurance
ER	Emotion Regulation
FSIQ	Full-Scale Intelligence Quotient
GAD	Generalized Anxiety Disorder
GMT	Goal Management Training
HHC	Homewood Health Centre
HLM	Hierarchical Linear Modelling
HRI	Homewood Research Institute
ICN	Intrinsic Connectivity Network
IOK	Impact of Killing in War
LEC	Life Events Checklist
MDD	Major Depressive Disorder
MDI	Multiscale Dissociation Inventory
MI	Moral Injury
MIES	Moral Injury Events Scale
M.I.N.I. 7.0.2.	Mini International Neuropsychiatric Interview 7.0.2.
MPV	Military personnel and veterans
PCL-5	PTSD Checklist for DSM-5
PD	Panic Disorder

PSP	Public Safety Personnel
PTSD	Posttraumatic Stress Disorder
PTSR	Program for Traumatic Stress Recovery
RAI-MH	Resident Assessment Instrument – Mental Health Assessment
RBANS	Repeatable Battery of Neuropsychological Status
RCT	Randomized Controlled Trial
REB	Research Ethics Board
SAD	Social Anxiety Disorder
SE	Standard Error
SES	Socioeconomic Status
SD	Standard Deviation
SN	Salience Network
SPSS	Statistical Package for Social Sciences
TBI	Traumatic Brain Injury
TMT	Trail Making Test
WAIS-IV	Wechsler Adult Intelligence Scale – IV
WASI-II	Wechsler Abbreviated Scale of Intelligence – II
WHODAS 2.0	World Health Organization Disability Assessment Schedule 2.0
WL	Waitlist
WSIB	Workplace Safety and Insurance Board
WTAR	Wechsler Test of Adult Reading

Declaration of Academic Achievement

This thesis contains five chapters. Chapter 1 provides a general introduction to the topics discussed throughout the thesis and its aims. Chapters 2 through 4 are empirical articles and Chapter 5 discusses the main conclusions, limitations, and future directions.

The research presented in chapter 2 was supported by the Canadian Institute for Military and Veteran Health Research and the Homewood Chair in Mental Health and Trauma at McMaster University. A. Battaglia was supported by an Undergraduate Student Research Award from McMaster University's Faculty of Social Sciences. Drs. McKinnon and Lanius were responsible for the conception of the research project. A. Protopopescu, A. Battaglia, and Dr. McKinnon collaborated on the research questions and the plan for data analysis, and its interpretation. Data were previously collected as part of a routine clinical assessment in the Program for Traumatic Stress Recovery (PTSR) at Homewood Health Centre (HHC). A. Protopopescu and A. Battaglia have shared first authorship on this paper. Dr. McKinnon, Dr. Lanius, Dr. Nazarov, Dr. Hood, Dr. Jetly, Dr. Lloyd, Dr. Boyd, and C. O'Connor provided revisions and edits to the manuscript. Chapter 2 was submitted and published in the *European Journal of Psychotraumatology* in January 2019.

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Dr. McKinnon provided supervision during all stages of the thesis.

Chapter 1: General Introduction

Military personnel, veterans, and public safety personnel (PSP) represent vulnerable individuals who remain at high risk for developing posttraumatic stress disorder (PTSD) and its associated psychological and functional outcomes (Boulos & Zamorski, 2013; Thompson et al., 2016; Carleton et al., 2018; Afifi et al., 2014; Afifi et al., 2016; Turner et al., 2018; Groll et al., 2020). Notably, a burgeoning area of research inquiry involves the psychological construct moral injury (MI) among military personnel, veterans, and PSP (Litz et al., 2009; Drescher et al., 2011; Shay, 2014; Jinkerson, 2016). While there has been significant investigation examining the relations between MI and psychiatric disorders such as PTSD (Williamson et al., 2018), little work has examined potential risk factors of MI. This dissertation explored potential risk factors of MI, including adverse childhood experiences (ACEs) (Battaglia*, Protopopescu*, et al., 2019 (chapter two)) and difficulties with emotion regulation (ER) (Protopopescu et al., 2021 (chapter three)) among military personnel and veterans with symptoms of PTSD.

Additionally, a symptom which has remained understudied among individuals with PTSD is difficulties with cognitive functioning and its remediation (Samuelson et al., 2021). Specifically, difficulties with cognitive functioning can negatively impact psychological treatment outcomes (Crocker et al., 2018) and persist among individuals with PTSD even after the completion of evidence-based psychological treatment (Larsen et al., 2019). Among military personnel, veterans, and PSP, difficulties with cognitive functioning can impact individuals' occupational functioning (Wrocklage et al., 2016; Geuze et al., 2009). Consequently, investigating whether difficulties with cognitive

functioning can be ameliorated is an important line of inquiry. Here, the effects of a cognitive remediation intervention, Goal Management Training (GMT), on neurocognitive functioning and functional outcomes among military personnel, veterans, and PSP were examined (Protopopescu et al., 2022 (chapter four)). Given the inextricable links between cognitive functioning and ER, as well as the associations of these variables with PTSD and symptoms associated with PTSD (e.g., dissociation), the effects of GMT on these variables were also examined.

1.1 What is PTSD?

PTSD is a severe psychiatric illness that occurs following exposure to one or more traumatic event(s) (American Psychiatric Association [APA], 2013). Such exposure may include when an individual directly experiences, observes, learns about, and/or has repeated experiences with traumatic events, such as through repeated childhood abuse or exposure to potentially traumatic events and their details. According to the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (DSM-5) (APA, 2013), PTSD is characterized by four symptom clusters which include (1) re-experiencing symptoms (e.g., flashbacks, nightmares, intrusive memories); (2) avoidance (e.g., avoidance of thoughts, feelings, people, situations); (3) alterations in mood and cognitions (e.g., negative beliefs about oneself, others, and the world; persistent negative emotions, distorted blame, anhedonia); and (4) alterations in arousal and reactivity (e.g., difficulties with concentration, hypervigilance, sleep disruptions, altered startle response). PTSD is also associated with dissociation symptoms, which includes feeling as though oneself is unreal or strange (i.e., depersonalization) or that the world around oneself appears unreal

or strange (i.e., derealization). When such symptoms of dissociation are significant and comorbid with a diagnosis of PTSD, individuals may also be diagnosed with the dissociative subtype of PTSD (APA, 2013).

Within the general Canadian population, it is estimated that the lifetime prevalence of PTSD is 9% (Van Ameringen et al., 2008). Individuals with PTSD also are significantly more likely than those without PTSD to have other comorbid psychiatric and health conditions (APA, 2013), including depression (APA, 2013; Kessler et al., 1995; Van Ameringen et al., 2008), anxiety (APA, 2013; Kessler et al., 1995), substance and alcohol use disorders (APA, 2013; Kessler et al., 1995; Van Ameringen et al., 2008), traumatic brain injuries (APA, 2013; Schell & Marshall, 2008; Stein & McAllister, 2009), and chronic pain (Lew et al., 2009; Fishbain et al., 2017; Siqveland et al., 2017). Subsequently, individuals with PTSD have one of the highest uses of medical services, including higher hospitalizations and greater use of primary care services such as psychiatry, psychology, social work, and counselling services, relative to individuals with anxiety disorders, such as panic disorder (PD), social anxiety disorder (SAD), and generalized anxiety disorder (GAD) (Greenberg et al., 1999). Together with its symptoms and comorbid diagnoses, PTSD significantly interferes with the ability to work, socialize, complete tasks of daily living (APA, 2013; Kessler, 2000; Kessler & Frank, 1997; Sayer et al., 2011), and significantly diminishes individuals' quality of life (APA, 2013; Olatunji et al., 2007; Schnurr et al., 2009).

1.2 Military Personnel, Veterans, and PSP

Relative to the general population, military personnel, veterans, and PSP (e.g., correctional officers, volunteer and career firefighters, municipal and provincial police officers, and paramedics) (Oliphant, 2016) represent a vulnerable group of individuals who are significantly more susceptible to developing PTSD due to several risk factors (Boulos & Zamorski, 2013; Thompson et al., 2016; Carleton et al., 2018; Afifi et al., 2014; Afifi et al., 2016; Turner et al., 2018; Groll et al., 2020). Such risk factors include being female, identifying as a racial-ethnic minority, low socioeconomic status, prior psychiatric history, low military rank, higher frequency and length of deployments (Xue et al., 2015), combat intensity (Brewin et al., 2000; Hoge et al., 2006), low education attainment, marital status (Iversen et al., 2008), poor post-deployment social support (Xue et al., 2015; Iversen et al., 2008), high occupational stress, and maladaptive coping strategies (Syed et al., 2020).

Another risk factor inherent to these populations is their working conditions. Specifically, military personnel, veterans, and PSP are frequently and repeatedly exposed to potentially traumatic events and their details throughout duty (Boulos & Zamorski, 2013; Thompson et al., 2016; Carleton et al., 2018). This may include direct and indirect exposure to events such as combat, motor vehicle accidents, assaults, natural disasters, child abuse (i.e., physical, sexual, and emotional abuse; neglect), and death (Carleton et al., 2018). Many military personnel and veterans also choose to have second careers as PSP, which may contribute to increased exposure to potentially traumatic events (Groll et al., 2020). Specifically, in a web-based self-report survey of PSP across Canada,

participants were asked to identify whether they had a previous history of military service before beginning their PSP careers (Carleton et al., 2018; Groll et al., 2020). Of those participants who completed the survey, 6.8% of PSP identified having an armed forces background (Groll et al., 2020), representing approximately 11,000 individuals working as PSP (Statistics Canada, 2011). Notably, those PSP who identified a previous history of military service were significantly more likely than their counterparts without a history of military service to screen positive for PTSD symptoms (OR =1.62, 95% CI 1.31-2.00) (Groll et al., 2020). Additionally, PSP with a history of military service reported significantly more exposures to potentially traumatic events and were approximately twice as likely to indicate their most traumatic event as one in which their lives were endangered compared to PSP without a military background.

Critically, increased exposure to potentially traumatic events and their details are thought to contribute to the higher prevalence of PTSD among these occupations when compared to the general population (Carleton et al., 2018; Sareen et al., 2021). Here, the lifetime prevalence rate of PTSD among military personnel and veterans within the Canadian Armed Forces is 22% (Sareen et al., 2021), while the past-month prevalence of PTSD among PSP is estimated to be 23% (Carleton et al., 2018). As indicated previously, the lifetime prevalence of PTSD is 9% among the general Canadian population (Van Ameringen et al., 2008). Although these rates of prevalence among military personnel, veterans, PSP, and the general Canadian population cannot be directly compared due to differences in methodology and sociodemographic compositions among the studies, the

data suggest that PTSD disproportionately affects military personnel, veterans, and PSP making them particularly vulnerable to PTSD and its sequelae.

1.3 ACEs among Military Personnel, Veterans, and PSP

Another risk factor which may contribute to the increased rates of PTSD among military personnel, veterans, and PSP are that they are significantly more likely to experience ACEs in comparison to the general population (Afifi et al., 2014; Afifi et al., 2016; Turner et al., 2018). ACEs can include sexual abuse, physical abuse, emotional abuse, neglect, and exposure to domestic or interpersonal violence (Felitti et al., 1998; Merrick et al., 2017). Approximately 32% of the general Canadian population has a history of experiencing childhood physical abuse, sexual abuse, and/or exposure to interpersonal violence (Afifi et al., 2014). Comparatively, 48% of military personnel (Afifi et al., 2016) and 56% of PSP (Turner et al., 2018) have a history of ACEs.

Research has found that among military personnel and veterans with a history of ACEs, there is an increased likelihood of negative physical (Mercado et al., 2015; Iversen et al., 2007) and mental health outcomes (Lee et al., 2016), such as PTSD (Cabrera et al., 2007; Afifi et al., 2021; Murphy & Turgoose, 2022), depression, GAD, PD, SAD (Afifi et al., 2021), and difficulties with anger (Murphy & Turgoose, 2022). Further, it has been found that military personnel who endorse experiencing ACEs, such as physical abuse, sexual abuse, and exposure to interpersonal violence, also endorse a higher perceived need for care and utilization of mental health services (Turner et al., 2017). These findings remain even after controlling for mental health diagnoses and deployment-related variables. Although fewer studies have examined the links between ACEs and

psychiatric outcomes among PSP exclusively, there are several studies which also report that ACEs among PSP are associated with increased PTSD and depression symptom severity (Violanti et al., 2021; Roth et al., 2022a), as well as dissociative symptoms (Roth et al., 2022a). Among military personnel, veterans, and PSP, ACEs are also associated with an increased risk of suicide-related thoughts and behaviours (i.e., ideation, plans, and attempts) (Afifi et al., 2016; Carroll et al., 2017; Turner et al., 2018).

Research has also examined whether specific ACEs are associated with greater PTSD symptom severity. For example, in a study of over 8300 military personnel, it was found that individuals who were diagnosed with post-deployment PTSD experienced a greater frequency of childhood physical neglect, emotional neglect, emotional abuse, and interpersonal violence and more ACEs overall, in comparison to those without a diagnosis of post-deployment PTSD (LeardMann et al., 2010). After adjusting for other ACEs, covariates, and confounders, military personnel diagnosed with PTSD were more likely to report that they had been physically neglected as children. In another study, Komarovskaya et al. (2014) compared police officers and firefighters with and without a history of physical victimization as children to determine whether they were more likely to develop symptoms of PTSD following their participation in the disaster response for Hurricane Katrina. Here, it was found that police officers and firefighters with a history of physical victimization were more likely to experience symptoms of PTSD and depression, peritraumatic dissociation, and sleep difficulties (Komarovskaya et al., 2014). Similarly, in a study examining male disaster workers who assisted with the aftermath of the September 11th, 2001, terrorist attack at the World Trade Center, it was found that

individuals who had a history of childhood sexual abuse were significantly more likely to have greater symptoms of PTSD and depression (Leck et al., 2002).

Generally, however, most research on childhood trauma has examined the cumulative effects of ACEs. Here, it has been found that there is a dose-dependent relationship between the number of ACEs and adult psychiatric symptoms (Cabrera et al., 2007; Iversen et al., 2008; Afifi et al., 2021; Katon et al., 2015; Lang et al., 2008; Lee et al., 2016; Merrick et al., 2017). Given the demonstrated relations between ACEs and psychiatric symptoms, as well as its evidence as a risk factor for the development of PTSD among military personnel, veterans, and PSP, research has sought to explore potential mechanisms underlying these associations. One such proposed mechanism includes ER.

1.4 ER and Difficulties with ER

ER has been proposed as a transdiagnostic factor across psychiatric disorders (Lukas et al., 2017; Sloan et al., 2017), including PTSD (Badour & Feldner, 2013; Seligowski et al., 2015; McLean & Foa, 2017; Tull et al., 2007; Tull et al., 2020), mood disorders (Dodd et al., 2019; Joormann & Siemer, 2014; Joormann & Stanton, 2016; Visted et al., 2018), anxiety disorders (Campbell-Sills et al., 2014; Dixon et al., 2020; Mennin et al., 2009; Sakiris & Berle, 2019; Suveg et al., 2010), substance and alcohol use disorders (Dingle et al., 2017; Fox et al., 2008; Gratz & Tull, 2009; Kober, 2014), eating disorders (Brockmeyer et al., 2014; Cooper et al., 2014; Pisetsky et al., 2017; Prefit et al., 2019), and borderline personality disorder (Carpenter & Trull, 2012; Chapman, 2019; Linehan, 1993; Salsman & Linehan, 2012). It is comprised of several abilities, including

having an awareness, understanding, and acceptance of one's emotions, as well as the ability to flexibly manage and moderate emotions during the emotion generation process to either alter specific emotions, their expression, intensity, or timing to achieve one's goals or respond accordingly to situational demands (Gratz & Roemer, 2004; Gross, 2015a; Gross, 2015b; Tull et al., 2020). These processes may occur consciously or unconsciously (Gross, 1998).

Conversely, difficulties with ER may be defined by several deficits, including non-acceptance of emotional responses, difficulties engaging in goal-directed behaviours while experiencing strong emotions, problems with impulse control, lack of emotional awareness, limited access to adaptive ER strategies, and lack of emotional clarity (Gratz & Roemer, 2004). Moreover, the over-reliance on specific ER strategies, such as rumination (i.e., repetitive and prolonged negative thoughts associated with personal experiences, emotions, and the self) (Watkins, 2008), thought suppression (e.g., monitoring of thoughts, attempts to suppress thoughts) (Nixon et al., 2008; Seligowski et al., 2015), expressive suppression (i.e., efforts to reduce behavioural expression of emotions) (Gross, 1998; Seligowski et al., 2015), and worry (i.e., predictive catastrophic thoughts and images about the self, others, or situations) (Seligowski et al., 2015) might also contribute to difficulties with ER and lead to mental health disorders and symptoms (Lukas et al., 2017; Sloan et al., 2017). Additionally, dissociative symptoms have been proposed as an ER strategy, as they prevent or reduce the experience of overwhelming emotions, which allows individuals to disengage from their emotional experiences either

during a traumatic event (i.e., peritraumatic dissociation) or following a traumatic event (Briere et al., 2005; Lanius et al., 2010).

Individuals who endorse higher ER dysfunction also are more likely to experience greater PTSD symptom severity (Ehring & Quack, 2010; Klemanski et al., 2012; Seligowski et al., 2015; Tull et al., 2007; Tull et al., 2018). Specifically, findings from a meta-analysis have demonstrated a significant association between general difficulties with ER and PTSD symptom severity (r = 0.53) (Seligowski et al., 2015). Here, maladaptive ER strategies, such as rumination (r = 0.51), thought suppression (r = 0.47), and experiential avoidance (r = 0.40) were found to have the largest associations with PTSD symptom severity. Strategies such as expressive suppression (r = 0.29) and worry (r = 0.28) demonstrated smaller but significant associations with PTSD symptom severity. Conversely, adaptive ER strategies such as acceptance of emotions (r = -0.22) and cognitive reappraisal (r = -0.04) were not significantly associated with PTSD symptom severity.

Research has also explored the prospective associations between the development of PTSD symptoms and difficulties with ER among military personnel and veterans. For example, in a sample of 93 veterans engaging in inpatient treatment for PTSD, the researchers found that a higher endorsement of expressive suppression before beginning treatment was prospectively associated with increased PTSD symptom severity at discharge (Boden et al., 2013). In another study among women veterans who experienced military sexual trauma, the results indicated that difficulties with ER were a significant predictor of treatment dropout (Gilmore et al., 2020). Specifically, participants who

experienced more difficulties with ER were more likely to discontinue treatment than those who experienced fewer difficulties with ER.

1.4.1 ER as a Mechanism of Symptom Expression

Several studies have also examined whether difficulties with ER may be a mechanism through which PTSD and PTSD-related sequelae (e.g., depression, dissociation, aggression, interpersonal relationship difficulties, etc.) may be associated (Klemanski et al., 2012; Miles et al., 2015; Godfrey et al., 2022). For example, in a study comparing groups of military personnel who were deployed and had a diagnosis of PTSD, deployed and who did not have a diagnosis of PTSD, or who were not yet deployed and who did not have a diagnosis of PTSD, it was found that those individuals who were deployed and had a diagnosis of PTSD endorsed more severe symptoms of depression, dissociation, alcohol use, and interpersonal difficulties in comparison to the other groups (Klemanski et al., 2012). Critically, difficulties with ER partially mediated the relationship between PTSD symptom severity and depressive symptoms, PTSD symptom severity and interpersonal difficulties, and PTSD symptom severity and dissociative symptoms. In another study among a sample of firefighters, the researchers found that difficulties with ER mediated the relations between PTSD symptom severity and relationship satisfaction (Godfrey et al., 2022). Furthermore, a study examining the relations between PTSD symptom severity, difficulties with ER, and impulsive aggression found that difficulties with ER mediated the relation between PTSD symptoms and impulsive aggression among a cross-sectional sample of male and female veterans (Miles et al., 2015).

As previously discussed, difficulties with ER have also been proposed as a mechanism by which ACEs and psychiatric symptoms, including PTSD, are associated (Burns et al., 2010; Demir et al., 2020; Cloitre et al., 2018). It is theorized that adaptive ER skills, such as learning to manage and moderate emotions, are learned and modelled by children's caregivers (Calkins & Hill, 2007; Cicchetti & Lynch, 1993; Morris et al., 2007; Morris et al., 2017). Alternatively, learning adaptive ER skills may become disrupted if a child experiences or is exposed to chronic traumatic events, as attachment between the child and caregiver may become insecure (Alink et al., 2009; Cloitre et al., 2005; van der Kolk et al., 2005; Pollak & Sinha, 2002; Shipman et al., 2000). Subsequently, this may impede the child's ability to experience and learn about managing and moderating emotions within a safe environment. For example, it has been found that ACEs, such as physical and sexual abuse, can interfere with the development of ER skills, such as recognizing (Pollak & Sinha, 2002), understanding, and managing emotions (Shipman et al., 2000).

Studies have also examined whether difficulties with ER mediate the relations between ACEs and PTSD. For example, a study examining over 900 female college students found that difficulties with ER partially mediated the relations between childhood emotional abuse and PTSD symptom severity, as well as the relations between childhood physical abuse and PTSD symptom severity (Burns et al., 2010). In another study, researchers assessed whether maladaptive cognitive ER strategies mediated the relations between ACEs and symptoms of PTSD, depression, and anxiety symptoms (Demir et al., 2020). Here, it was found that maladaptive cognitive ER strategies partially

mediated the relations between ACEs and symptoms of PTSD and ACEs and symptoms of depression. Maladaptive cognitive ER strategies did not mediate the relations between ACEs and anxiety symptoms, however. Similarly, another study of women who were in a clinical trial for PTSD found that difficulties with ER mediated the relations between ACEs and symptoms of PTSD, depression, and physical health difficulties (Cloitre et al., 2018).

Together, the findings reviewed underscore the important role that difficulties with ER plays among individuals with PTSD, including its role in the development, maintenance, and severity of PTSD symptoms. Given its critical role, examination of difficulties with ER warrants continued study among military personnel, veterans, and PSP (Tull et al., 2020; Cloitre et al., 2018). Specifically, given its transdiagnostic nature and impact on symptom severity, examining difficulties with ER is of interest in the emerging area of MI research (Protopopescu et al., 2021 (chapter three)), as well as in its relations to other PTSD symptoms (e.g., cognitive dysfunction) (Protopopescu et al., 2022 (chapter four)).

1.5 MI

MI broadly refers to the distress associated with transgressing one's morals via one's actions or inactions, observing a transgression against one's morals via another's actions or inactions (e.g., a colleague's, an organization's, or group's actions or inactions), or learning about a potentially morally injurious event (Litz et al., 2009; Drescher et al., 2011; Shay, 2014; Jinkerson, 2016). This psychological distress may manifest as a sense of perceived betrayal (Litz et al., 2009; Shay, 2014; Freyd et al.,

2005), guilt (i.e., the self-conscious emotion associated with feeling responsible for an outcome and subsequently engaging in behaviours to repair interpersonal relationships), shame (i.e., the self-conscious emotion associated with negative global self-evaluations which lead one to withdraw from others) (Nazarov et al., 2015; Tangney & Dearing, 2002), anger, and alternations in thoughts and beliefs about the self, others, and the world (Farnsworth, 2014; Farnsworth et al., 2019; Jinkerson, 2016; Frankfurt & Frazier, 2016). Subsequently, these responses may contribute to difficulties with forgiveness, isolation, and withdrawal from others (Litz et al., 2009; Hall et al., 2021).

Notably, MI has been linked to several psychiatric symptoms and adverse outcomes among military personnel and veterans, including PTSD (Nazarov et al., 2018; Williamson et al., 2018; Hall et al., 2021), major depressive disorder (MDD), anxiety (Williamson et al., 2018; Hall et al., 2021), self-harm, suicidality (Williamson et al., 2018; Hall et al., 2021; Nichter et al., 2021), and difficulties with social functioning (e.g., loss of trust) (Drescher et al., 2011).

While most MI research has focused on military personnel and veterans, the study of MI within PSP has only recently begun to proliferate (Lentz et al., 2021). Like military personnel and veterans, PSP must routinely make morally difficult decisions under stressful, unpredictable, and sometimes life-threatening conditions in which they are required to protect the public, their colleagues, and themselves (Lentz et al., 2021; Angehrn et al., 2020). For example, PSP may be required to make decisions regarding the application of lethal force (Weiss et al., 2010; Papazoglou & Chopko, 2017), assisting and treating the injuries of not only victims but also the perpetrators of crimes, and

determining when to discontinue rescue efforts (Roth et al., 2022b). Moreover, PSP may also have to manage stressors associated with their organization and its operations, including perceived or real public scrutiny (Carleton et al., 2020) and scapegoating, ostracizing, or disciplining their coworkers (Roth et al., 2022b). Specifically, such events may conflict with PSP's moral values and their occupations' ethics, policies, and procedures (Lentz et al., 2021).

While much of the work among military personnel, veterans, and PSP has sought to examine MI and its associations with psychiatric outcomes, little research has examined potential risk factors for the development of MI (Litz et al., 2009; Thompson & Jetly, 2014; Griffin et al., 2019). Here, preliminary work suggests that situations within the combat theatre (e.g., attempting to discriminate between enemies and civilians; rules of engagement preventing military personnel from assisting bystanders and civilian casualties; ambiguous military objectives), the hierarchical structure of the military (e.g., lack of acknowledgement from superiors following injuries sustained during combat; abuse of power by colleagues or leaders, including sexual assault), or the potential roles with which military personnel are tasked (e.g., peacekeeping, crisis management and stabilization) may confer risk for the development of a MI (Litz et al., 2009; Thompson & Jetly, 2014; Griffin et al., 2019).

Despite the demonstrated links between MI and psychiatric symptoms among military personnel and veterans, as well as the emerging evidence suggesting the prevalence of MI among PSP, few studies have considered whether MI shares similar risk factors for its associations with PTSD. Consequently, given the research evidence which

demonstrates the associations between ACEs and psychiatric symptoms, as well as the associations between difficulties with ER and psychiatric symptoms among military personnel and veterans, part of the aims of this dissertation was to investigate whether ACEs (Battaglia*, Protopopescu*, et al., 2019 (chapter two)) and difficulties with ER (Protopopescu et al., 2021 (chapter three)) were associated with MI among a sample of military personnel and veterans. Specifically, within chapter two of this dissertation, the correlations between cumulative ACEs and the different types of ACEs with MI were assessed. Chapter three examined the associations among MI, symptoms of PTSD, depression, anxiety, stress, and difficulties with ER among a sample of military personnel and veterans. Although neither of these investigations was carried out among PSP, the findings of these studies served as part of the body of evidence for future investigations among our research group (e.g., see Easterbrook et al., 2022, Roth et al., 2022a, and Roth et al., 2022b).

1.6 Cognitive Dysfunction and PTSD

Finally, an additional area of investigation within this dissertation was to examine cognitive dysfunction and its remediation among military personnel, veterans, and PSP with PTSD symptoms. Specifically, cognitive dysfunction is a transdiagnostic symptom associated with several neuropsychiatric conditions, including PTSD (APA, 2013). Alongside the diagnostic criterion of difficulties with concentration (APA, 2013), PTSD is associated with additional objective and subjective cognitive difficulties (Aupperle, Allard et al., 2012; Aupperle, Melrose et al., 2012; Brewin et al., 2007; Jak et al., 2016; Polak et al., 2012; Qureshi et al., 2011; O'Neil et al., 2019; Samuelson, 2011; Samuelson

et al., 2021; Samuelson et al., 2017; Schuitevoerder et al., 2013; Scott et al., 2015; Woon et al., 2017). Here, meta-analyses have demonstrated small to moderate effects of PTSD in multiple domains of cognitive functioning (Qureshi et al., 2011; Polak et al., 2012; Scott et al., 2015; Schuitevoerder et al., 2013; Woon et al., 2017), including in visual memory (Cohen's d = -0.29), visual learning (Cohen's d = -0.32), visuospatial functioning (Cohen's d = -0.38), language (Cohen's d = -0.43), executive functioning (Cohen's d = -0.45), verbal memory (Cohen's d = -0.46), attention and working memory (Cohen's d = -0.50), processing speed (Cohen's d = -0.59), and verbal learning (Cohen's d = -0.62) with PTSD demonstrating a medium effect on cognitive functioning overall (Cohen's d = -0.49) (Scott et al., 2015). Moreover, research has found that the executive functioning deficits associated with PTSD are not moderated by PTSD symptom severity, suggesting that executive functioning deficits may occur regardless of PTSD symptom severity and that such difficulties may be a feature of the clinical presentation of PTSD (Woon et al., 2017). Among individuals with PTSD and comorbid dissociative symptoms, evidence also demonstrates that cognitive functioning is compromised in multiple neurocognitive domains, including attention, executive functioning, autobiographical memories (Roca et al., 2006), verbal memory, and visual memory (Rivera-Vélez et al., 2014).

Concerning subjective cognitive functioning, individuals with PTSD often recognize changes in their cognitive functioning; however, self-reported cognitive difficulties are not necessarily concordant with objective cognitive impairment as assessed through neuropsychological testing (Samuelson et al., 2021; O'Neil et al., 2019;

Spencer et al., 2010; Mattson et al., 2019). Here, research has found that the relations between objective cognitive functioning and subjective cognitive functioning are mediated by PTSD symptom severity (Mattson et al., 2019), suggesting that the cognitive distortions typically associated with PTSD, such as negative beliefs related to self-efficacy or self-worth, may subsequently impact beliefs about cognitive functioning (Samuelson et al., 2017; Spencer et al., 2010). Moreover, other studies report that the severity of self-reported cognitive difficulties is associated with PTSD symptom severity, as well as the severity of other psychiatric symptoms, including depression and anxiety (Spencer et al., 2010).

Objective and subjective cognitive difficulties are also associated with increased functional impairment across physical (Wrocklage et al., 2016), social, and occupational outcomes among veterans with PTSD (Wrocklage et al., 2016; Geuze et al., 2009). Additionally, cognitive dysfunction is associated with poorer psychological treatment outcomes among military personnel, veterans, and civilians with PTSD (Crocker et al., 2018; Haaland et al., 2016; Nijdam et al., 2015; Wild et al., 2008) with cognitive difficulties persisting in approximately 25% of individuals who have completed psychological treatment for PTSD (Larsen et al., 2019). Despite these associations with increased symptom severity and poor functional outcomes, cognitive dysfunction among individuals with PTSD remains an undertreated symptom (Samuelson et al., 2021).

1.6.1. Intersection of PTSD, Difficulties with ER, and Cognitive Dysfunction

Critically, there is a large body of evidence which suggests that the relations between cognitive functioning and ER are interdependent (Storbeck & Clore, 2007).

Specifically, evidence indicates that among individuals with PTSD, altered patterns of activation within neuroanatomical regions (Lanius et al., 2010; Liberzon & Sripada, 2007; Hayes et al., 2012; Brown & Morey, 2012; Lanius et al. 2012; Nicholson et al., 2017; Fitzgerald et al., 2018; Andrewes & Jenkins, 2019) and within large-scale neural circuitry (Breukelaar et al., 2021; Akiki et al., 2017; Lanius et al., 2015; Patel et al., 2012) of emotion-processing and emotion-regulating regions of the brain can influence PTSD symptoms and may contribute to dissociative or hyperarousal symptom presentations (Lanius et al., 2010; Lanius et al., 2012; Nicholson et al., 2017). These neuroanatomical regions and neural circuitry demonstrate overlap with regions associated with specific cognitive functions, such as executive functioning, attention, and working memory (Weber et al., 2005; Levine et al., 2011; Jak et al., 2016; Aupperle, Allard et al., 2012; Aupperle, Melrose et al., 2012; Polak et al., 2012; Woon et al., 2016). Moreover, altered functioning of these neuroanatomical regions and networks may disrupt top-down cognitive control and bottom-up regulation, which can contribute to difficulties with cognitive functioning and ER (Fitzgerald et al., 2018; Akiki et al., 2017; Lanius et al., 2015; Patel et al., 2012). For example, executive functioning, working memory, and attention can exert top-down control on emotion-generating, emotion-processing, and emotion-regulating centres of the brain (Damasio & Carvalho, 2013; Ochsner et al., 2004; Ochsner et al., 2012; Gross & Thompson, 2007; Schmeichel et al., 2008; Hofmann et al., 2012). Specifically, these skills allow individuals to engage in the cognitive reappraisal of a stimulus, which can moderate the intensity of an emotional response (Gross & Thompson, 2007; Ochsner et al., 2012; Shurick et al., 2012). Additionally, adequate ER is

required for higher-order cognitive skills, such as problem-solving, goal management (Dams-O'Connor & Gordon, 2013), and encoding information to memory (Richards & Gross, 2000). Given the significant interactions and shared commonalities between difficulties with cognition and ER, an intervention which is aimed at reinstating top-down cognitive control to address cognitive difficulties, may also assist with PTSD symptoms and difficulties with ER more generally.

1.7 GMT

A potential intervention to address difficulties with cognition and ER among individuals with PTSD is GMT (Levine et al., 2011). GMT is a skills-based, top-down cognitive remediation intervention that assists with the reinstatement of top-down cognitive control so that automatic processes can be interrupted in order to monitor whether behaviours align with goals, and, if so, are adjusted accordingly (Levine et al., 2000; Levine et al., 2011). It consists of nine, two-hour sessions that discuss psychoeducation related to cognitive functioning, as well as introduces skills and strategies, such as mindfulness (Kabat-Zinn & Hanh, 2009), self-monitoring (Levine et al., 2000, Levine et al., 2011), assistance with maintaining goals within working memory (Levine et al., 2000; Robertson & O'Connell, 2010; O'Connor et al., 2011), and assistance with breaking down large goals into intermediate and small steps to improve patients' abilities to perform activities of daily living (Levine et al., 2011).

GMT has been utilized for several medical, neuropsychiatric, and psychiatric conditions to address difficulties with cognitive functioning (Levine et al., 2011, In de Braek et al., 2017; Alfonso et al., 2011; Stubberud et al., 2013; Stamenova & Levine,

2018; Cameron et al., 2020; Boyd et al., 2019; Boyd et al., 2022). Such conditions include acquired brain injury (e.g., traumatic brain injury, stroke, tumour) (Levine et al., 2011), advanced age (Levine et al., 2007), schizophrenia (Levaux et al., 2012), spina bifida (Stubberud et al., 2013), multiple sclerosis (Richard, 2013), attention deficit hyperactivity disorder (ADHD) (In de Braek et al., 2012), substance abuse (Alfonso et al, 2011), obsessive-compulsive disorder (Cameron et al., 2020), and depression (Boyd et al., 2022). Notably, studies demonstrate that individuals who have participated in GMT experience improvements in executive functioning (e.g., organization, planning), attention, and memory (Levine et al., 2000). Here, data from a meta-analysis demonstrated a significant small to moderate effect of GMT on neuropsychological tests of executive functioning (Hedges' $g = 0.227$), which were sustained during follow-up testing (Hedges' $g = 0.549$) (Stamenova & Levine, 2018). These improvements in executive functioning were also observed in neuropsychological assessments of everyday executive functioning (Hedges' $g = 0.297$) and sustained at follow-up (Hedges' $g = 0.385$). Patients also rated their subjective assessment of executive functioning as improving (Hedges' $g = 0.136$). The results of the meta-analysis also demonstrated significant beneficial effects for instrumental activities of daily living (e.g., cooking, cleaning, managing finances) (Hedges' $g = 0.662$), which remained after follow-up (Hedges' $g = 0.390$). There were also significant benefits of GMT immediately post-intervention (Hedges' $g = 0.309$) and at follow-up (Hedges' $g = 0.274$) for mental health outcomes. Finally, there were improvements in working memory (Hedges' $g = 0.438$) and long-term memory (Hedges' $g = 0.269$).

Work from our research group has begun to explore the effects of GMT on cognitive functioning among patients with PTSD symptoms. Specifically, Boyd et al. (2019) investigated the effects of a modified GMT protocol among inpatients with trauma exposure and symptoms of PTSD. Relative to individuals who did not receive GMT, those inpatients receiving GMT demonstrated significant improvements in executive functioning, processing speed, sustained attention, and verbal memory (Boyd et al., 2019). Notably, inpatients who participated in GMT also reported significant improvements in their ability to engage in goal-directed behaviours when experiencing strong emotions. Critically, this initial work demonstrated the ability of GMT to not only improve difficulties with cognitive dysfunction among individuals with symptoms of PTSD but also improve clinical symptomatology associated with PTSD, such as difficulties with ER. Subsequently, in chapter four of this thesis (Protopopescu et al., 2022), we expanded upon Boyd et al.'s (2019) work by examining the effects of GMT on cognitive functioning (objective and subjective) via a pilot randomized controlled trial (RCT) among military personnel, veterans, and PSP with symptoms of PTSD. In addition, the effects of GMT on difficulties with ER and other symptoms associated with PTSD (e.g., dissociative symptoms, depression symptoms, anxiety symptoms, functioning) were examined.

1.8 Dissertation Aims and Hypotheses

This dissertation examined PTSD and PTSD-related symptoms among military personnel, veterans, and PSP. Specifically, MI and its potential risk factors were examined in chapters two (Battaglia*, Protopopescu*, et al., 2019) and three (Protopopescu et al.,

2021) of this dissertation. Based upon the literature documenting relations between ACEs and PTSD, difficulties with ER and PTSD, and MI and psychiatric symptoms (e.g., PTSD, depression symptoms, etc.), it was hypothesized that ACEs and difficulties with ER would be associated with MI among military personnel and veterans.

Another line of inquiry examined whether difficulties with cognitive functioning could be ameliorated among military personnel, veterans, and PSP with symptoms of PTSD (Protopopescu et al., 2022 (chapter four)). Here, a pilot, RCT was conducted to assess the effectiveness of GMT as compared to a waitlist condition. It was hypothesized that individuals allocated to the GMT intervention would experience improvements in measures of cognitive functioning (objective and subjective assessments of cognitive functioning) and in measures of general functioning. Additionally, given the relations among difficulties with cognitive functioning, difficulties with ER, symptoms of PTSD, and symptoms associated with PTSD (e.g., depression, dissociation, anxiety), it was predicted that individuals allocated to receive GMT would experience improvements across these symptoms.

Chapter 2: The relation between adverse childhood experiences and moral injury in the Canadian Armed Forces

Chapter Link

The work in the following chapter was published in January 2019 in the *European Journal of Psychotraumatology, 10*(1), 1546084, DOI: 10.1080/20008198.2018.1546084.

MI represents a burgeoning area of research among military personnel and veterans. It is associated with several negative psychiatric health outcomes, including PTSD. ACEs represent a significant risk factor for developing PTSD and other physical and psychiatric outcomes; however, the association between MI and ACEs has not been investigated. This chapter examines whether there is an association between MI and ACEs.

The relation between adverse childhood experiences and moral injury in the Canadian Armed Forces

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Abstract

Background: There is increasing evidence that moral injuries (MIs) may affect the mental health of Canadian Armed Forces (CAF) members and veterans. Despite knowledge suggesting that MIs are related to multiple negative mental health outcomes, including the onset of post-traumatic stress disorder (PTSD), it is unknown whether pre-traumatic variables, including the presence of childhood abuse, are related to MIs.

Objective: This study seeks to investigate the potential relationship between adverse childhood experiences and later onset MI in military members.

Methods*:* Thirty-three patients newly admitted to an inpatient unit for treatment of trauma-related disorders received a standardized self-assessment package, including the PTSD Checklist for the DSM-5 (PCL-5), the Moral Injury Events Scale (MIES; adapted for the Canadian context), and the Adverse Childhood Experiences Questionnaire (ACE-Q), which is a retrospective measure of childhood abuse.

Results: Analyses revealed a significant relation between childhood emotional abuse and the presence of MI in adulthood. Specifically, emotional abuse during childhood was correlated with total score on the MIES ($p = 0.006$) and with its two subscales, perceived betrayals ($p = 0.022$) and perceived transgressions ($p = 0.016$). These correlations remained significant when controlling for age and gender.

Conclusions: Among CAF members and veterans, childhood events are related to the presence of MI during adulthood. These preliminary data are provocative in suggesting that emotional abuse during childhood may increase the likelihood of endorsing MI during adult military service. Further work is needed to identify pre-traumatic variables

that may serve to increase risk or enhance resilience to the development of MI in military members.

Key Words: Moral injury; posttraumatic stress disorder; adverse childhood experiences; military members; veterans; Canadian Armed Forces

Highlights:

- Prior research suggests that adverse childhood experiences influence the development of adult post-traumatic stress disorder (PTSD) in civilian and military populations.
- Moreover, research suggests a relation between PTSD and moral injury (MI) in military populations.
- The current study finds that experiencing childhood emotional abuse is related to the presence of MI during adult military service, even after controlling for age and gender.

Introduction

The modern era of unconventional and asymmetric warfare has changed the landscape of combat; ill-defined enemies, morally ambiguous objectives, and strict rules of engagement, including those requiring soldiers to bear passive witness to atrocities, may result in combatants experiencing moral injury (MI; Jordan, Eisen, Bolton, Nash, & Litz, 2017; Thompson & Jetly, 2014). MI can occur through experiences of betrayal by military leadership (e.g., a military physician following an order to triage military members over gravely injured civilians), and/or transgressions: perpetrating, observing, failing to prevent, or learning about perceived unethical acts (e.g., witnessing or contributing to civilian deaths) (Litz et al., 2009; Shay, 1991).

Increasing evidence suggests that experiencing morally injurious events may be linked with adverse mental health consequences (e.g., Currier, Holland, & Mallott, 2015; Nazarov et al., 2015; Nazarov, Fikretoglu, Liu, Thompson, & Zamorski, 2018; Nazarov et al., 2015; Watkins, Sudom, & Zamorski, 2016). Indeed, a 2018 meta-analysis linked MI to a host of negative mental health outcomes, including post-traumatic stress disorder (PTSD), major depressive disorder (MDD), hostility, and suicidality in both military and civilian populations (Williamson, Stevelink, & Greenberg, 2018). Moreover, MI has been associated with other adverse outcomes including perceived loss of trust, self-deprecation, spiritual/existential crises, and difficulties with social functioning and interpersonal relationships (Vargas, Hanson, Kraus, Drescher, & Foy, 2013).

Within the Canadian Armed Forces (CAF), evidence suggests that MIs also may affect the mental health of military personnel and veterans (Nazarov et al., 2018; Watkins

et al., 2016). Over half of deployed personnel reported exposure to at least one potentially morally injurious event, which served as an independent risk factor for PTSD and MDD (Nazarov et al., 2018). Critically, psychological dysfunction, such as PTSD and MDD, within the CAF has been associated with heightened levels of disability (Hoge et al., 2005; Weeks, Garber, & Zamorski, 2016), and negative occupational outcomes (e.g., attrition, discharge) (Boulos & Zamorski, 2016; Hoge, Auchterlonie, & Milliken, 2006; Hoge et al., 2005). Given this linkage, it is probable that identifying factors related to the onset of MI will have a positive impact on the occupational outcomes (e.g., attrition and discharge) of armed forces personnel in Canada and abroad.

Exposure to adverse childhood experiences (ACEs) (Cook et al., 2017; Litz et al., 2009) may influence the onset of MI among CAF members. ACEs include events such as neglect or exposure to physical, emotional, and/or sexual abuse (Cook et al., 2017). Approximately 33.1% of Canadians are estimated to have experienced childhood physical abuse, sexual abuse, and/or exposure to interpersonal violence, with significantly higher rates (i.e., 47.7%) reported among Canadian military members (Afifi et al., 2016). This connection between ACEs and voluntary military enlistment is thought to stem, in part, by the somewhat lower socioeconomic status (SES) of military enrollees (Lutz, 2008), with lower SES linked previously to increased exposure to ACEs (Bank, 2013). Furthermore, it has been suggested that individuals exposed to childhood trauma may voluntarily join the military in greater numbers to escape the adversity encountered in their homes (Blosnich, Dichter, Cerulli, Batten, & Bossarte, 2014), improving their life circumstances through the career and education opportunities available within the military

(Afifi et al., 2016). Critically, both low SES and exposure to ACEs have been identified as risk factors for the development of combat-related PTSD (Xue et al., 2015).

Moreover, similarly to exposure to morally injurious experiences, ACEs have also been linked to a wide range of negative psychological outcomes among military members (e.g., Afifi et al., 2016; Lang et al., 2008; Skopp, Luxton, Bush, & Sirotin, 2011). Specifically, a dose-response relation (e.g., Iversen et al., 2008) links ACEs and negative mental health outcomes in both male (Katon et al., 2015) and female (Lang et al., 2008) military members. Notably, higher rates of exposure to ACEs among Canadian military members are associated not only with heightened suicidal ideation, suicide, and suicide attempts (Afifi et al., 2016; Skopp et al., 2011), but also with higher perceived needs for mental health care and higher mental health-care service utilization (Turner et al., 2017). ACEs have also been associated with the development of PTSD among military members, even when controlling for combat exposure (Iversen et al., 2008, 2007; LeardMann, Smith, & Ryan, 2010). For example, in a prospective study, the presence of past ACEs was found to be a stronger predictor of PTSD and depression outcomes than combat exposure (Cabrera, Hoge, Bliese, Castro, & Messer, 2007). In a separate military sample, when controlling for combat trauma, ACEs statistically increased the likelihood of poor health, fatigue, severe substance abuse, and self-harm (Iversen et al., 2007). Within a CAF sample, exposure to ACEs and deployment-related traumatic experiences (DRTEs) were associated with an increased odds ratio of developing mood and anxiety disorders, such as PTSD, when compared to individuals in the same sample who were not

exposed to either of these events, or who were exposed to DRTEs but not to ACEs (Sareen et al., 2013).

ACEs and MI may exert a similar influence on individual's appraisals of him or herself, others, and the world (Cook et al., 2017; Litz et al., 2009; Vargas et al., 2013). Specifically, both MI and ACEs may alter existing schemas that the world is benevolent and meaningful, that others are trustworthy, and that the self is worthy (Cook et al., 2017; Litz et al., 2009; Vargas et al., 2013). Self-handicapping behaviours, including shunning positive experiences and social withdrawal, have been related to both ACEs and MI (Cook et al., 2017; Litz et al., 2009; Vargas et al., 2013), where sense of self may be altered by low self-esteem, shame, and guilt (Cook et al., 2017; Litz et al., 2009). As such, exposure to childhood traumas may "prime" military members to MI, by setting a context that is already characterized by low self-worth, shame, and ongoing guilt about past experiences (e.g., the belief that oneself is "bad"), which together may contribute to the potential onset of a MI.

Despite the potentially additive effects of ACEs and MIs on an individual's beliefs about themselves, others, and the world, and knowledge of negative mental health outcomes that can follow both MI and ACEs among Canadian military members and veterans, it remains unknown whether exposure to ACEs is related to the endorsement of MI during adult military service. Accordingly, we sought to examine this relation in a sample of CAF members and veterans. Data were analyzed as part of a retrospective review of admission data collected in patients admitted to an inpatient psychiatric unit for treatment of PTSD and trauma-related disorders. Here, we hypothesized that exposure to

ACEs, as measured by the Adverse Childhood Experiences Questionnaire (ACE-Q) (Felitti et al., 1998), would be associated with elevated levels of MI among this sample. Following a study by Merrick et al. (2017), this relation was examined for both the total ACE-Q score and individual ACE-Q items reflecting different types of ACEs (e.g., physical neglect; emotional abuse).

Methods

Participants and procedure

As part of routine clinical assessment, inpatients admitted to the Program for Traumatic Stress Recovery (PTSR) at Homewood Health Centre in Guelph, ON, Canada, between 22 May 2015 and 30 June 2016 completed a comprehensive standardized self-report assessment battery. Patients were admitted to this unit based on presumed exposure to traumatic events. The Homewood Research Ethics Board approved a retrospective medical chart review of an anonymized version of these data (REB 17-03). Of the 201 individuals who underwent assessment over this period, 43 participants identified as being veterans or active CAF personnel.

Demographic information (i.e., gender, age, marital status, education, and income) was requested from the Resident Assessment Instrument – Mental Health Assessment (RAI-MH), an Ontario Ministry of Health and Long-Term Care mandated measure for collection of clinical and administrative data. Participants were excluded from the analyses based on missing or incomplete data (n = 5; list-wise deletion based on missing data from any variable in the analysis), multiple admissions (n = 2), and joint first responder status (n = 3), leaving a final sample of 33 participants. Symptom severity was

assessed using the PTSD Checklist for DSM-5 (PCL-5) (Weathers et al., 2013). The clinical and demographic characteristics of the study sample are reported in Table 1. A subset of participants from the current study (samples not identical; based on available data) also appears in other reports, which examine the relations between dissociation among military members, veterans, and first responders and functional outcomes (Boyd et al., 2018) and between MI and emotion dysregulation in military members and veterans (Protopopescu et al., submitted).

Materials

Adverse Childhood Experiences Questionnaire (ACE-Q) (Felitti et al., 1998; Merrick et al., 2017). The ACE-Q is a 7-item self-report, retrospective measure that assesses commonly experienced ACEs (Felitti et al., 1998). Here, we administered an expanded 10-item version of this scale, similar to Merrick et al. (2017), with the exception that spanking was not included. Whereas the majority of studies involving the ACE-Q report a cumulative index (i.e., total ACE score) that combines ACE items assessing childhood abuse and neglect (emotional, physical, and sexual abuse, and emotional and physical neglect) with those assessing household dysfunction (separation/divorce of parents, domestic violence, and substance abusing, mentally ill, or incarcerated family members), here we relied on a scoring approach described by Merrick et al. (2017). Specifically, each of the 10 items was scored on a dichotomous scale of either 0 (no) or 1 (yes), and responses were analyzed for each item and for the cumulative score.

PTSD Checklist for DSM-5 (PCL-5) (Weathers et al., 2013). The PCL-5 is a 20-item, self-report questionnaire assessing the severity of PTSD symptoms following the Diagnostic and Statistical Manual for Mental Health Disorders-5 (DSM-5) (American Psychiatric Association, 2013) criteria of intrusive symptoms, avoidance, negative alterations in mood and cognition, and alterations in arousal and reactivity (Weathers et al., 2013). Items are scored on a five-point Likert scale, with total scores ranging from 0 to 80; greater scores are associated with greater symptom severity (Weathers et al., 2013). The scale demonstrates high internal consistency ($\alpha = 0.94$), and good test-retest reliability ($r = 0.82$) (Blevins, Weathers, Davis, Witte & Domino, 2015).

Moral Injury Events Scale (MIES) (Nash et al., 2013). The MIES is a nine-item, self-report measure intended to assess exposure to MI in military populations along two dimensions: perceived transgressions and perceived betrayals (Nash et al., 2013). In the present study, the MIES was modified for the Canadian context (Nash et al., 2013). Perceived transgressions include witnessing or committing acts, or failing to act in ways that violate one's internal moral code (Nash et al., 2013). The MIES assesses whether respondents perceive exposure to moral transgressions and whether they are distressed by these occurrences (Nash et al., 2013). Perceived betrayals may relate to leaders, fellow soldiers, or those outside the military (Nash et al., 2013). Each item is scored on a six-point Likert scale, with summed scores ranging from 9 to 54; higher scores indicate greater severity of MI (Nash et al., 2013). This scale has excellent internal consistency, with a Cronbach's alpha of 0.9, and good temporal stability (Nash et al., 2013).

Statistical analysis

SPSS version 23.0 (IBM Corp., Armonk, NY, USA) was used to conduct all analyses. Owing to non-normality of the data distributions and outliers, non-parametric tests were used to analyze the data. Spearman's (rho) correlation (r_s) was used to assess any associations between the ranked continuous overall scores and subscale scores on the three self-report measures. Following this, rank-biserial (r_{bs}) correlations were calculated between individual dichotomous ACE items and the ranked overall/subscale scores on the MIES. Spearman's partial correlations and rank-biserial partial correlations were used to control for age and gender. Statistical significance was set at $\alpha = 0.05$ for this pilot investigation.

Results

Sample demographics

The mean age of the sample was 44.7 (SD = 10.3). The greatest proportions of individuals were male (87.9%), were married or in a common-law relationship (48.5%), had obtained a high school education (27.3%), and were currently receiving income from employment (39.4%). The demographic characteristics of the study sample are summarized in Table 1.

Table 1. Demographic characteristics of participants (*N* = 33)

Variable	*n*	% of sample
Gender		
Male	29	87.9
Female	4	12.1
Marital Status		
Never married	4	12.1
Married/common law	16	48.5
Living with significant other	3	9.1
Widowed	0	0.0
Separated	7	21.2
Divorced	3	9.1
Highest level of education attained		
No schooling	0	0.0
8th grade or less	1	3.0
9 – 11 grades	4	12.1
High school	9	27.3
Tech/trade school	5	15.2
Some college/university	7	21.2
Diploma/bachelor's	5	15.2
Graduate	2	6.1
Unknown	0	0.0
Income		
Employed	13	39.4
Unemployed (EI)	1	3.0
Pension	11	33.3
Disability	9	27.3
Other Income	1	3.0
No Income	4	12.1
	Mean	*SD*
Age at intake (years)	44.7	10.3

Descriptive statistics

The mean, standard deviation, and range of each of the scales and their corresponding subscales are summarized in Table 2, along with the frequencies of each reported ACE-Q item. The mean ACE-Q total score for this sample was 3.0 (*SD* = 2.5),

with emotional abuse reported most frequently (48.5%) and having an incarcerated family member reported least frequently (9.1%). The mean total score among the sample on the PCL-5 was 57.9 (*SD* = 14.5), falling well above the clinical cut-off of 33 for a provisional diagnosis of PTSD (Weathers et al., 2013). Finally, the mean score on the MIES was 38.0 (SD = 12.7) (measure range of 0 – 54; sample range of 10 - 54), pointing to the presence of MI in this inpatient sample of trauma-exposed participants.

Table 2. Summary of ACE-Q, PCL, and MIES scores

Scale	Mean (*SD*)	Min.	Max.
ACE-Q total	3.0 (2.5)	0	9
PCL total	57.9 (14.5)	14	79
PCL intrusions	14.2 (5.1)	2	20
PCL avoidance	6.1 (1.9)	1	8
PCL cognition/mood	20.9 (5.1)	4	28
PCL reactivity	16.7 (4.4)	7	23
MIES total	38.0 (12.7)	10	54
MIES betrayal	12.7 (4.8)	3	18
MIES transgressions	25.3 (9.2)	6	36
ACE-Q Item	**Yes (% endorsing)**	**No (% endorsing)**	
Emotional abuse	16 (48.5)	17 (51.5)	
Physical abuse	13 (39.4)	20 (60.6)	
Sexual abuse	8 (24.2)	25 (75.8)	
Emotional neglect	9 (27.3)	24 (72.7)	
Physical neglect	7 (21.2)	26 (78.8)	
Separation/divorce	14 (42.4)	19 (57.6)	
Domestic violence	7 (21.2)	26 (78.8)	
Substance abuse	11 (33.3)	22 (66.7)	
Mental illness	10 (30.3)	23 (69.7)	
Incarceration	3 (9.1)	30 (90.9)	

ACE-Q = Adverse Childhood Experiences Questionnaire; PCL = PTSD Checklist for DSM-5; MIES = Moral Injury Events Scale

Correlations between ACE-Q, PCL-5, and MIES

There was a significant correlation between the MIES betrayals subscale and the PCL avoidance subscale (r_s = 0.360, p = 0.039), and between the MIES betrayals subscale and the PCL subscale negative alterations in cognition/mood (r_s = 0.372, p = 0.033). Although the correlations were not significant, the relations between the MIES betrayals subscale and the PCL total score (r_s = 0.343, p = 0.051), as well as the MIES total score and the PCL avoidance subscale (r_s = 0.321, p = 0.068) showed a trend towards significance. There were no significant correlations between total scores on the MIES, PCL, and ACE-Q (Table 3).

Even after controlling for age and gender, the correlations between the MIES betrayals subscale and the PCL avoidance subscale (r_s = 0.366, p = 0.043), and between the MIES betrayals subscale and the PCL subscale negative alterations in cognition/mood (r_s = 0.376, p = 0.037) remained significant. Although still not significant, the relations between the MIES betrayals subscale and the PCL total score (r_s = 0.344, p = 0.058), and between the MIES total score and the PCL avoidance subscale (r_s = 0.315, p = 0.085) continued to trend towards significance.

Table 3. Spearman's rank (rho) correlations between ACE-Q, PCL-5, and MIES

	ACE total	PCL total	PCL intrusions	PCL avoidance	PCL cognition/mood	PCL reactivity	MIES transgressions	MIES betrayals
PCL total	0.100	-						
PCL intrusions	0.120	**0.818****	-					
PCL avoidance	-0.084	**0.626****	**0.563****	-				
PCL cognition/mood	0.059	**0.901****	**0.638****	**0.510****	-			
PCL reactivity	0.105	**0.882****	**0.627****	**0.459****	**0.743****	-		
MIES transgressions	0.224	0.178	-0.032	0.170	0.210	0.103	-	
MIES betrayals	0.086	**0.343**^{a}	0.137	**0.360***	**0.372***	0.260	**0.519****	-
MIES total	0.154	0.282	0.065	0.281	**0.321**^{b}	0.187	**0.901****	**0.787****

ACE-Q = Adverse Childhood Experiences Questionnaire; PCL = PTSD Checklist for DSM-5; MIES = Moral Injury Events Scale

**Correlation is significant at the 0.01 level (two-tailed).

*Correlation is significant at the 0.05 level (two-tailed).

[a]Correlation is trending at $p = 0.051$ (two-tailed).

[b]Correlation is trending at $p = 0.068$ (two-tailed).

ACE-Q items correlated with MIES

We next conducted an analysis of individual ACE-Q items and MIES scores. Critically, emotional abuse, as measured by the ACE-Q, was significantly positively correlated with MIES total score (r_{bs} = 0.469, p = 0.006), and with the two subscales betrayals (r_{bs} = 0.397, p = 0.022) and transgressions (r_{bs} = 0.415, p = 0.016). Detailed statistics are presented in Table 4.

After controlling for age and gender, emotional abuse remained positively correlated with MIES total score (r_{bs} = 0.500, p = 0.006), and with the MIES subscales betrayals (r_{bs} = 0.451, p = 0.022) and transgressions (r_{bs} = 0.429, p = 0.016).

Table 4. Rank-biserial correlations between ACE-Q items and MIES

	MIES total	PCL total	MIES transgressions	MIES betrayals
Emotional abuse	**0.469****	0.268	**0.415***	**0.397***
Physical abuse	-0.003	0.010	0.000	-0.059
Sexual abuse	0.037	-0.033	0.186	-0.149
Emotional neglect	0.229	0.047	0.283	0.111
Physical neglect	0.144	-0.203	0.242	-0.024
Separation/ divorce	-0.164	0.055	-0.171	-0.029
Domestic violence	0.078	0.156	0.187	-0.004
Substance abuse	0.007	-0.081	0.129	0.017
Mental illness	0.052	-0.010	0.191	-0.052
Incarceration	0.188	0.078	0.250	0.072

ACE-Q = Adverse Childhood Experiences Questionnaire; PCL = PTSD Checklist for DSM-5; MIES = Moral Injury Events Scale
*Correlation is significant at the 0.05 level (two-tailed).

**Correlation is significant at the 0.01 level (two-tailed).

Discussion

Our study is the first to identify an association between self-reported childhood emotional abuse and the endorsement of MI in CAF personnel and veterans. This association remained significant after controlling for age and gender. Here, exposure to ACEs antedated the exposure to MI in adulthood, pointing towards a possible childhood risk factor for the perception of MI over the course of military service. Notably, rates of childhood exposure to emotional abuse (i.e., 48.5%) among this treatment-seeking inpatient sample of CAF members and veterans exposed to traumatic events were in line with those reported in a larger sample (i.e., Afifi et al., 2016). Moreover, the reported extent of MI on the MIES was high; an average score of 38.0 was reported on this scale, with 54.0 being the upper boundary of the sample, the maximum score one can receive. Taken together, these results not only confirm the high rates of exposure to ACEs among CAF members and veterans, and highlight the presence of MI in this sample, but also suggest that emotional abuse in childhood may continue to confer risk for the perception of MI into adulthood (Cook et al., 2017; Litz et al., 2009; Iversen et al., 2008; LeardMann et al., 2010). Specifically, individuals who have experienced ACEs, such as childhood emotional abuse, may develop alternative negative beliefs regarding themselves, others, and the world, which may put these individuals at risk for the development of MI (Cook et al., 2017; Litz et al., 2009; Vargas et al., 2013).

Comparison to other findings

In keeping with previous studies (e.g., Currier et al., 2015; Marx et al., 2010; Nazarov et al., 2015), we found significant positive correlations between some, but not all, symptoms of PTSD and MI in a military sample. Here, severity of MIES perceived betrayals was correlated positively with the PCL-5 subscales avoidance and negative alterations in cognition/mood, suggesting that MI is associated with avoidance behaviors, the onset of negative emotions such as guilt and shame, and the inability to experience positive emotion. Critically, this correlation remained significant after controlling for age and gender. It is perhaps unsurprising that MI did not correlate with all PTSD symptoms, as MI captures aspects of traumatic experience outside those defined by the DSM-5's diagnostic criteria of PTSD (Litz et al., 2009; Shay, 2014). Although the DSM-5 PTSD criteria now recognizes negative emotions including guilt, shame, and anger that often accompany MI, it fails to recognize other instances that may have broad adverse mental health sequelae (e.g., experiences that violate deeply held moral values or instances in which an individual perceives oneself to be the "perpetrator" of an immoral action) (Farnsworth, Drescher, Nieuwsma, Walser, & Currier, 2014; Litz et al., 2009).

It also is interesting that whereas the betrayal component of MI was significantly associated with some symptoms of PTSD, the transgressions MI scale was not, suggesting that betrayals may play an important role in the relation between MI and PTSD. This finding may be unique to the CAF, where operations, until recently, have placed greater emphasis on peacekeeping, resulting in less exposure to direct combat operations than, for example, its American counterpart (Granatstein, Panneton, & Foot, 2006, April 29).

These operations, for example, in Rwanda, involved exposure to difficult situations where military members were unable to act (e.g., preventing the death of civilians) despite a strong moral prerogative to do so (e.g., Dallaire & Beardsley, 2003), perhaps resulting in a greater likelihood of perceived betrayal by authority figures providing direction to these operations.

Clinical implications

These findings have important clinical implications. Here, we hypothesize that an emotionally abused child may internalize feelings of guilt and shame, developing a schema such as, “I'm no good”. Subsequent events in the operational theatre may reactivate these same core beliefs, heightening the risk of MI.

With respect to treatment, adaptive disclosure (AD) and impact of killing in war (IOK) are two treatment modalities designed to address MI; however, neither of these treatments explores early childhood trauma (Litz et al., 2009; Maguen et al., 2017). Specifically, AD utilizes imaginal exposure in which the patient holds imagined discussions with moral authority figures from their life (Litz et al., 2009). Conversely, IOK utilizes a cognitive-behavioral framework to address attributions related to killing in war (Maguen et al., 2017). The findings of this study suggest that prior to proceeding with treatment of MI, clinicians should screen military members and veterans for instances of ACEs, such as childhood emotional abuse, for appropriate treatment planning. Future research, however, is required to determine how to appropriately incorporate ACEs into the treatment of MI.

Moreover, these findings also have important implications for prevention efforts, where military members exposed to ACEs may benefit from psychoeducation regarding MI and its associated psychological symptoms, which may normalize the reactions of personnel to morally injurious events, allowing them to overcome shame and guilt. This, in turn, may facilitate reporting of these types of events and treatment-seeking behaviours. Notably, some military personnel may feel uncomfortable disclosing morally injurious events due to perceived violations of the rules of engagement surrounding military operations, and associated legal ramifications, limiting disclosure in some circumstances.

When working clinically with military personnel who have experienced ACEs or who have been exposed to morally injurious events, it is important not to assume that they have developed a MI. In particular, mere exposure to morally injurious events or childhood emotional abuse may not always result in MI, in the same manner in which exposure to trauma does not always lead to PTSD (Santiago et al., 2013). For example, potentially similar to MI, there are many mediating factors, including cognitive appraisals such as negative sense of self, which influence the development of PTSD following trauma (Sheerin et al., 2018). Many individuals may have natural buffers that allow them to process and overcome these events without negative mental health sequelae.

Strengths and limitations

The present study's strengths included having clinicians administer the self-assessment package, so that if distress was provoked by any of the questions, it could be addressed within a therapeutic setting. This also ensured that participants' identity

remained unknown to the research team. Our sample is largely representative of the larger CAF where females represent 14.7% of the CAF and comprised 12.1% in our sample. Moreover, 95% of our sample fell in the age range of 24.1-65.3, where 80.7% of the CAF fell in this range (Park, 2008). Levels of education were also similar to those reported in the CAF, with 27.3% of our sample reporting having obtained a high school diploma compared with 28% of the CAF (Park, 2008).

There are several limitations to the present study. First, the study utilized an inpatient sample where severity of PTSD and MI was high among the majority of individuals and variation between patients was relatively constricted. This contrasts with similar studies involving outpatient samples with large variations in symptom severity on measures of mental illness (e.g., Cabrera et al., 2007: Iversen et al., 2008; Iversen et al., 2007; LeardMann et al., 2010). Here, restricted variability due to high symptom scores may have limited the ability of statistical tests to detect correlations, increasing the chance of type II error.

Another limitation of the study was its sample size, which limited the generalizability of our findings to the greater CAF population, and contributed to the non-normal distribution of the variables. As a result, we implemented non-parametric tests, which are known to be less sensitive than tests requiring normality. Despite the restricted power, our key finding of a significant relation between childhood emotional abuse (reported retrospectively) and MI emerged, highlighting the signal strength of this provocative new observation.

Although the retrospective nature of reporting ACEs is a potential limitation of our study, there is little evidence that individuals falsely report (false-positive) ACEs, thus inflating scores on the ACE-Q. Instead, in a meta-analytic report, Hard and Rutter (2004) found that reports of early child adversity are more prone to false negatives than to false positives; individuals are more likely to neglect reporting an ACE that did occur than to falsely report one that did not occur. Hence, although we cannot be certain, an underestimation of ACEs may have occurred in our sample.

In addition, the MIES has been criticized as a measure of MI (Frankfurt & Frazier, 2016). Specifically, some items on this scale measure exposure to events of a potentially morally injurious nature as opposed to capturing fully psychological response to this exposure (Frankfurt & Frazier, 2016). Coupling exposure and the effects of this exposure into one score can yield inflated levels of MI (Frankfurt & Frazier, 2016). Efforts to improve the measurement of MI, such as the Moral Injury Symptoms Scale-Military Version (Koenig et al., 2018), are currently underway.

Future directions

Longitudinal, prospective studies of at-risk populations will provide the strongest evidence for the relation between ACEs and the onset of MI in a military sample. Studies may examine the severity of MI pre- and post-deployment, and timing of MI events during deployment, to better assess how multiple factors including, ACEs, deployment length, and time since MI event influence the onset of MI. It will also be important to replicate the present findings in a larger sample, according to the sociodemographic distribution of the CAF, allowing for more variation in MI scores—which were high in

the present sample—and to obtain results which are more representative of the entire CAF population. Moreover, it will be critical to investigate the generalizability to other populations including public safety personnel/first responders and journalists, who are also susceptible to exposure to morally injurious events where intervention may be prohibited or impossible (e.g., atrocities and mass accidents). Finally, future studies may examine the efficacy of treatment interventions that incorporate discussion of ACEs.

Conclusions

The present study highlights the impact that ACEs may continue to exert on mental health outcomes into adulthood. Specifically, self-reported exposure to emotional abuse during childhood was associated with the onset of MI into adulthood among CAF personnel and veterans. These findings point towards the need for early intervention efforts that target specifically the presence of ACEs as a potential risk factor for the development of MI among military personnel and veterans. Accordingly, emerging treatments for MI may consider carefully the impact of ACEs on current interpretations of morally injurious events (e.g., as a lens for interpreting actions of others), and may assist military members and veterans in reframing events from the perspective of a competent adult rather than a vulnerable child. As noted, psychological dysfunction is associated with negative occupational outcomes among military members (Boulos & Zamorski, 2016; Hoge et al., 2006, 2005). Accordingly, increased identification of risk factors for the development of MI and the development of effective interventions for this psychological injury is expected to reduce attrition and discharge in military populations. Ultimately, these efforts are expected to improve quality of life and functional outcomes

(e.g., return to service; transition from military to civilian life) among current CAF members and its veterans.

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Chapter 3: Examining the associations among moral injury, difficulties with emotion regulation, symptoms of PTSD, depression, anxiety, and stress among Canadian military members and Veterans: A preliminary study

Chapter Link

The work in the following chapter was published in May 2021 in the *Journal of Military, Veteran and Family Health*, *7*(2), 71-80, DOI: 10.3138/jmvfh-2020-0036.

The previous chapter examined whether ACEs may be a risk factor for the development of MI. Notably, it was found that childhood emotional abuse was significantly associated with MI in adulthood. As previously discussed, ACEs are associated with several negative psychiatric outcomes, including PTSD. Research evidence suggests that a potential mechanism to explain these associations may be difficulties with ER, which is a transdiagnostic factor associated with the development, maintenance, and severity of PTSD symptoms. Specifically, learning adaptive ER skills may become disrupted during development if a child is exposed to ACEs as a child may not have a safe environment or poor caregiver role models from which to learn adaptive ER skills. Moreover, ACEs may be associated with the development of negative beliefs about the self, others, and/or the world and these beliefs may be re-triggered in the face of additional adult traumas causing significant difficulties with ER and subsequent psychiatric symptoms, such as PTSD. Given the demonstrated links between ACEs and

MI, the purpose of this study was to examine whether difficulties with ER would also confer risk for MI among a sample of military personnel and veterans.

Examining the associations among moral injury, difficulties with emotion regulation, symptoms of PTSD, depression, anxiety, and stress among Canadian military members and Veterans: A preliminary study

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Abstract

Introduction: Moral injury (MI) refers to the psychological distress associated with perceived betrayals or perceived transgressions of one's moral values. It has been studied primarily among military personnel and Veterans and has been found to be associated with posttraumatic stress disorder (PTSD), depression, anxiety, and other psychiatric symptoms. Recently, research has begun to investigate MI and its potential risk factors. Difficulties with emotion regulation (ER), which refers to difficulties with managing and moderating emotions, is a transdiagnostic factor associated with several psychiatric conditions, including PTSD, depression, and anxiety. The objective of the current study was to investigate the relations among MI, symptoms of PTSD, depression, anxiety, stress, and difficulties with emotion regulation in a sample of Canadian military personnel and Veterans. A secondary aim was to discuss the potential relevance of these relations for military personnel, Veterans, and front-line health care workers during the COVID-19 pandemic.

Method: Assessments of MI, PTSD, depression, anxiety, stress, and difficulties with ER were administered to Canadian military personnel and Veterans. Correlational analyses were used to assess the relation of MI to these symptoms.

Results: Increased levels of MI were associated with avoidance and alterations in mood and cognition symptom clusters of PTSD. Perceived betrayals were also significantly correlated with PTSD-related alterations in mood and cognition symptoms. Symptoms of PTSD were significantly associated with depression, anxiety, and stress. Difficulties with

emotion regulation were correlated significantly with symptoms of PTSD, depression, anxiety, and stress, but not with MI ($p = 0.07$).

Discussion: These results reveal an association between MI and specific symptom clusters of PTSD, and they highlight the association between difficulties with ER and symptoms of psychiatric illness among Canadian military personnel and Veterans. The potential implications of these findings and future work examining MI in military personnel, Veterans, and front-line health care workers during the COVID-19 pandemic are discussed.

Key Words: anxiety, Canada, COVID-19, depression, difficulties with emotion regulation, military, moral injury, posttraumatic stress disorder, stress

Lay summary: Moral injury (MI) refers to the distress experienced when people do, or do not, do something that goes against their morals or values. It can also occur when people perceive that their values have been betrayed. MI is associated with several mental health conditions, including posttraumatic stress disorder (PTSD), depression, and anxiety. A potential risk factor for MI may include difficulties with emotion regulation (ER). Difficulties with ER refers to the ability to manage emotions. It is associated with the same mental health conditions linked to MI, including PTSD. The purpose of this study was to examine whether difficulties with ER were associated with MI in a Canadian military personnel and Veteran sample. Participants completed several questionnaires assessing for MI, difficulties with ER, and other mental health symptoms, such as PTSD, while they were inpatients at a psychiatric hospital. It was found that MI and perceived betrayals were associated with symptoms of PTSD. Symptoms of PTSD, depression, and

anxiety were also associated with one another. Difficulties with ER were also associated with symptoms of PTSD, depression, and anxiety but were not related to MI. The findings serve as a first step in examining potential risk factors of MI.

Introduction

The Canadian Armed Forces (CAF) employs more than 100,000 individuals[1], with personnel distributed across the globe[2]. Critically, the CAF faces unconventional and asymmetric warfare in the combat theatre involving ill-defined enemies, and the presence of what may be perceived as morally ambiguous objectives. A burgeoning area of research suggests that military personnel exposed to these situations have the potential to develop moral injury (MI)[3–5], defined as the psychological distress associated with committing, failing to prevent, observing, or learning about an event that violates one's moral and ethical values[3]. MI may result in response to a person's own acts of omission or commission (i.e., perceived transgressions), or through witnessing acts of omission or commission by an authoritative individual or group, resulting in a sense of betrayal[3,5]. Specifically, Litz and colleagues suggest that the ambiguous context of some combat (e.g., difficulty discriminating between enemies and civilians; guerrilla warfare; rules of engagement limiting assistance to bystanders) and the other roles that military personnel are assigned (e.g., difficulty discriminating between enemies and civilians, guerrilla warfare, rules of engagement limiting assistance to bystanders) and the other roles that military personnel are assigned (e.g., peacekeeping, stabilization, crises work), may expose personnel to situations in which they are required to act in a manner that may or may not be in keeping with their ethical and moral values[3].

Notably, MI has been associated with numerous psychological difficulties including, posttraumatic stress disorder (PTSD), major depressive disorder (MDD)[6,7], anxiety[7], suicidal ideation, difficulties with social functioning[4], loss of trust and

spirituality, and feelings of guilt and shame. Preliminary work has begun to examine potential risk factors for MI in an effort to identify those individuals who are more susceptible to the development of distress after a morally injurious event[8,9]. Here, qualitative work in a Veteran sample has identified that MI could occur after events in which loss of vulnerable persons occurs[8]. Moreover, perceived lack of support from leaders, friends, and families, as well as perceived lack of responsibility from leadership, were also indicated as risk factors for the development of distress after a morally injurious event. Veterans also reported that perceived unawareness of the potential emotional and psychological consequences of their actions, or lack of actions; concurrent exposure to other traumatic events or life stressors; and lower educational attainment may contribute to the risk of developing MI. In addition, a study examining a sample of Canadian military personnel and Veterans found that childhood emotional abuse was significantly associated with MI during adulthood[9], suggesting that it may also confer risk in the development of MI.

Difficulties with emotion regulation may also constitute another risk factor for the development of MI among military personnel and Veterans, but it remains unexplored within this population. Specifically, difficulties with emotion regulation have been linked to PTSD[10,11], MDD[12] , anxiety disorders[13], and borderline personality disorder[14,15], including among military personnel and Veterans. Emotion regulation includes the ability to manage and moderate emotional responses[16]. Notably, difficulties with emotion regulation have been identified as a transdiagnostic factor and a mechanism of symptom expression and severity in psychiatric disorders, where as difficulty with emotion

regulation increases, psychological symptom expression and severity worsen[17–19]. Consequently, difficulty with emotion regulation is a linking factor across several psychological and emotional conditions and may subsequently play a critical role in the relations among MI and other psychiatric conditions.

The effort to identify risk factors of MI, such as difficulties with emotion regulation, may help to identify those individuals who are more susceptible to the development of distress after a morally injurious event and who may subsequently require additional support services and treatment. Notably, this effort may be relevant during the COVID-19 pandemic, in which Canadian military personnel have been tasked with assisting and supporting the Government of Canada's pandemic response[20]. Here, military personnel may also have been exposed to moral and ethical dilemmas. For example, military personnel were tasked with assisting front-line health care workers to provide care in long-term-care facilities within Ontario and Quebec[20]. Accordingly, a report by the Department of National Defence and the CAF was released after the military's involvement in long-term-care facilities, which detailed the deplorable conditions nursing home residents were living in, including how residents were found in soiled bedding after days of neglect[21]. These findings demonstrate the potential of encountering morally injurious events, including bearing witness to the pain and suffering among patients and their families, during the COVID-19 pandemic. Such events may transgress the central dictums of medical care and front-line intervention, which may also increase the susceptibility to experiencing a MI.

Therefore, given the dearth of Canadian research examining MI and its potential risk factors, the objective of this study was to investigate the relations among MI, psychological symptoms, and difficulties with emotion regulation in a sample of Canadian military personnel and Veterans. An additional goal was to discuss the potential relevance of such findings for military personnel, Veterans, and other front-line health care workers within the context of the COVID-19 pandemic.

Methods

Procedures and participants

Data for this study were collected via Research-Ethics-Board-approved retrospective chart review of standardized assessment batteries administered to all newly admitted patients at the Program for Traumatic Stress Recovery (PTSR) at Homewood Health Centre in Guelph, Ontario, Canada, between May 22nd, 2015 and June 30th, 2016. These data were also combined with data collected prospectively at the centre between August 2017 and November 2019. Of the 634 unique individuals included in the retrospective and prospective sample, 128 participants identified as being either active military personnel or Veterans and were included in the sample.

Demographic information were requested from the Resident Assessment Instrument – Mental Health Assessment, an Ontario Ministry of Health and Long-Term Care mandated assessment for the collection of clinical and administrative data. Participants were excluded from the analyses on the basis of missing or incomplete data (n = 32; listwise deletion based on missing data from any variable in the analysis), and also for simultaneously identifying as military personnel or Veterans and public safety

personnel (n = 23), leaving a final sample of 73 military personnel and Veterans. Patients were admitted to the PTSR unit on the basis of presumed exposure to traumatic events. Demographic and clinical characteristics of the sample are reported in Table 1. Data from a subset of participants from the current study (based on available data; samples are not identical) also appear in other reports[9,22,23].

Table 1. Demographic and clinical characteristics

Characteristics	Sample ($N = 73$)
Demographic characteristics	
Sex, male:female	62:11
Age, Mean, (SD)	43.7 (9.3)
Marital Status	*n* (%)*
Never married	13 (17.8)
Married or common law	41 (56.2)
Living with partner or significant other	4 (5.5)
Separated	9 (12.3)
Divorced	6 (8.2)
Education	
≤ 8th grade	1 (1.4)
Some high school	8 (11.0)
High school	16 (21.9)
Technical or trade school	11 (15.1)
Some college or university	19 (26.0)
Diploma or bachelor's degree	11 (15.1)
Graduate degree	7 (9.6)
Income	
Employed	27 (37.0)
Employment insurance	5 (6.8)
Pension	24 (32.9)
Social Assistance	1 (1.4)
Disability insurance	18 (24.7)
Other (e.g., investment, WSIB, inheritance)	12 (16.4)
No income	2 (2.7)
Clinical characteristics	Mean (SD)
Moral Injury	
MIES Transgress	23.5 (9.8)
MIES Betrayal	13.1 (4.6)
MIES Total score	36.6 (12.4)
Posttraumatic Stress Symptoms	
PCL-5 Intrusions	14.3 (4.3)
PCL-5 Avoidance	6.2 (1.9)
PCL-5 Mood and Cognitions	21.6 (4.4)
PCL-5 Reactivity	17. 6 (3.8)
PCL-5 Total score	59.6 (11.9)
Depression, anxiety, and stress symptoms	
DASS-21 Depression	28.1 (10.9)
DASS-21 Anxiety	23.5 (9.6)

DASS-21 Stress	28.7 (8.2)
Emotion Dysregulation	
DERS Nonacceptance	21.3 (7.4)
DERS Goals	20.5 (4.5)
DERS Impulse	18.4 (6.4)
DERS Awareness	21.1 (5.0)
DERS Strategies	28.6 (7.3)
DERS Clarity	16.7 (4.2)
DERS Total score	126.5 (25.3)

Note. Percentages may not total 100 because of rounding.

*Unless otherwise indicated.

WSIB = Workplace Safety and Insurance Board; MIES = Moral Injury Events Scale; Transgress = Transgression sub-scale; Betrayal = Betrayal sub-scale; PCL-5 = PTSD Checklist for DSM-5; Intrusions = Intrusions sub-scale; Avoidance = Avoidance sub-scale; Mood and Cognitions = Negative Alterations in Mood and Cognitions sub-scale; Reactivity = Arousal and Reactivity sub-scale; DASS-21 = Depression, Anxiety, and Stress Scale; Depression = Depression sub-scale; Anxiety = Anxiety sub-scale; Stress = Stress sub-scale; DERS = Difficulties in Emotion Regulation Scale; Nonacceptance = Nonacceptance sub-scale; Goals = Goals sub-scale; Impulse = Impulse sub-scale; Awareness = Acceptance sub-scale; Strategies = Strategies sub-scale; Clarity = Clarity sub-scale.

Measures

*Moral Injury***.** MI was assessed using the Moral Injury Events Scale (MIES)[24], which was adapted for the Canadian military context. Patients rated their agreement on a nine-item, self-report measure, which assessed MI along two dimensions: perceived betrayals (MIES Betrayals sub-scale) and perceived transgressions (MIES Transgression sub-scale). High internal consistency coefficients for the MIES have been reported for a military sample in the United States (Cronbach's $\alpha = 0.90$)[24]. Within the current sample, Cronbach's alpha was 0.87 for the MIES total score.

Posttraumatic Stress Symptoms. The PTSD Checklist for DSM-5 (PCL-5) was administered to patients in order to assess the severity of PTSD symptoms (PCL-5 Total

Score) according to the diagnostic criteria outlined in the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (DSM-5)[25,26]. The symptom domains included intrusive symptoms (PCL-5 Intrusions sub-scale), avoidance (PCL-5 Avoidance sub-scale), negative alterations in mood and cognitions (PCL-5 Negative Alterations in Moods and Cognitions sub-scale), and alterations in arousal and reactivity (PCL-5 Arousal and Reactivity sub-scale). The PCL-5 shows high internal consistency in military (Cronbach's $\alpha = 0.95$) and Veteran (Cronbach's $\alpha = 0.95$) samples[27,28]. In the current sample, Cronbach's α was 0.90 for the PCL-5 total score.

Depression, Anxiety, and Stress Symptoms. The 21-item version of the Depression, Anxiety, and Stress Scale (DASS-21) was administered in order to assess the severity and presence of symptoms related to depression (DASS-21 Depression sub-scale), anxiety (DASS-21 Anxiety sub-scale), and stress (DASS-21 Stress sub-scale) within the past week[29]. The DASS-21 has been shown to have good internal consistency (Cronbach's $\alpha = 0.73$ to 0.81). Here, the Cronbach's α values were 0.89, 0.81, and 0.79 for the Depression, Anxiety, and Stress sub-scales, respectively.

Difficulties with emotion regulation. The Difficulties in Emotion Regulation Scale (DERS)[16], a 36-item self-report measure, was used to assess challenges with emotion regulation across six domains including difficulties with accepting negative emotions (DERS Nonacceptance sub-scale); difficulties completing tasks due to negative emotions (DERS Goals sub-scale); difficulties with controlling impulses while experiencing distressing emotions (DERS Impulse sub-scale); difficulties with awareness of emotional experiences (DERS Awareness sub-scale); negative beliefs regarding the ability to

regulate emotions (DERS Strategies sub-scale); and difficulties with insight regarding emotions (DERS Clarity sub-scale). Higher scores indicate greater dysfunction with emotion regulation. The DERS has been shown to have good psychometric properties, including internal consistency and construct validity[16]. Within the current sample, Cronbach's α was 0.94 for the DERS total score.

Statistical methods

Data were analyzed using IBM SPSS Version 26.0 (IBM Corporation, Armon, NY). Analyses were preceded by tests of normality. Measures and their sub-scales were found to be non-normal. Therefore, non-parametric analyses were performed. Given the small sample size, in order to determine whether MI and symptoms of PTSD, depression, anxiety, and stress were associated with difficulties with emotion regulation, correlation analyses (i.e., Spearman's rho) controlling for age and sex were performed. Analyses were two-tailed, and α was set at 0.05.

Results

The mean MI score was 36.6 (SD = 12.4) with a range of scores falling between 9 and 54. Moreover, the mean symptom severity for PTSD, depression, anxiety, stress, and difficulties with emotion regulation were 59.6 (SD = 11.9), 28.1 (SD = 10.9), 23.5 (SD = 9.6), 28.7 (SD = 8.2), and 126.5 (SD = 25.3), respectively.

Significant positive correlations were found between MI and symptoms of PTSD avoidance (r_s = 0.3, p = 0.03; Table 2) and MI and alterations in cognition and mood symptoms related to PTSD (r_s = 0.2, p = 0.04). Perceived betrayals also correlated significantly with alterations in cognition and mood symptoms (r_s = 0.3, p = 0.02). No

significant correlations were found among MI, perceived transgressions, and perceived betrayals with PTSD symptom severity (r_s = 0.2, p = 0.06; r_s = 0.2, p = 0.1; and r_s = 0.2, p = 0.06, respectively), depression (r_s = 0.2, p = 0.08; r_s = 0.2, p = 0.1; and r_s = 0.2, p = 0.1, respectively), anxiety (r_s = 0.1, p = 0.3; r_s = 0.1, p = 0.2; and r_s = 0.03, p = 0.8, respectively), or stress (r_s = 0.1, p = 0.2; r_s = 0.09, p = 0.4; and r_s = 0.2, p = 0.1, respectively) symptoms. Perceived transgressions and perceived betrayals were not significantly associated with difficulties with emotion regulation (r_s = 0.2, p = 0.1; and r_s = 0.2, p = 0.1, respectively). MI and difficulties with emotion regulation approached significance, but did not reach the alpha threshold (i.e., r_s = 0.2, p = 0.07).

PTSD symptom severity correlated significantly with depression (r_s = 0.6, p <0.001), anxiety (r_s = 0.6, p <0.001), and stress (r_s = 0.6, p <0.001) symptoms. Difficulties with emotion regulation also were correlated significantly with PTSD (r_s = 0.6, p <0.001), depression (r_s = 0.7, p <0.001), anxiety (r_s = 0.6, p <0.001), and stress (r_s = 0.7, p <0.001) symptoms.

Table 2. Summary of Spearman's r_s (controlling for age and sex) for MIES, PCL-5, DASS-21, and DERS sub-scales and total scores

Measure	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. MIES Transgress	–	0.4†	1.0†	0.06	0.2	0.2	0.2	0.2	0.2	0.1	0.09	0.1	0.2	0.2	0.08	0.2	0.1	0.2
2. MIES Betrayal		–	0.7†	0.05	0.2	0.3*	0.1	0.2	0.2	0.03	0.2	0.1	0.2	0.09	0.01	0.2	0.2	0.2
3. MIES Total score			–	0.05	0.3*	0.2*	0.2	0.2	0.2	0.1	0.1	0.1	0.2	0.2	0.08	0.2	0.1	0.2
4. PCL-5 Intrusions				–	0.4†	0.5†	0.5†	0.8†	0.4†	0.5†	0.4†	0.3*	0.3*	0.2*	0.05	0.2	0.3*	0.3*
5. PCL-5 Avoidance					–	0.4†	0.3*	0.6†	0.3*	0.4†	0.3*	0.3*	0.4†	0.3*	0.2	0.2	0.3*	0.4†
6. PCL-5 Mood and Cognitions						–	0.7†	0.9†	0.6†	0.5†	0.6†	0.5†	0.3†	0.5†	0.2	0.4†	0.5†	0.6†
7. PCL-5 Reactivity							–	0.8†	0.4†	0.5†	0.6†	0.4†	0.4†	0.6†	0.2	0.4†	0.4†	0.6†
8. PCL-5 Total score								–	0.6†	0.6†	0.6†	0.4†	0.5†	0.5†	0.2	0.4†	0.5†	0.6†
9. DASS-21 Depression									–	0.6†	0.6†	0.6†	0.4†	0.5†	0.4†	0.6†	0.5†	0.7†
10. DASS-21 Anxiety										–	0.8†	0.5†	0.4†	0.6†	0.1	0.5†	0.4†	0.6†
11. DASS-21 Stress											–	0.6†	0.5†	0.6†	0.1	0.6†	0.5†	0.7†
12. DERS Nonacceptance												–	0.6†	0.5†	-0.04	0.7†	0.4†	0.8†
13. DERS Goals													–	0.6†	0.2	0.7†	0.4†	0.8†
14. DERS Impulse														–	0.06	0.6†	0.3†	0.7†
15. DERS Awareness															–	0.2*	0.5†	0.4†

16. DERS Strategies	–	0.4†	0.9†
17. DERS Clarity		–	0.6†
18. DERS Total score			–

Note. *Spearman's* r_s correlations for a sample of Canadian military and Veteran participants ($N = 73$).
* $p \leq 0.05$ (two-tailed).
† $p \leq 0.01$ (two-tailed).
MIES = Moral Injury Events Scale; Transgress = Transgression sub-scale; Betrayal = Betrayal sub-scale; PCL-5 = PTSD Checklist for DSM-5; Intrusions = Intrusions sub-scale; Avoidance = Avoidance sub-scale; Mood and Cognitions = Negative Alterations in Mood and Cognitions sub-scale; Reactivity = Arousal and Reactivity sub-scale; DASS-21 = Depression, Anxiety, and Stress Scale; Depression = Depression sub-scale; Anxiety = Anxiety sub-scale; Stress = Stress sub-scale; DERS = Difficulties in Emotion Regulation Scale; Nonacceptance = Nonacceptance sub-scale; Goals = Goals sub-scale; Impulse = Impulse sub-scale; Awareness = Acceptance sub-scale; Strategies = Strategies sub-scale; Clarity = Clarity sub-scale.

Discussion

This study was the first to examine the relations among MI, symptoms of PTSD, depression, anxiety, stress, and difficulties with emotion regulation in a Canadian military personnel and Veteran sample. Here, significant positive correlations emerged between levels of self-reported MI and symptoms of PTSD-related avoidance (*DSM-5* cluster C criteria for a diagnosis of PTSD) and alterations in cognition and mood (*DSM-5* Cluster D criteria for diagnosis of PTSD)[26], which are findings in keeping with previous work demonstrating a link between symptoms of PTSD and MI[6,7]. Notably, the relation between symptoms of MI and PTSD-related avoidance may support previous research that has found that individuals with MI experience challenges with social functioning[4]. Specifically, challenges related to social functioning may be associated with feelings of guilt (i.e., feeling though one is at fault for a specific outcome) and shame (i.e., negative global self-evaluations)[30], which are symptoms found within PTSD Cluster D criteria. Critically, guilt and shame are generally believed to drive social avoidance and withdrawal from others[30]. Within the context of MI, these emotions may elicit the belief that one's behaviours (i.e., actions or inactions) have caused irreparable harm[31,32], leading to avoidance of reminders of one's actions and detachment from others, as individuals with MI may not want others to see "the stain upon [their] soul"[33(p.413)].

Moreover, these associations may also be supported by the link found between perceived betrayals and alterations in cognitions and mood (i.e., PTSD Cluster D criteria). Specifically, when betrayal occurs in the context of an interpersonal or institutional relationship, it may elicit several psychological and behavioural responses, such as

avoidance behaviours[34–36]. More important, betrayal can occur within the military context due to its hierarchical organization[3,4,37,38], such as when an individual does not receive acknowledgment from his or her superiors if injuries are sustained during warfare, or if one experiences within-rank violence, such as sexual assault[4,37].

Moreover, difficulties with emotion regulation among military personnel and Veterans were associated with heightened symptoms of PTSD, depression, anxiety, and stress ($ps < 0.001$). These findings are consistent with earlier reports in the literature[10–13], in which, for example, the use of maladaptive emotion regulation strategies, such as rumination and non-acceptance of emotional experiences[12], is thought to contribute to the maintenance of depressive symptomology and severity, anxiety symptoms[13], and PTSD[10,11]. Together, this constellation of symptoms is associated with negative outcomes in military personnel and Veterans, including social and occupational withdrawal, increased mental health service utilization, and difficulties with the transition to civilian life [39], which warrants continued investigation of potential risk factors and potential treatments for MI.

Of note, the associations among MI, perceived transgressions, and perceived betrayals with PTSD symptom severity, depression, anxiety, and stress symptoms were not significant. Furthermore, the relations between difficulties with emotion regulation, MI, and its subsequent dimensions (i.e., perceived transgressions and betrayals) also did not reach the threshold for significance. This is contrary to our prediction that MI and difficulties with emotion regulation are associated with one another. Critically, these non-significant findings may be due to several limitations of the study. In particular, the

current study is limited by a relatively small sample size. Future work should aim to replicate these findings within a larger sample. Moreover, clinical data were partly acquired through a retrospective medical chart review, as well as through data collected at one time point, making this study cross-sectional in nature. Accordingly, no conclusions regarding the temporal nature of the relations among the variables may be drawn (i.e., whether symptoms of PTSD made individuals more susceptible to developing MI or vice versa). Future studies may address these issues by utilizing prospective data collection. In addition, clinical data should be collected using structured clinical interviews to confirm the findings from the self-report measures and to assess the index traumas, as well as to confirm exposures to potentially morally injurious events.

An additional weakness of the study includes the use of the MIES[24]. Specifically, the MIES makes it difficult to discern whether it was the exposure to morally injurious events, or the expression of distress associated with MI that contributed to the findings. Future work should ensure that exposure to morally injurious events and the expression of distress associated with MI are clearly delineated. Another weakness of the study is that guilt and shame are indirectly assessed via PTSD cluster D criteria; future studies may address this weakness by including measures of guilt and shame in order to directly test these relations. Collectively, these limitations also impact the representativeness of the significant findings and it is cautioned that these findings are preliminary in nature. Subsequently, future work should endeavor to replicate these findings.

An additional avenue for future work is the further exploration of the relation between perceived betrayals and PTSD symptoms. As discussed previously, within the

context of the COVID-19 pandemic, military personnel and Veterans have been called on to assist front-line health care workers within long-term-care facilities where they have witnessed patients within deplorable conditions[20,21]. Notably, not only have military personnel witnessed and experienced these events, but so too did front-line health care workers. Although these two groups are marked by significant differences, including their training, work environments (e.g., health care settings vs. battle theatres), and organizational structures, the betrayal of the central dictums of care alongside the betrayals and failures of the health care system and government to protect patients and front-line health care workers may subsequently expose both groups to potentially morally injurious events and its subsequent consequences[40]. Future work should consider exploring these potential associations and differences among military personnel, Veterans, and front-line health care workers in the wake of the COVID-19 pandemic. Finally, much future work is needed to elucidate whether targeting difficulties with emotion regulation will improve military personnel's and Veterans' psychological distress after exposure to morally injurious experiences.

Despite the study's limitations and preliminary findings, it serves as an initial step in considering additional risk factors associated with MI among military personnel and Veterans, and it postulates whether other populations, such as front-line health care workers, may be considered as also experiencing potentially morally injurious events. Accordingly, this lays the foundation for future research regarding MI and subsequently, improving overall social and occupational functioning.

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Chapter 4: A pilot randomized controlled trial of Goal Management Training in Canadian military members, veterans, and public safety personnel experiencing post-traumatic stress symptoms

Chapter Link

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Another transdiagnostic symptom associated with PTSD includes difficulties with cognitive functioning. Several meta-analyses have demonstrated small to moderate effects of PTSD across multiple areas of objective cognitive functioning, including executive functioning, attention, working memory, and processing speed. Among individuals with PTSD, difficulties with cognitive functioning are associated with increased functional impairment and poorer psychological treatment outcomes. Evidence has also demonstrated the dynamic relations among difficulties with cognitive functioning, symptoms of PTSD, and difficulties with ER. Despite this evidence, few studies have examined whether difficulties with cognitive functioning, daily functioning, and symptoms of PTSD, including difficulties with ER, could be improved among military personnel, veterans, and PSP following a cognitive remediation intervention. Here, we conducted a pilot, RCT to investigate whether GMT, a cognitive remediation intervention, improved objective and subjective neurocognitive functioning and daily functional outcomes among military personnel, veterans, and PSP with symptoms of

PTSD when compared to a waitlist control. We also investigated whether symptoms of PTSD, difficulties with ER, and symptoms associated with PTSD (e.g., dissociation, depression, and anxiety) also improved following GMT.

A pilot, randomized controlled trial of Goal Management Training in Canadian military members, Veterans, and public safety personnel experiencing post-traumatic stress symptoms

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Abstract

Post-traumatic stress disorder (PTSD) is a severe psychiatric illness that disproportionately affects military personnel, veterans, and public safety personnel (PSP). Evidence demonstrates that PTSD is significantly associated with difficulties with emotion regulation (ER) and difficulties with cognitive functioning, including difficulties with attention, working memory, and executive functioning. A wide body of evidence suggests a dynamic interplay among cognitive dysfunction, difficulties with ER, and symptoms of PTSD, where numerous studies have identified overlapping patterns of alterations in activation among neuroanatomical regions and neural circuitry. Little work has examined interventions that may target these symptoms collectively. The primary objective of this pilot randomized controlled trial (RCT) with a parallel experimental design was to assess the effectiveness of goal management training (GMT), a cognitive remediation intervention, in reducing difficulties with cognitive functioning, and to determine its effects on PTSD symptoms and symptoms associated with PTSD, including difficulties with ER, dissociation, and functioning among military personnel, veterans, and PSP. Forty-two military personnel, veterans, and PSP between the ages of 18 and 70 with symptoms of PTSD were recruited across Ontario, Canada between October 2017 and August 2019. Participants were randomized to either the waitlist (WL) (n = 18) or the GMT (n = 22) condition. Participants in both conditions received self-report measures and a comprehensive neuropsychological assessment at baseline, post-intervention, and 3-month follow-up. Following their completion of the 3-month follow-up, participants in the WL condition were given the opportunity to participate in GMT. Assessors and

participants were blind to intervention allocation during the initial assessment. A series of 2 (time) × 2 (group) ANOVAs were conducted to assess the differences between the WL and GMT conditions from pre- to post-intervention for the self-report and neuropsychological measures. The results demonstrated significant improvements in measures of executive functioning (e.g., verbal fluency, planning, impulsivity, cognitive shifting, and discrimination of targets) and trending improvements in short-term declarative memory for participants in the GMT condition. Participants in the GMT condition also demonstrated significant improvements from pre- to post-testing in measures of subjective cognition, functioning, PTSD symptom severity, difficulties with ER, dissociative symptom severity, and depression and anxiety symptoms. No adverse effects were reported as a result of participating in GMT. The results of this pilot RCT show promise that GMT may be a useful intervention to improve symptoms of cognitive dysfunction, symptoms of PTSD, and symptoms associated with PTSD within military personnel, veterans, and PSP. Future work is needed to address the small sample size and the durability of these findings.

Key Words: cognitive dysfunction; cognitive remediation; emotion regulation; goal management training; military; posttraumatic stress disorder; public safety personnel; veterans

Introduction

Post-traumatic stress disorder (PTSD) is a severe psychiatric illness that occurs as a result of experiencing, witnessing, or learning about a traumatic event or events [1]. Military personnel, veterans, and public safety personnel (PSP) (i.e., dispatchers, correctional workers, police officers, firefighters, paramedics, and emergency medical technicians) [2] are regularly exposed to potentially traumatic events, such as natural disasters, military conflicts, motor vehicle accidents, assaults, and death, due to the nature of their work [3], placing these individuals at increased risk for the development of PTSD relative to the general population [3,4,5]. Here, compared to Canadian civilians, where approximately 9% meet the criteria for lifetime prevalence of PTSD [6], the lifetime prevalence of PTSD within Canadian military personnel and veterans is estimated to be 22% [7]. Although no lifetime prevalence estimates of PTSD currently exist for PSP, approximately 23% of PSP met the diagnostic criteria of PTSD within the past month when assessed using a web-based self-report survey [3].

According to the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition* (DSM-5) [1], PTSD is characterized by re-experiencing symptoms (e.g., intrusive and distressing memories, dreams, or flashbacks), avoidance, alterations in mood and thoughts (e.g., negative beliefs about oneself, others, the world; persistent low mood or anhedonia), and changes in arousal (e.g., hypervigilance, angry outbursts). Individuals with PTSD may also experience symptoms of dissociation associated with feelings of derealization (i.e., feeling as though the world around oneself is unreal or strange) or depersonalization (i.e., perception of the self feels unreal or strange) and may be

diagnosed with the dissociative subtype of PTSD [1]. Notably, approximately 16% to 19% of veterans diagnosed with PTSD meet the criteria for this subtype [8].

PTSD is also comorbid with several other psychiatric disorders, including major depressive disorder (MDD) [1,6,9], anxiety disorders [1,9], and alcohol and substance use disorders [1,6,9]. For example, among a Canadian military personnel and veteran sample diagnosed with PTSD during their lifetime, approximately 80% also had a comorbid diagnosis of MDD, 59% had a comorbid diagnosis of social anxiety disorder, 51% had a comorbid diagnosis of panic disorder, and 46% had a comorbid diagnosis of generalized anxiety disorder [7].

Critically, PTSD is highly associated with difficulties with emotion regulation (ER), a transdiagnostic factor across various psychiatric conditions that refers to difficulties with moderating and managing emotions [10,11,12,13,14,15,16,17,18,19]. Here, elevated levels of difficulties with ER are associated with increased PTSD symptom severity and expression [13,14,16,18,19]. Moreover, symptoms of dissociation associated with PTSD may serve as a form of ER strategy, allowing individuals to disengage from experiencing highly distressing emotions [15]. Together, these findings suggest that difficulties with ER may contribute to PTSD symptom maintenance and point towards the need for targeted treatment approaches for the resolution of ER difficulties among individuals with PTSD [20]. Despite this knowledge, to date, systematic approaches for the treatment of ER difficulties are seldom employed in the treatment of PTSD, instead forming a relatively small component of more cognitively

oriented approaches such as cognitive processing therapy [21,22] and prolonged exposure therapy [23].

Along with other neuropsychiatric presentations, such as MDD and anxiety disorders, PTSD is also associated with difficulties in cognitive functioning [1,24]. Here, negative alterations in verbal learning, declarative memory [25,26,27,28], attention, working memory, executive functioning [26,29,30,31,32], and processing speed [26,28] are routinely observed among individuals with PTSD. Data from a meta-analysis have demonstrated medium effect size impairments associated with PTSD occurring in verbal learning (Cohen's $d = -0.62$), processing speed (Cohen's $d = -0.59$), and attention and working memory (Cohen's $d = -0.50$), with executive functioning (Cohen's $d = -0.45$), verbal memory (Cohen's $d = -0.46$), language (Cohen's $d = -0.43$), visuospatial functioning (Cohen's $d = -0.38$), visual learning (Cohen's $d = -0.32$), and visual memory (Cohen's $d = -0.29$) demonstrating smaller effect sizes [28]. Notably, this meta-analysis found an overall medium effect size impairment of PTSD on neurocognitive functioning (Cohen's $d = -0.49$). In another meta-analysis, the researchers compared executive functioning in a PTSD group to healthy and trauma-exposed control groups [32]. Here, it was found that individuals in the PTSD group demonstrated small to moderate impairments in executive functioning (i.e., Hedges' $g = 0.464$ and Hedges' $g = 0.414$ for the healthy and trauma-exposed control groups, respectfully), independent of PTSD symptom severity, suggesting that difficulties with executive functioning may be present across varying levels of PTSD symptom severity. These findings also align with previous meta-analysis results [28].

Additional work has explored cognitive difficulties among individuals with PTSD and comorbid dissociative symptoms [33,34,35]. Here, it has been found that there are negative alterations in verbal and visual memory [34], attention, executive functioning, and autobiographical memory [35] among individuals with PTSD and co-occurring dissociative symptoms. In conjunction with these objective cognitive difficulties, individuals with PTSD also report subjective difficulties with cognitive functioning [36,37], which are associated with increased psychological symptom severity among military veterans [38] and civilians [39].

Cognitive dysfunction also is associated with negative impacts on physical [40], social, and occupational functioning (e.g., increased absenteeism) [40,41], as well as poorer psychological treatment outcomes, among military personnel and civilians with PTSD [42,43,44,45]. These difficulties may be long-standing, where alterations in cognitive performance continue to persist in approximately 25% of individuals who have completed either cognitive processing therapy or prolonged exposure therapy [46]. Like difficulties in ER, however, negative alterations in cognitive functioning (i.e., both objective and subjective difficulties) are rarely addressed as a specific treatment target in PTSD, despite their associations with poorer outcomes and increased symptom severity [36].

Importantly, a wide body of evidence suggests a dynamic interplay among cognitive dysfunction, difficulties with ER, and symptoms of PTSD, where numerous studies have identified overlapping patterns of alterations in activation among neuroanatomical regions [15,47,48,49,50,51,52,53] and large-scale neural circuitry

[54,55,56,57]. Here, reductions in activation of pre-frontal cortical regions, such as the medial pre-frontal cortex and the rostral anterior cingulate cortex, have been associated with decreases in top-down control of emotion processing and regulation centres of the brain, such as the amygdala and other limbic regions [15,50,51]. Conversely, increases in activation of pre-frontal cortical regions have been associated with increases in top-down control of emotion processing and regulation centres of the brain. This profile of hypoactivation of pre-frontal cortical regions and concomitant hyperactivation of emotion processing and regulation centres of the brain is thought to contribute to emotional undermodulation and associated re-experiencing and hyperarousal symptoms among individuals with PTSD [15,50]. Comparatively, hyperactivation of pre-frontal cortical regions and concomitant hypoactivation of emotion processing and regulation centres of the brain contribute to emotional overmodulation, which is associated with symptoms of dissociation. Critically, many of these same pre-frontal cortical regions are associated with higher-order cognitive functioning, including executive functioning, working memory, and attentional control [58,59], with alterations in neural activity thought to underlie, in part, alterations in cognitive functioning among individuals with PTSD [26,29,30,31,32].

These neuroanatomical regions form larger brain networks, including the default mode network (DMN), the central executive network (CEN), and the salience network (SN) [60,61,62]. In the absence of any significant dysfunction, these neurocognitive networks work in conjunction with one another and are responsible for the top-down control of various processes, including cognitive functioning, emotions, and ER.

Specifically, the DMN is associated with self-referential mental activity, such as self-monitoring, autobiographical memory, and future- or past-oriented thinking [61,63]. It is typically activated during rest and deactivated during cognitive tasks. Moreover, the DMN is anchored within the posterior cingulate cortex, the medial pre-frontal cortex, and the medial temporal lobe [61]. The CEN contributes to executive functioning, attention, memory, goal-directed behaviours, and the cognitive control of emotions and ER. It includes nodes in the pre-cuneus, dorsolateral pre-frontal cortex, and lateral posterior parietal cortex [60,61,64]. Finally, the SN is involved with directing attention to relevant internal and external stimuli and is co-activated with the CEN during cognitive tasks [60]. It is associated with nodes within the amygdala, anterior cingulate cortex, and anterior insula [60,61].

Like the evidence demonstrating differences in neural activity amongst the different brain regions in individuals with PTSD and its dissociative subtype [15,50], evidence demonstrates that these neural networks show aberrant patterns of connectivity at rest and during symptom provocation [56,65,66,67,68,69,70,71,72,73]. Generally, findings have shown patterns of hypoconnectivity within the DMN [55,74,75,76], hypoconnectivity between the DMN and the CEN [54,55,56,74,76,77], hypoconnectivity within the CEN [55,56,75], and hyperconnectivity within the SN [54,55,56]. Critically, these patterns of connectivity are associated with symptoms of PTSD, including symptoms of dissociation, avoidance, re-experiencing symptoms, a reduced ability to switch between task-relevant and task-irrelevant behaviours, cognitive deficits, hypervigilance, and fear [54,55,56,70]. Moreover, evidence has demonstrated differential

patterns of neural connectivity among individuals with PTSD, individuals with the dissociative subtype of PTSD, and healthy controls [70]. For example, among individuals with the dissociative subtype of PTSD, Nicholson et al. (2020) reported that there were increased connections amongst nodes within the DMN, such as the middle dorsal pre-frontal cortex, as well as hyperconnectivity within the CEN, in comparison to individuals with PTSD alone. It was hypothesized that the hyperconnectivity levels within the DMN and CEN were associated with symptoms of emotional overmodulation and subsequently the presentation of dissociative symptoms, such as depersonalization and derealization [15,68,69,78]. Such patterns of connectivity within the DMN and CEN have been postulated to be associated with changes in cognitive functioning found amongst individuals with PTSD and co-occurring dissociative symptoms [33]. Among individuals with PTSD, the findings demonstrated hyperconnectivity between the posterior SN and the anterior insula relative to individuals with the dissociative subtype [70]. Notably, this pattern of hyperconnectivity between the posterior SN and the anterior insula within the PTSD group is thought to reflect increased internal and external stimuli processing [56,62,67], which can contribute to symptoms of hypervigilance and increased reactivity [79].

Disruption to these networks may confer difficulties with top-down cognitive control and bottom-up regulation, subsequently disrupting both cognitive function and ER [52,55,56,57]. In many instances, for example, the ability to successfully regulate emotions is dependent on the ability to inhibit a pre-potent response and executive control [80,81]. For example, cognitive ER, which is the ability to reappraise the meaning of an

initial stimulus such that the emotional response is altered [82,83,84], is dependent upon cognitive processes such as working memory, executive functioning, and attention [82,83,85,86]. Notably, impairments in these cognitive functions have been associated with increased risk of developing psychiatric disorders, such as anxiety [87]. Conversely, ER is necessary for successful cognitive functioning, such that different ER strategies confer different cognitive benefits or consequences [80,88]. For example, in a study by Richards and Gross (2000), the researchers examined whether differences between the types of ER strategy impacted memory [88]. Here, it was found that individuals who utilized expressive suppression (i.e., inhibiting behavioural urges to act on emotions) performed significantly worse on tasks of nonverbal and verbal memory versus those who engaged in cognitive reappraisal during an emotion-inducing slide presentation.

Given the wide-ranging dysfunction associated with the loss of top-down cognitive control in PTSD, an intervention that assists with reinstating cognitive control and favors the implementation of generalizable skills to address multiple neurocognitive domains, such as impulsivity and executive functioning, may be of benefit. Specifically, such an intervention may not only address the cognitive dysfunction associated with PTSD but also symptoms associated with PTSD, such as difficulties with ER and dissociation, given the commonalities amongst the neuroanatomical regions and networks associated with these symptoms [56]. Such an intervention may include goal management training (GMT) [59,89], which is a skills-based, top-down, cognitive remediation intervention. It is theorized that GMT targets the brain's sustained attention system [59,90,91,92]. This system is activated within the dorsolateral pre-frontal cortex, posterior

parietal cortex, and thalamic regions of the brain [92], which are regions associated with executive functioning. Moreover, this network shares similar neuroanatomical regions with the CEN [60,61,64]. Critically, disruption to the sustained attention system can impede higher-order goal-directed behaviours, such that automatic responding or other behaviours inconsistent with these goals can subsequently supersede these goals [59]. This may contribute to difficulties with attention and executive functioning. The purpose of GMT is to assist with the reinstatement of executive and supervisory control, such that individuals are taught skills and strategies to monitor goals [59,93] and to subsequently interrupt automatic responding [59].

GMT has been used to address cognitive difficulties across a variety of medical and neuropsychiatric disorders, including traumatic brain injury (TBI) [59], attention deficit hyperactivity disorder (ADHD) [94], substance abuse [95], and spina bifida [96]. It consists of nine two-hour, group-based sessions that provide individuals with psychoeducation, self-monitoring, and mindfulness-based strategies, as well as other skills to reduce the frequency and severity of cognitive difficulties, including difficulties with planning, organizing, attention, and memory [89]. A recent meta-analysis found that across various medical (e.g., TBI, multiple sclerosis) and neuropsychiatric (e.g., ADHD, substance use disorders) conditions, there was a significant small to moderate positive effect of GMT on executive functioning (Hedges' $g = 0.227$), which remained during follow up testing (Hedges' $g = 0.549$) [97]. Moreover, the meta-analysis revealed significant small to moderate positive effects of GMT in the domains of working memory (Hedges' $g = 0.438$), long-term memory (Hedges' $g = 0.269$), instrumental activities of

daily living (e.g., cleaning the house, managing finances, cooking) (Hedges' $g = 0.662$), and various psychiatric symptoms (Hedges' $g = 0.309$) [97].

Recent work has sought to apply GMT within psychiatric samples [98,99]. For example, work by Cameron et al., (2020) examined the feasibility of GMT within an obsessive–compulsive disorder outpatient sample [98]. Relative to waitlist controls, individuals in the GMT condition improved on neuropsychiatric measures assessing problem-solving, planning, impulsivity, attention, and processing speed. Individuals in the GMT condition also demonstrated significant improvements on subjective ratings of cognitive functioning, as well as on self-report measures of functioning, including lessened interference of their obsessive–compulsive disorder symptoms during daily functioning and improvements in instrumental tasks of daily living. Studies have also begun to directly examine PTSD and trauma-exposed samples. Specifically, Boyd et al. (2019) conducted an initial open-label feasibility trial of a modified GMT protocol within an inpatient trauma-exposed sample [99]. The results from this study demonstrated that patients who participated in a modified GMT protocol while receiving treatment as usual experienced improvements in several areas of cognitive functioning, including executive functioning, processing speed, sustained attention, and verbal memory. In addition, relative to patients who did not participate in GMT, patients receiving GMT as an adjunctive treatment also reported an improvement in their ability to engage in goal-directed behaviours while experiencing difficulties with ER. Together, these initial findings suggest that GMT may not only be effective in improving areas of cognitive dysfunction (i.e., both objective and subjective cognitive functioning) typically associated

with PTSD, but also that GMT has the potential to improve symptoms associated with PTSD, such as difficulties with ER, dissociation, and difficulties with functioning.

Study objectives and hypotheses

To date, no randomized control trial of GMT has been conducted among individuals experiencing symptoms of PTSD, nor have its effects been fully elucidated within a military, veteran, and PSP sample expected to experience PTSD and its deleterious impacts at a higher prevalence than their civilian counterparts [3,4,5,100]. Moreover, as cognitive dysfunction can persist among individuals who have received treatment for PTSD [46], participants who did not meet a current diagnosis of PTSD (e.g., those who had a history of a PTSD diagnosis or who exhibited symptoms of PTSD that did not meet the full diagnostic criteria) were also considered for inclusion within the trial. Accordingly, the primary aim of the present study was to build upon Boyd et al.'s (2019) previous findings [99] and conduct a pilot randomized controlled trial (RCT) to determine the effectiveness of GMT as compared to a waitlist (WL) condition in a sample of military personnel, veterans, and PSP experiencing symptoms of PTSD. We hypothesized that individuals randomly assigned to receive GMT in comparison to the WL condition would experience improvements in areas of objective measures of cognitive functioning, including executive functioning, processing speed, sustained attention, and verbal memory, as well as in a measure of subjective cognitive functioning. In addition, we hypothesized that participants assigned to the GMT groups would show significantly greater functional improvement compared to participants in the WL condition. Finally, we predicted that participants in the GMT condition compared to those

in the WL condition would experience a subsequent improvement in symptoms of PTSD and symptoms associated with PTSD, including difficulties with ER, dissociation, depression, and anxiety.

In addition to these objectives and hypotheses, a secondary objective of the study was to explore the trajectory of symptom change (i.e., self-reported cognitive difficulties, PTSD symptoms, difficulties with ER, dissociative symptoms, depression symptoms, and anxiety symptoms) over the course of GMT. It was hypothesized that the severity of these self-reported symptoms would decrease over the course of GMT. Moreover, given the noted interactions among PTSD symptoms, symptoms associated with PTSD, and cognition, an additional aim was to explore whether any self-reported symptoms at baseline (e.g., self-reported cognitive difficulties, difficulties with ER, etc.) influenced the trajectory of symptom change across the GMT intervention. Given that these analyses were exploratory in nature, no hypotheses regarding these outcomes were made.

Methods

This study was approved by the Homewood Health Centre Regional Centre for Excellence in Ethics (REB 15–29) and is registered at ClinicalTrials.gov (NCT04076839). A copy of the study protocol is available upon request.

Participants

The participants were 42 men (64.3% of the sample) and women (35.7% of the sample) who were either current or former military personnel, veterans, or PSP. Individuals were recruited by a research coordinator (i.e., a paid staff member of the Homewood Research Institute (HRI)) during recruitment groups at the Homewood Health

Centre (HHC) while completing treatment on the Program for Traumatic Stress Recovery (PTSR) inpatient unit in Guelph, Ontario, Canada. Additionally, recruitment occurred at HHC's Outpatient clinic in Mississauga, Ontario, the PTSR's external referral agencies (e.g., Military Family Resource Centres, Department of National Security Case Management), external community agencies and support groups (e.g., Military Causality Support Foundation, Project Trauma Support, etc.), and social media websites (e.g., Facebook groups, Twitter, etc.) via recruitment posters, information letters, e-mails, social media postings, and directly through clinician or staff member referrals at recruitment sites.

To be included in the study, participants had to meet the following inclusion criteria: (a) be between the ages of 18 and 70; (b) have a diagnosis or a history of a PTSD diagnosis based upon the Clinician-Administered PTSD Scale for DSM-5 (CAPS-5) [101], meet or exceed the clinical cut-off score on the PTSD Scale for DSM-5 (PCL-5) [102], or have a history of trauma as indicated on the Life Events Checklist (LEC) [103]; (c) be fluent in written and spoken English; (d) be able to provide written informed consent; (e) have been discharged from the PTSR inpatient unit, if applicable. Exclusion criteria included: (a) individuals who had no history of employment as military personnel, veterans, or PSP; (b) individuals who had a history of alcohol or substance abuse within the past three months; (c) individuals who had a history of a medical disorder within the past year known to adversely affect cognition (e.g., severe TBI).

Participants were randomly allocated to either participate in the GMT group intervention (n = 22) or were assigned to the WL condition (n = 20). Within both

conditions, one individual switched from GMT to the WL condition and from the WL condition to GMT due to other scheduling commitments, leaving the initial sample sizes the same. Within the GMT condition, one individual dropped out following their baseline assessment, while three individuals began the GMT group but dropped out of the group before completing the sessions. Here, 18 individuals attended and completed the GMT sessions (i.e., 83.3% of the GMT condition sample attended seven or more GMT sessions). All 18 individuals completed the GMT post-testing assessments. Fifteen individuals completed the three-month post-testing assessments. Three individuals did not complete their three-month post-testing appointments due to loss of contact.

Within the WL condition, two individuals did not meet the criteria for the study during the baseline assessment and were excluded from the WL sample. Here, one participant was excluded as they were not a military personnel, veteran, or PSP, while the other participant identified that they had completed a previous GMT study with the same principal investigator. Of the 18 eligible individuals, 11 participants completed the post-delay testing. Eleven participants also completed the three-month delay post-testing assessment; however, one of these participants did not complete the initial post-delay assessment appointment. Therefore, only ten participants completed both the post-delay and three-month delay assessment appointments. Nine individuals from the WL condition attended and completed the GMT sessions (i.e., 88.9% attended seven or more GMT sessions). See Figure 1 for a CONSORT diagram depicting study recruitment, enrollment, and loss to follow up. Demographic and clinical characteristics of the initially eligible GMT and WL participants are reported in Table 1.

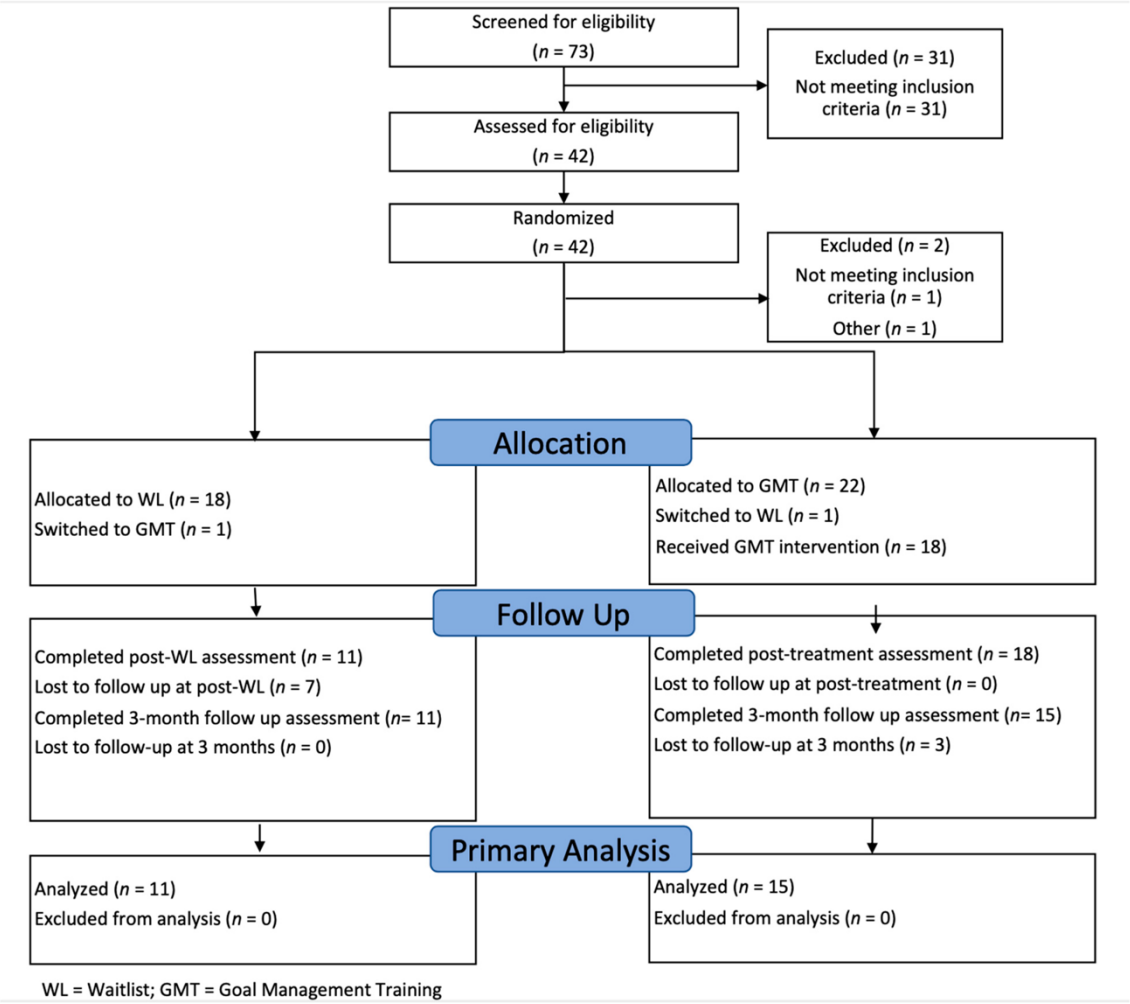

Figure 1. CONSORT diagram depicting recruitment, drop-out, and follow-up of study participants.

Table 1. Demographic and clinical characteristics of eligible participants

Characteristics	WL (*n* = 18)	GMT (*n* = 22)
Demographic characteristics		
Sex (female: male)	3:15	10:12
Age (Mean, (SD))	44.61 (8.54)	43.95 (6.73)
Race (Caucasian: Aboriginal: Hispanic)	15:2:1	22:1:0
Marital Status	% of Sample	
Single	5.6	13.6
Married or common law	72.2	77.3
Separated/Divorced	16.7	0
Long-term relationship	5.6	9.1
Highest Level of Education Completed		
Completed high school	5.6	0
Some college or university	5.6	9.1
Completed college or university	77.8	77.3
Some graduate level education	5.6	4.5
Completed graduate degree	5.6	9.1
Current Employment Status		
Working full time	44.4	27.3
Working part time	5.6	0
Medical Leave/Long-term Disability	22.2	22.7
Modified duties/Return to work	0	4.6
On leave/WSIB	22.2	27.3
Not currently employed	5.6	9.1
Other	0	9.1
Military, Veteran, or Public Safety Personnel Status		
Military	0	18.2
Veteran	5.6	13.6
Public Safety Personnel	94.4	95.5
Both	0	27.3
Clinical characteristics		
CAPS-5 – Severity Score (Mean, (SD))	36.00 (14.33)	40.86 (12.67)
CAPS-5 – PTSD Criteria Met (% of Sample)	77.8	90
Additional M.I.N.I. 7.0.2 diagnoses	% of Sample	
Major Depressive Disorder	61.1	63.6
Generalized Anxiety Disorder	27.8	54.5
Social Anxiety Disorder	27.8	50.0
Panic Disorder	16.7	27.3
Agoraphobia	11.1	40.9
Alcohol Use Disorder, Past 12 Months	5.6	13.64
Substance Use Disorder, Past 12 Months	0	4.55

Binge Eating Disorder	15.0	4.55
IQ	Mean (SD)	
WTAR Estimated IQ	113.44 (6.08)	113.32 (5.38)
WASI-II FSIQ	105.56 (16.00)	108.45 (14.13)

Note. WL = Waitlist; GMT = Goal Management Training; WSIB = Workplace Safety and Insurance Board; CAPS-5 = Clinician-Administered PTSD Scale for DSM-5; IQ = Intelligence Quotient; WTAR = Wechsler Test of Adult Reading; WASI-II = Wechsler Abbreviated Scale of Intelligence, Second Edition; M.I.N.I. 7.0.2 = Mini International Neuropsychiatric Interview 7.0.2.

Experimental design and procedure

This study followed a pilot RCT with a parallel experimental design, which recruited and followed participants between October 2017 and August 2019. The website https://www.sealedenvelope.com/simple-randomiser/v1/lists (last accessed on 5 September 2017) was used to generate the random allocation sequence. Ten blocks were specified so that there would be an equal number of participants allocated to the GMT and WL conditions [104,105]. A randomization list was created for each site where participants were assessed and participated in GMT (i.e., HRI, Guelph, Ontario and HHC Outpatient Clinic, Mississauga, Ontario). The randomization lists were password protected and were only accessible by the research coordinator.

The research coordinator contacted participants who indicated their interest in the study and screened them for their eligibility. If eligible, the initial baseline testing appointment was scheduled with a trained assessor (i.e., a graduate student or individual with higher credentials and experience). Participants selected which research site they wished to attend before their initial assessment appointment.

During the baseline assessment, the assessors and participants were blind to the intervention allocation. Following informed consent, baseline testing consisted of a

battery of assessor-administered and self-report assessment measures that included psychological, functional, and neuropsychological assessments. The research coordinator contacted participants following the initial baseline assessment to inform them of their intervention allocation (i.e., GMT or WL).

Individuals who were randomized to receive GMT participated in the 9-week, group-based cognitive remediation intervention. The GMT groups were closed, and each group consisted of four to ten participants to ensure adequate group facilitation and group member participation. During GMT, a battery of self-report measures was administered to participants at the initial GMT session and every third session thereafter. Following GMT, participants were assessed during a post-intervention assessment and again at a 3-month follow-up assessment.

After their baseline assessment, participants who were assigned to the WL condition were assessed following a 9-week waiting period and at a 3-month follow-up. Following this 3-month assessment, participants were given the opportunity to participate in GMT. Those who participated in GMT were administered the same battery and schedule of self-report measures during the GMT intervention (i.e., initial GMT session and every third session thereafter).

Study conditions

GMT. As previously described, GMT consists of nine two-hour, weekly, group-based sessions that provide individuals with psychoeducation, self-monitoring strategies, mindfulness-based strategies, and other skills to reduce the frequency and severity of cognitive difficulties, including difficulties with planning, organizing, attention, and

memory [89]. The GMT sessions were facilitated by an occupational therapist with significant GMT facilitation experience and treatment of military personnel, veterans, and PSPs with PTSD and trauma histories. Given this, GMT was tailored to this population by including psychoeducation and examples related to how PTSD and trauma can affect cognition (e.g., acknowledging how difficulties with dissociation, ER, and hypervigilance can affect attentional resources). These modifications to the protocol were not previously assessed and were also being piloted within this study. GMT also was co-facilitated by a clinical psychology graduate student who assisted with the group's administration and session content, as needed.

WL. Participants who were randomly assigned to the WL condition were required to wait for at least a three-month period after which they were offered the ability to participate in GMT. Participants completed testing following the initial nine-week waiting period, as well at the three-month follow-up. As previously described, following their participation in GMT (if elected), participants were assessed following the intervention and again at 3-months post-intervention.

Measures

Clinician-administered interviews

The *Mini International Neuropsychiatric Interview 7.0* (M.I.N.I.) [106] is a semi-structured, clinician-administered interview, which assesses 17 psychiatric disorders, including mood, anxiety, alcohol, and substance use disorders according to the DSM-5 [1]. The M.I.N.I. was only administered during baseline testing.

The *Clinician-Administered PTSD Scale for DSM-5* (CAPS-5) [101] is a semi-structured interview that assesses the DSM-5's PTSD diagnostic criteria in the past month. It assesses the onset, duration, frequency, and intensity of symptoms. The CAPS-5 was administered at baseline only.

Neuropsychological assessment

A standardized neuropsychological assessment battery aimed at assessing intellectual functioning, executive functioning, processing speed, attention, and memory was administered to both GMT and WL condition participants.

Intellectual functioning (assessed at baseline only): (a) the *Wechsler Test of Adult Reading* (WTAR) [107] was used to assess pre-morbid intellectual functioning in adults; (b) the *Wechsler Abbreviated Scale of Intelligence—Second Addition* (WASI-II) [108] is a brief estimate of intelligence. Here, the Vocabulary and Matrix Reasoning subtests were administered to yield a Full-Scale Intelligence Quotient (FSIQ).

Measures of executive functioning, processing speed, and attention (administered at baseline, post-intervention, and at three months post-intervention for the GMT and WL conditions): (a) the *Controlled Oral Word Association Task* (COWAT) [109] was used to assess verbal fluency, including phonemic (FAS) and semantic (animals) fluency; (b) the *Stroop Color and Word Test* [110,111] was used to assess processing speed (word and color reading) and sensitivity to suppress habitual responses; (c) the *Delis-Kaplan Executive Function System* (DKEFS) *Tower Test* [112] was used as a measure of planning, rule learning, response inhibition, and perseveration; (d) the *Wechsler Adult Intelligence Scale-IV* (WAIS-IV) *Digit Symbol Coding Subtest* [113] assessed processing

speed in adults; (e) the *Trail Making Test* (TMT) *Part A and B* [109] was used as a measure of attention, speed, and mental flexibility. Participants were required to connect numbers in sequential order (TMT part A) and numbers and letters in alternating order (TMT part B) as quickly as possible; (f) *Conners' Continuous Performance Task* (CPT 3.0) [114] was used as a measure of inattentiveness, impulsivity, sustained attention, and vigilance.

Declarative memory (administered at baseline, post-intervention, and at three months post-intervention for the GMT and WL conditions): The *California Verbal Learning Test II* (CVLT-II) [115] is a multiple-trial, word list learning task, which provides indices of immediate and delayed memory performance, interference learning, and recognition.

Subjective cognition

The *Cognitive Failures Questionnaire* (CFQ) [116,117] is a 25-item self-report measure that captures daily errors in distractibility, blunders, names, and memory. The CFQ has been demonstrated to have good construct validity and internal consistency (α = 0.76–0.86) for its four subscales [117]. The CFQ was assessed at all clinician-administered assessment time points (i.e., baseline, post-intervention, and at three months post-intervention for the GMT and WL conditions) and during the GMT intervention (i.e., initial, third, sixth, and final GMT sessions) for those who initially were allocated to the GMT condition or who elected to participate in GMT following their participation in the WL condition.

Functional outcomes

The *World Health Organization Disability Assessment Schedule 2.0* (WHODAS 2.0) [118] was administered to assess individuals' functioning across six domains, including cognition, mobility, self-care, getting along with others, life activities, and participation in the community. It has demonstrated high internal consistency across its six domains (α = 0.94–0.96), good test–retest reliability, and good convergence with other comparable measures [118]. It was administered during all clinician-administered assessment time points.

Self-report symptom measures

The *PTSD Checklist for DSM-5* (PCL-5) [102] was administered to participants to assess the severity of PTSD symptoms according to the diagnostic criteria outlined in the DSM-5 [1]. The symptom domains included intrusive symptoms, avoidance, negative alterations in mood and cognitions, and alterations in arousal and reactivity [1,102]. Participants rated the severity of their symptoms in the past month on a Likert scale from 0 (not at all) to 4 (extremely). A cut-point of 33 is suggested to indicate a probable PTSD diagnosis [119]. It has demonstrated high internal consistency among military (α = 0.95) [119] and veteran (α = 0.95) [120] samples. This measure was administered at all clinician-administered assessment time points and during the GMT intervention.

The *Difficulties in Emotion Regulation Scale* (DERS) [10] is a 36-item self-report measure, which assesses difficulties with ER across six domains, including difficulties with accepting negative emotions; difficulties completing tasks or goals due to negative emotions; difficulties with controlling impulses while experiencing distressing emotions; difficulties with awareness of emotional experiences; negative beliefs regarding the

ability to regulate emotions; and difficulties with insights regarding emotions. Higher scores indicated greater dysfunction with ER. The DERS was shown to have good psychometric properties, including internal consistency ($\alpha = 0.93$) and construct validity [10]. This measure was administered at all clinician-administered assessment time points for the GMT and WL conditions. It also was administered during the GMT intervention.

The *Multiscale Dissociation Inventory* (MDI) [121] is a 30-item self-report measure, which assesses six domains of dissociative symptoms over the past month, including disengagement, depersonalization, derealization, emotional constriction, memory disturbance, and identity dissociation. The MDI Total score has been demonstrated to have high internal consistency ($\alpha = 0.96$) [121]. This measure also was administered at all clinician-administered assessment time points and during the GMT intervention.

The *Beck Depression Inventory-II* (BDI-II) [122] is a 21-item self-report questionnaire that assesses the presence and severity of symptoms of depression over the past 30 days. Symptoms assessed include hopelessness and irritability, feelings of guilt or feelings of being punished, as well as physical symptoms such as fatigue, weight loss, and loss of interest in sex. Respondents rate their symptoms on a Likert scale from 0 to 3, with higher scores reflecting greater symptom severity. The BDI-II has been demonstrated to have high internal consistency in psychiatric outpatients ($\alpha = 0.91$) [123] and adequate convergent and discriminant validity [122]. The BDI-II was administered at all clinician-administered testing sessions and during the GMT intervention.

The *Beck Anxiety Inventory* (BAI) [124] is a 21-item self-report questionnaire that assesses anxiety symptoms over the past 30 days. The items consist of common symptoms of anxiety, such as numbness, tingling, sweating, and fear of perceived catastrophic outcomes. Participants rate their symptoms on a four-point Likert Scale from 0 (not at all) to 3 (severely). It has been demonstrated to have excellent reliability in psychiatric outpatient samples ($\alpha = 0.92$) [125]. It was administered at all clinician-administered testing sessions and during the GMT intervention.

Statistical methods

Data were analyzed using IBM SPSS Version 26.0. Independent samples t-tests and chi-square tests were used to analyze differences in demographic, clinical, neuropsychological, and self-report variables between WL and GMT groups at baseline.

To assess our primary objectives, a series of 2 (time) × 2 (group) ANOVAs were conducted to assess the differences between the WL and GMT conditions from pre- to post-intervention, with analyses completed on participants who did not have any missing data from pre- to post-intervention for each measure of interest (i.e., modified intention-to-treat analysis). Subsequently, sample sizes are indicated for each measure and its analysis. Effect sizes were reported as partial eta-squared (interpreted as small = 0.01, medium = 0.10, and large = 0.25) for the neuropsychological, subjective cognition, functional, and self-report symptom measures. Given the large number of neuropsychological and self-report variables available from this comprehensive battery relative to the small number of participants in the pilot sample, the clinician-administered 3-month assessment time point was excluded from the primary analyses to minimize the

risk of type I error. Moreover, due to the pilot nature of this study, the results of the ANOVAs were followed up with simple main effects analyses based on significant main effects (e.g., time or condition), observations of effect sizes, or inspection of means and SDs between the groups, as the pilot sample may not have been large enough in every case to assess results based on *p*-values alone.

To evaluate our secondary objectives in examining the trajectory of self-reported symptom changes and the effects of baseline variables on the trajectory of symptom changes during the GMT intervention, a series of one- and two-level hierarchical linear models was conducted. Hierarchical linear modelling (HLM) [126] was used given its ability to evaluate individual differences in the trajectory of change over time, and because it can accommodate missing data at level 1. The restricted maximum likelihood approach was used as the method for parameter estimation. The primary outcome variables were the CFQ, PCL-5, DERS, MDI, BDI-II, and BAI total scores, with the assessment time point as a level 1 predictor. Baseline PCL-5, DERS, MDI, BDI-II, and BAI total scores were used as predictors at level 2 in subsequent analyses, and level 2 variables were centred around the grand mean. All analyses assessed changes from baseline to post-intervention across six time points with the unit of time standardized to one week. Specifically, these analyses included all participants who participated in the GMT intervention (i.e., participants who were allocated to the GMT condition and those WL participants who agreed to participate in GMT following their wait period) and included their self-report assessments before, during, and after the GMT intervention. The one-level models assessed the trajectory of change in a single variable over time, whereas

each of the two-level models assessed the effect of a level 2 predictor on the trajectory of change in the self-report symptom measures over time. Individuals missing greater than 30% of the data were excluded from the analysis. Analyses were completed using the HLM 7.0 statistical program.

Results

The participants' mean age across the WL and GMT conditions was 44.25 (*SD* = 7.50). Further, the mean years of education for the sample was 17.27 (*SD* = 2.87). Within the WL and GMT conditions, 77.8% and 90% of the participants, respectively, met the diagnostic criteria for PTSD according to the CAPS-5. Overall, 85.0% of the participants met the criteria for a diagnosis of PTSD across both samples.

With respect to the pre-morbid IQ (i.e., WTAR Estimated IQ), participants in the WL and GMT conditions had mean IQ scores of 113.44 (*SD* = 6.08) and 113.32 (*SD* = 5.38), respectively. Further, the mean estimated IQs (i.e., WASI-II FSIQ) within the WL and GMT conditions were 105.56 (*SD* = 16.00) and 108.45 (*SD* = 14.13), respectively. Collectively, these pre-morbid and estimated IQ scores represent scores between the average and high average range.

No significant differences emerged for the demographic and clinical characteristics between the WL and GMT conditions at baseline. All variables were assessed for homogeneity of variance (Levene's test) and normality (using Kolmogorov–Smirnov and Shapiro-Wilk tests) prior to analyses being conducted. There were several violations of homogeneity of variance and normality (i.e., $p < 0.05$). Transformation of variables were completed [127]; however, the normality and homogeneity of variance

were not improved. Therefore, the results of the non-transformed variables are reported. Subsequently, cautious interpretation of the findings is warranted.

Importantly, no adverse effects were reported as a result of participating in GMT.

Pre- and post-analysis of neuropsychological assessment performance

Means and *SD*s for the pre-treatment neuropsychological assessment performance in each of the WL and GMT groups are presented in Table 2. A series of *t*-tests were performed on these data to ensure no baseline differences in cognitive performance between groups. All results were insignificant ($p = 0.099$ to 0.996).

Table 2. Means and SDs for baseline neuropsychological assessment performance between WL and GMT

Variable	Group	*n*	Mean	SD
COWAT				
FAS T Score	WL	18	42.28	8.98
	GMT	22	41.41	10.25
Animals T Score	WL	18	48.28	12.84
	GMT	22	49.32	12.81
Stroop Color and Word Test				
Word T-Score	WL	18	36.78	10.64
	GMT	22	37.55	11.28
Color T-Score	WL	18	39.17	10.43
	GMT	22	41.14	10.74
Color-Word Trial T Score	WL	18	43.44	8.00
	GMT	22	44.09	11.17
Interference T-Score	WL	18	49.56	6.78
	GMT	22	49.41	6.96
DKEFS Tower Test				
Total Scaled Score	WL	18	11.22	2.53
	GMT	22	11.45	2.18
First Move Time Scaled Score	WL	18	10.61	2.57
	GMT	22	9.23	2.58
Time Per Move Scaled Score	WL	18	9.61	2.85
	GMT	22	8.82	3.51
Move Accuracy Scaled Score	WL	18	9.17	2.68
	GMT	22	9.50	3.40
Rule Violations	WL	18	.78	1.16
	GMT	22	.45	.67

WAIS-IV				
Digit Symbol Coding Scaled Score	WL	18	9.78	3.00
	GMT	22	9.36	2.26
TMT				
TMT Part A T-Score	WL	17	50.00	9.25
	GMT	21	47.43	11.47
TMT Part B T-Score	WL	16	46.88	9.16
	GMT	21	44.67	10.73
CPT 3.0[a]				
Omissions T Score	WL	18	47.94	8.35
	GMT	22	47.95	5.10
Commissions T Score	WL	18	51.89	7.75
	GMT	22	52.27	8.95
Detectability T Score	WL	18	48.94	6.03
	GMT	22	50.27	8.40
Hit Reaction Time T Score	WL	18	46.83	8.58
	GMT	22	43.68	7.93
Variability T Score	WL	18	50.50	11.13
	GMT	22	52.00	7.80
Perseverations T Score	WL	18	45.94	3.12
	GMT	22	48.55	7.58
CVLT-II				
Trial 1 Z Score	WL	18	-.22	1.73
	GMT	22	.52	1.15
Trials 5 Z Score	WL	18	-.14	.78
	GMT	22	-.21	.97
Trial 1-15 Z Score	WL	18	50.61	10.88
	GMT	22	55.68	10.37
Trial B Z Score	WL	18	.14	1.61
	GMT	22	.02	.88
Short-Delay Free Recall Z-Score	WL	18	.17	.73
	GMT	22	-.14	1.20
Short-Delay Cued Recall Z-Score	WL	18	.17	.82
	GMT	22	.09	1.07
Long-Delay Free Recall Z-Score	WL	18	.11	.96
	GMT	22	-.07	1.15
Long-Delay Cued Recall Z-Score	WL	18	-.08	.77
	GMT	22	-.09	.93
Repetitions Z Score	WL	18	.14	1.30
	GMT	22	.07	1.13
Intrusions Z Score	WL	18	.23	1.53
	GMT	22	-.16	1.00
Discriminability Z Score	WL	18	-.06	1.14
	GMT	22	.25	1.09

Note. WL = Waitlist; GMT = Goal Management Training; COWAT = Controlled Oral Word Association Task; FAS represents the letters "F", "A", and "S" for the COWAT subtest; DKEFS = Delis-Kaplan Executive Function System; WAIS-IV = Wechsler Adult Intelligence Scale Fourth Edition; TMT = Trail Making Test; CPT 3.0 = Conner's Continuous Performance Test – Third Edition; CVLT-II = California Verbal Learning Test – Second Edition. [a]Higher T scores for CPT 3.0 indicates poorer performance.

The results of the 2 x 2 ANOVAs for the neuropsychological assessments are reported in Table 3.

Table 3. 2x2 ANOVA table for neuropsychological assessments

Tests of Executive Functioning, Processing Speed, and Attention					
Neuropsychological Test	**Neuropsychological Subtest**	**Source**	***F***	***p***	η^2_p
COWAT[a]	FAS T Score	Time	9.044	.006**	.251
		Condition	.373	.547	.014
		Time*Condition	.149	.703	.005
	Animals T Score	Time	.932	.343	.033
		Condition	.664	.422	.024
		Time*Condition	.022	.883	.001
Stroop Color and Word Test[a]	Word T Score	Time	3.352	.078	.110
		Condition	.002	.968	.000
		Time*Condition	.056	.815	.002
	Color T Score	Time	5.137	.032*	.160
		Condition	.101	.754	.004
		Time*Condition	1.564	.222	.055
	Color-Word T Score	Time	12.477	.002**	.316
		Condition	.016	.901	.001
		Time*Condition	2.903	.100	.097
	Interference T Score	Time	9.402	.005**	.258
		Condition	.076	.785	.003
		Time*Condition	.953	.338	.034
DKEFS Tower Test[b]	Total Score Scaled Score	Time	3.557	.071	.120
		Condition	.251	.621	.010
		Time*Condition	.002	.964	.000
	First Move Time Scaled Score	Time	11.186	.003**	.301
		Condition	6.559	.017*	.201
		Time*Condition	1.945	.175	.070
	Time Per Move Scaled Score	Time	16.065	.000**	.382
		Condition	1.550	.224	.056
		Time*Condition	4.066	.054	.135

	Move Accuracy Scaled Score	Time	.035	.854	.001
		Condition	.812	.376	.030
		Time*Condition	.730	.401	.027
	Rule Violations	Time	5.935	.022*	.186
		Condition	1.335	.258	.049
		Time*Condition	3.393	.077	.115
WAIS-IV[a]	Digit Symbol Coding Scaled Score	Time	12.675	.001**	.319
		Condition	1.054	.314	.038
		Time*Condition	.400	.533	.015
TMT[c]	TMT Part A T Score	Time	.604	.445	.024
		Condition	.223	.641	.009
		Time*Condition	.198	.660	.008
	TMT Part B T Score	Time	7.581	.011*	.233
		Condition	.025	.875	.001
		Time*Condition	.056	.815	.002
CPT 3.0[b]	Omissions T Score	Time	.018	.895	.001
		Condition	.005	.946	.000
		Time*Condition	2.133	.156	.076
	Commissions T Score	Time	17.009	.000**	.395
		Condition	.012	.915	.000
		Time*Condition	.148	.703	.006
	Detectability T Score	Time	4.912	.036*	.159
		Condition	.328	.572	.012
		Time*Condition	1.147	.294	.042
	Hit Reaction Time T Score	Time	.235	.632	.009
		Condition	.107	.746	.004
		Time*Condition	2.078	.161	.074
	Variability T Score	Time	.450	.508	.017
		Condition	1.086	.307	.040
		Time*Condition	.375	.546	.014
	Perseverations T Score	Time	6.259	.019*	.194

		Condition	.916	.347	.034
		Time*Condition	.263	.613	.010
Tests of Declarative Memory					
CVLT-II[a]	Trial 1 Z Score	Time	.032	.860	.001
		Condition	2.997	.095	.100
		Time*Condition	.228	.637	.008
	Trial 5 Z Score	Time	14.603	.001**	.351
		Condition	.293	.593	.011
		Time*Condition	.690	.413	.025
	Trial 1-5 T Score	Time	.592	.448	.021
		Condition	1.668	.207	.058
		Time*Condition	1.247	.274	.044
	Trial B Z Score	Time	.944	.340	.034
		Condition	.494	.488	.018
		Time*Condition	2.976	.096	.099
	Short Delay Free Recall Z Score	Time	.129	.722	.005
		Condition	.356	.556	.013
		Time*Condition	7.963	.009**	.228
	Short Delay Cued Recall Z Score	Time	.217	.645	.008
		Condition	.880	.357	.032
		Time*Condition	3.530	.071	.116
	Long Delay Free Recall Z Score	Time	.475	.496	.017
		Condition	.426	.519	.016
		Time*Condition	1.955	.173	.068
	Long Delay Cued Recall Z Score	Time	.824	.372	.030
		Condition	1.621	.214	.057
		Time*Condition	2.372	.135	.081
	Repetitions Z Score	Time	.107	.746	.004
		Condition	.884	.355	.032
		Time*Condition	.604	.444	.022
	Intrusions Z Score	Time	2.495	.126	.085

	Condition	.480	.494	.017
	Time*Condition	.782	.384	.028
Discriminability Z Score	Time	1.838	.186	.064
	Condition	1.161	.291	.041
	Time*Condition	.472	.498	.017

Note. GMT = Goal Management Training; WL = Waitlist; COWAT = Controlled Oral Word Association Task; FAS represents the letters "F", "A", and "S" for the COWAT subtest; DKEFS = Delis-Kaplan Executive Function System; WAIS-IV = Wechsler Adult Intelligence Scale Fourth Edition; TMT = Trail Making Test; CPT 3.0 = Conner's Continuous Performance Test – Third Edition; CVLT-II = California Verbal Learning Test – Second Edition. [a]GMT n = 18, WL n = 11. [b]GMT n =18, WL n = 10. [c]GMT n = 17, WL n = 10. * $p < .05$. ** $p < .01$.

Tests of executive functioning, processing speed, and attention

COWAT. There was a main effect of Time for the FAS subtest ($F(1,27) = 9.044$, $p=0.006$, $\eta^2_p=0.251$), indicating improved task performance for both the GMT and WL conditions from pre- to post-intervention. Simple main effects analyses revealed that while participants' scores in the GMT condition improved significantly ($F(1, 27) = 7.587$, $p=0.010$, $\eta^2_p=0.219$) from pre- to post-intervention, participants' scores in the WL condition did not ($F(1, 27) = 2.768$, $p=0.108$, $\eta^2_p=0.093$). This suggests that GMT had a medium effect on verbal fluency. There were no significant interactions or main effects for the COWAT Animals subtest (*p*s = 0.343 to 0.883).

Stroop Color and Word Test. The results of the 2 x 2 ANOVA for the Stroop Color and Word Test demonstrated significant main effects of Time in the Color subtest ($F(1,27) = 5.137$, $p=0.032$, $\eta^2_p=0.160$), the Color-Word subtest ($F(1,27) = 12.477$, $p=0.002$, $\eta^2_p=0.316$), and the Interference score ($F(1,27) = 9.402$, $p=0.005$, $\eta^2_p=0.258$), suggesting improvements for both groups from pre- to post-intervention. Simple main effects analyses were carried out. Notably, results demonstrated that across the Color ($F(1,27) = 4.982$, $p=0.034$, $\eta^2_p=0.156$), Color-Word ($F(1, 27) = 11.043$, $p=0.003$, $\eta^2_p=0.290$), and Interference ($F(1, 27) = 6.582$, $p=0.016$, $\eta^2_p=0.196$) scores, individuals' scores within the WL condition improved significantly, while those in the GMT condition (*p*s = 0.417, 0.149, and 0.101, respectively) did not.

DKEFS Tower Test. There was a significant main effect of Time ($F(1,26) = 11.186$, $p=0.003$, $\eta^2_p=0.301$) and Condition ($F(1,26) = 6.559$, $p=0.017$, $\eta^2_p=0.201$) for the DKEFS First Move Time scaled score from pre- to post-intervention. Simple main

effects analyses revealed that there was a significant increase in task initiation time from pre- to post-intervention for those participants in GMT ($F(1,26) = 15.722$, $p=0.001$, $\eta^2_p =0.377$), but not for those in the WL condition ($F(1,26) = 1.479$, $p=0.235$, $\eta^2_p =0.054$). This suggests that following GMT, individuals took longer to make their first move on the task than those in the WL condition. These findings represent a large effect. Moreover, there were also significant main effects of Time for Time Per Move scaled score ($F(1,26) = 16.065$, $p <0.001$, $\eta^2_p =0.382$) and Rule Violations ($F(1,26) = 5.935$, $p=0.022$, $\eta^2_p =0.186$). Simple main effects analyses for the Time Per Move scaled score demonstrated that there was a significant increase in the amount of time taken per move from pre-to post-intervention for those participants in GMT ($F (1, 26) = 25.405$, $p<0.001$, $\eta^2_p=0.494$), but not for those participants in the WL condition ($F (1, 26) = 1.543$, $p=0.225$, $\eta^2_p =0.056$). Moreover, the simple main effects for Rule Violations demonstrated that there was a significant decrease (i.e., less rule breaking) for the participants in the WL condition over time ($F (1, 26) = 7.118$, $p=0.013$, $\eta^2_p =0.215$), but not for GMT participants ($F (1, 26) = 0.247$, $p=0.623$, $\eta^2_p =0.009$).

WAIS-IV Digit Symbol Coding Subtest. Analyses demonstrated that there was a significant main effect for Time ($F (1, 27) = 12.675$, $p=0.001$, $\eta^2_p =0.319$), with simple main effects revealing significant increases in participants' scores for both the GMT ($F (1, 27) = 5.650$, $p=0.025$, $\eta^2_p =0.173$) and WL ($F (1, 27) = 7.079$, $p=0.013$, $\eta^2_p =0.208$) conditions from pre- to post-intervention.

TMT. There was a significant main effect of Time ($F (1, 25) = 7.581$, $p=0.011$, $\eta^2_p =0.233$) for the TMT Part B score from pre- to post-intervention. Notably, there was a

simple main effect demonstrating a significant increase in scores for the participants in the GMT condition (F (1, 25) = 4.277, p=0.049, η^2_p =0.146), suggesting a reduction in the time taken to complete the task. Moreover, those in the WL condition also demonstrated an increase in their TMT Part B scores over time; however, this result did not reach the alpha level of significance (F (1, 25) = 3.549, p=0.071, η^2_p =0.124).

CPT 3.0. There were significant improvements (i.e., decreases) in Commissions (F (1, 26) = 17.009, p= <0.001, η^2_p =0.395) and Detectability (F (1, 26) = 4.912, p=0.036, η^2_p =0.159) scores across time for both groups. Furthermore, there was a significant increase in Perseverations across time for both groups (F (1, 26) = 6.259, p=0.019, η^2_p =0.194). With respect to Commissions, simple main effects demonstrated significant decreases for both the GMT (F (1, 26) = 14.233, p=0.001, η^2_p =0.354) and WL (F (1, 26) = 5.437, p=0.028, η^2_p =0.173) conditions from pre- to post-intervention. Moreover, simple main effects analyses demonstrated a similar significant decrease for Detectability from pre- to post-intervention within the GMT condition F (1, 26) = 7.564, p=0.011, η^2_p =0.225), but not within the WL condition (F (1, 26) = 0.510, p=0.481, η^2_p =0.019). These findings represented a medium to large effect size. Finally, analyses of the simple main effect for Perseverations demonstrated a significant increase in scores (i.e., a worsening) within the GMT condition (F (1, 26) = 6.360, p=0.018, η^2_p =0.197), but not the WL condition (F (1, 26) = 1.539, p=0.226, η^2_p =0.056).

Declarative memory

CVLT. Results of the 2 x 2 ANOVAs for the CVLT also reveal several significant effects. Critically, there was a significant Group x Time interaction for the CVLT-II Short

Delay Free Recall Z score (F(1, 27)=7.963, p=0.009, η^2_p=0.228), with simple main effects indicating that participants in the GMT condition freely recalled a greater number of words from a list (F(1, 27)=3.997, p=0.056, η^2_p=0.129). This finding, however, did not reach the alpha threshold for significance. Those in the WL condition experienced a decline in their ability to freely recall words from a list; however, this finding also did not reach the alpha threshold for significance (F (1, 27) = 4.076, p =0.054, η^2_p =0.131). Further, there was a significant main effect of Time for the Trial 5 Z scores (F (1, 27) = 14.603, p =0.001, η^2_p =0.351). Here, simple main effects revealed a significant improvement for participants in the GMT condition (F (1, 27) = 14.264, p =0.001, η^2_p =0.346), with those participants in the WL condition also improving (F (1, 27) = 3.602, p =0.068, η^2_p =0.118), but did not reach the alpha level for significance.

Pre and post-analysis of subjective cognition, functioning, and self-report symptom measures

A series of *t*-tests were conducted to assess baseline differences between the GMT and WL conditions on each of the self-report variables. No significant differences were present between the two groups (*p*s=0.057 to 0.292). The means and *SD*s for those participants who completed both pre- and post-intervention assessments on each self-report measure are reported in Table 4.

Table 5. Means and SDs for pre- and post-intervention scores for the subjective cognition, functioning, and self-report symptom measures for WL and GMT groups

		Pre-Intervention		Post-Intervention	
Measures	**Group (*n*)[a]**	**Mean**	**SD**	**Mean**	**SD**
CFQ	WL (11)	50.82	12.55	49.09	12.79
	GMT (18)	54.50	20.54	46.50	15.74
WHODAS Score	WL (11)	31.44	11.35	32.39	14.51
	GMT (17)	42.03	19.67	33.70	13.79
PCL-5 Total Score	WL (11)	38.55	15.92	39.82	15.77
	GMT (14)	38.71	12.08	32.71	14.90
DERS Total Score	WL (11)	94.09	23.79	90.91	24.00
	GMT (17)	101.53	23.87	90.53	23.55
MDI Total Score	WL (11)	50.36	15.48	52.82	16.67
	GMT (18)	55.61	16.68	49.56	12.52
BDI-II Total Score	WL (10)	25.30	8.31	21.40	6.62
	GMT (18)	28.11	12.10	21.11	11.21
BAI Total Score	WL (9)	26.33	14.20	23.56	12.08
	GMT (18)	25.44	12.55	18.50	10.15

Note. WL = Waitlist; GMT = Goal Management Training; CFQ = Cognitive Failures Questionnaire; WHODAS = World Health Organization Disability Assessment Schedule 2.0; PCL-5 = PTSD Checklist for DSM-5; DERS = Difficulties in Emotion Regulation Scale; MDI = Multiscale Dissociation Inventory; BDI-II = Beck Depression Inventory II; BAI = Beck Anxiety Inventory. [a]Sample sizes reflect the total number of participants who did not have any missing data for the indicated measure at pre- and post-intervention.

The results of the 2 x 2 ANOVAs for the subjective cognition, functional, and self-report symptom measures are reported in Table 5. Inspection of the means for the CFQ total score indicated a potential effect of the GMT intervention (i.e., an approximate eight-point decrease versus a two-point decrease in mean CFQ total scores between GMT and the WL condition; Table 4). Indeed, simple main effect analyses demonstrated that the CFQ total score for those participants in the GMT condition decreased significantly over time ($F(1,27)=5.344$, $p=0.029$, $\eta^2_p=0.165$), while it did not for those in the WL condition ($F(1,27)=0.152$, $p=0.699$, $\eta^2_p=0.006$), suggesting a medium effect of the GMT intervention on subjective cognitive function.

Moreover, the WHODAS score showed a significant Group x Time interaction, with simple main effects indicating that scores for the GMT condition significantly decreased over time ($F(1, 26)=11.39$, $p=0.002$, $\eta^2_p=0.305$), while the WL group did not ($F(1,26)=0.095$, $p=0.760$, $\eta^2_p=0.004$). These results indicate a large positive effect of GMT on functioning.

The interaction for PCL-5 total score approached significance ($F(1,23) = 3.641$, $p=0.069$, $\eta^2_p=0.137$). Simple main effects showed that the PCL-5 total score for participants in the GMT condition decreased significantly over time ($F(1,23)=5.63$, $p=0.026$, $\eta^2_p=0.197$), while it did not for those in the WL condition ($F(1,23)=0.199$, $p=0.660$, $\eta^2_p=0.009$). This suggests a reduction in PTSD symptom severity following participation in the GMT intervention.

There also was a significant main effect of time for the DERS total score ($F(1,26)=4.473$, $p=0.044$, $\eta^2_p=0.147$; Table 5), suggesting that both groups experienced decreases in their DERS total scores from pre- to post-intervention. The results of the simple main effects revealed that participants in the GMT condition showed a significant reduction in DERS total score ($F(1,26)=6.85$, $p=0.015$, $\eta^2_p=0.209$); however, this finding was not observed for those participants in the WL condition ($F(1,26)=0.371$, $p=0.548$, $\eta^2_p=0.014$). These results indicate a medium effect of the GMT intervention on reductions in difficulties with ER.

With respect to MDI total score, the interaction between time and intervention approached significance ($F(1,27)=3.164$, $p=0.087$, $\eta^2_p=0.105$). Here, simple main effects demonstrated that following their participation in the GMT condition, participants

experienced a significant reduction in MDI total scores ($F(1,27)=4.223$, $p=0.050$, $\eta^2_p=0.135$), whereas those participants in the WL condition did not ($F(1,27)= 0.424$, $p=0.520$, $\eta^2_p=0.015$). This represented a moderate effect of GMT on dissociative symptoms.

Finally, there also were significant main effects of time for BDI-II ($F(1,26)= 9.797$, $p=0.004$, $\eta^2_p=0.274$) and BAI ($F(1,25)= 5.088$, $p=0.033$, $\eta^2_p=0.169$) total scores across both conditions. Specifically, for the BDI-II total score, simple main effects revealed that those participants in the GMT condition showed a significant reduction in total score from pre- to post-intervention ($F(1,26)=11.314$, $p=0.002$, $\eta^2_p=0.303$), which was not found for those participants in the WL condition ($F(1,26)=1.951$, $p=0.174$, $\eta^2_p=0.070$).

A similar result was observed for the BAI with a reduction in BAI total scores for those participants in the GMT condition ($F(1,25)=7.788$, $p=0.010$, $\eta^2_p=0.238$), but not for those participants in the WL condition ($F(1,25)=0.623$, $p=0.437$, $\eta^2_p=0.024$). These results indicate medium to large effects for self-reported depressive and anxiety symptoms for those participants in the GMT condition.

Table 6. 2x2 ANOVA tables for the subjective cognition, functioning, and self-report symptom measures

Measures	Source	*F*	*p*	η^2_p
CFQ Total Score	Time	2.997	.095	.100
	Condition	.009	.924	.000
	Time*Condition	1.246	.274	.044
WHODAS Score	Time	3.516	.072	.119
	Condition	1.092	.306	.040
	Time*Condition	5.552	.026	.176
PCL-5 Total Score	Time	1.538	.227	.063
	Condition	.388	.539	.017
	Time*Condition	3.641	.069	.137
DERS Total Score	Time	4.473	.044	.147
	Condition	.167	.686	.006
	Time*Condition	1.359	.254	.050
MDI Total Score	Time	.567	.458	.021
	Condition	.035	.854	.001
	Time*Condition	3.164	.087	.105
BDI-II Total Score	Time	9.797	.004	.274
	Condition	.115	.737	.004
	Time*Condition	.792	.382	.030
BAI Total Score	Time	5.088	.033	.169
	Condition	.456	.506	.018
	Time*Condition	.935	.343	.036

Note. CFQ = Cognitive Failures Questionnaire; WHODAS = World Health Organization Disability Assessment Schedule 2.0; PCL-5 = PTSD Checklist for DSM-5; DERS = Difficulties in Emotion Regulation Scale; MDI = Multiscale Dissociation Inventory; BDI-II = Beck Depression Inventory II; BAI = Beck Anxiety Inventory.

Trajectory of change for subjective cognition and self-report symptom measures

Table 6 demonstrates the level-1 HLM analyses for the trajectory of subjective cognition and symptom severity change over time for those individuals who participated in GMT (i.e., either initially randomized to GMT or those individuals from the WL who

participated after their waiting period). With respect to subjective cognition, CFQ total scores significantly decreased across time (b = -1.44, t(33) = -2.72, p = 0.010). Furthermore, PCL-5 total score (b = -2.23, t(33) = -5.97, p < 0.001), DERS total score (b = -2.36, t(33) = -3.89, p <0.001), MDI total score (b = -1.24, t(33) = -3.70, p <0.001), BDI-II total score (b = -1.39, t(33) = -4.56, p <0.001), and BAI total score (b = -1.33, t(33) = -4.25, p <0.001) also significantly decreased over time.

Table 6. Results of Hierarchical Linear Models assessing the trajectory of change in subjective cognition and self-report symptom measures over time[a]

CFQ Total Score						
Effect	***b***	***SE***	***t***	***df***	***p***	***d***
Initial CFQ Severity (Intercept)	53.90	2.58	20.88	33	<.001	
CFQ Severity Over Time (Slope)	-1.44	.53	-2.72	33	.010	-.47
PCL-5 Total Score						
Effect	***b***	***SE***	***t***	***df***	***p***	***d***
Initial PCL-5 Severity (Intercept)	43.13	2.48	17.40	33	<.001	
PCL-5 Severity Over Time (Slope)	-2.23	3.74	-5.97	33	<.001	-1.02
DERS Total Score						
Effect	***b***	***SE***	***t***	***df***	***p***	***d***
Initial DERS Severity (Intercept)	103.02	3.67	28.11	33	<.001	
DERS Severity Over Time (Slope)	-2.36	.61	-3.89	33	<.001	-.67
MDI Total Score						
Effect	***b***	***SE***	***t***	***df***	***p***	***d***
Initial MDI Severity (Intercept)	55.95	2.71	20.64	33	<.001	
MDI Severity Over Time (Slope)	-1.24	0.34	-3.70	33	<.001	-.63
BDI-II Total Score						
Effect	***b***	***SE***	***t***	***df***	***p***	***d***
Initial BDI-II Severity (Intercept)	28.07	20.2	13.90	33	<.001	

BDI-II Severity Over Time (Slope)	-1.39	.31	-4.56	33	<.001	-.78
BAI Total Score						
Effect	***b***	***SE***	***t***	***df***	***p***	***d***
Initial BAI Severity (Intercept)	25.12	2.00	12.57	33	<.001	
BAI Severity Over Time (Slope)	-1.33	.31	-4.25	33	<.001	-.73

Note. CFQ = Cognitive Failures Questionnaire; PCL-5 = PTSD Checklist for DSM-5; DERS = Difficulties in Emotion Regulation Scale; MDI = Multiscale Dissociation Inventory; BDI-II = Beck Depression Inventory II; BAI = Beck Anxiety Inventory. [a]Unit of measurement in Time is one week.

The findings for the level-2 HLMs assessing the effects of baseline variables on the trajectory of change in subjective cognition and self-reported symptoms over time are presented in Table 7. Here, DERS total score significantly influenced the trajectory of MDI total score over the duration of GMT, such that those with higher baseline DERS total scores experienced significantly greater reductions in MDI total scores over time (b = -0.02, $t(30)$ = -2.11, p = 0.044). Similarly, the baseline BAI total score significantly influenced the trajectory of CFQ total score over time (b = -0.08, $t(31)$ = -2.14, p = 0.041). Although it did not reach the alpha level of significance of p = 0.05, an additional finding suggests that MDI total score may influence the trajectory of CFQ total score over time (b = -0.06, $t(31)$ = -1.77, p = 0.087). Additional investigations of this trend within a more robust sample size may be warranted in future studies. No other level-2 HLMs investigated demonstrated significant findings.

Table 7. Results of Hierarchical Linear Models assessing the impact of baseline variables on trajectory of change in subjective cognition and self-report symptom measures over time[a]

Effect of Baseline PCL-5 on CFQ total score trajectory						
Effect	***b***	***SE***	***t***	***df***	***p***	***d***
Initial CFQ Severity (Intercept)	48.49	2.30	21.05	27	<.001	
PCL-5 Total	.57	.15	3.82	27	<.001	.71
CFQ Severity Over Time (Slope)	-.97	.59	-1.65	27	.110	-.31
PCL-5 Total	-.04	-.05	-.92	27	.365	-.17
Effect of Baseline DERS on CFQ total score trajectory						
Effect	***b***	***SE***	***t***	***df***	***p***	***d***
Initial CFQ Severity (Intercept)	51.61	2.27	22.79	30	<.001	
DERS Total	.34	.09	3.64	30	.001	.64
CFQ Severity Over Time (Slope)	-1.25	.56	-2.25	30	.032	-.40
DERS Total	-.03	.02	-1.69	30	.102	-.30
Effect of baseline DERS on PCL-5 total score trajectory						
Effect	***b***	***SE***	***t***	***df***	***p***	***d***
Initial PCL Severity (Intercept)	40.14	2.07	19.37	30	<.001	
DERS Total	.41	.08	5.08	30	<.001	.90
PCL Severity Over Time (Slope)	-2.46	.41	-5.98	30	<.001	-1.06
DERS Total	.01	.02	.39	30	.702	.07
Effect of baseline DERS on MDI total score trajectory						
Effect	***b***	***SE***	***t***	***df***	***p***	***d***
Initial MDI Severity (Intercept)	54.04	2.28	23.73	30	<.001	
DERS Total	.36	.10	3.72	30	<.001	.66
MDI Severity Over Time (Slope)	-1.14	.28	-4.12	30	<.001	-.73
DERS Total	-.02	.01	-2.11	30	.044	-.37
Effect of baseline DERS on BDI-II total score trajectory						
Effect	***b***	***SE***	***t***	***df***	***p***	***d***
Initial BDI Severity (Intercept)	25.77	1.27	20.22	30	<.001	
DERS Total	.36	.05	6.80	30	<.001	1.20
BDI Severity Over Time (Slope)	-1.47	.30	-4.89	30	<.001	-.86
DERS Total	-.00	.01	-.44	30	.664	-.08

Effect of baseline DERS on BAI total score trajectory						
Effect	***b***	***SE***	***t***	***df***	***p***	***d***
Initial BAI Severity (Intercept)	22.60	1.61	14.01	30	<.001	
DERS Total	.34	.06	5.45	30	<.001	.96
BAI Severity Over Time (Slope)	-1.25	.33	-3.76	30	<.001	-.67
DERS Total	-.02	.01	-1.63	30	.113	-.29
Effect of baseline MDI on CFQ total score trajectory						
Effect	***b***	***SE***	***t***	***df***	***p***	***d***
Initial CFQ Severity (Intercept)	51.80	1.88	27.63	31	<.001	
MDI Total	.62	.16	3.88	31	<.001	.68
CFQ Severity Over Time (Slope)	-1.25	.48	-2.63	31	.013	-.46
MDI Total	-.06	.04	-1.77	31	.087	-.31
Effect of baseline BDI-II on CFQ total score trajectory						
Effect	***b***	***SE***	***t***	***df***	***p***	***d***
Initial CFQ Severity (Intercept)	52.73	2.23	23.63	31	<.001	
BDI Total	.73	.14	5.36	31	<.001	.93
CFQ Severity Over Time (Slope)	-1.32	.52	-2.52	31	.017	-.44
BDI Total	-.02	.04	-.586	31	.562	-.10
Effect of baseline BAI on CFQ total score trajectory						
Effect	***b***	***SE***	***t***	***df***	***p***	***d***
Initial CFQ Severity (Intercept)	52.58	1.97	26.64	31	<.001	
BAI Total	.87	.14	6.34	31	<.001	1.10
CFQ Severity Over Time (Slope)	-1.31	.49	-2.66	31	.012	-.46
BAI Total	-.08	.04	-2.14	31	.041	-.37

Note. PCL-5 = PTSD Checklist for DSM-5; CFQ = Cognitive Failures Questionnaire; DERS = Difficulties in Emotion Regulation Scale; MDI = Multiscale Dissociation Inventory; BDI-II = Beck Depression Inventory II; BAI = Beck Anxiety Inventory.
[a]Unit of measurement in Time is one week.

Discussion

The primary objective of this pilot RCT was to determine the effectiveness of GMT as compared to a WL condition in improving objective and subjective cognition, functioning, symptoms of PTSD, and symptoms associated with PTSD (i.e., difficulties

with ER, dissociation, depression, and anxiety) in a sample of military personnel, veterans, and PSP. It was hypothesized that those participants randomized to the GMT condition would experience significant improvements in these outcomes relative to the WL condition. Generally, the results of this pilot RCT support these hypotheses. Specifically, relative to participants in the WL condition, participants in the GMT condition experienced significant improvements in areas of executive functioning, such as improvements in verbal fluency, planning, impulsivity, cognitive shifting, and discrimination of targets. Collectively, the effect sizes for these significant simple main effects ranged from medium to large, suggesting that the effects of the GMT intervention may be replicated within a larger-scale RCT. Moreover, the findings suggest that GMT may improve short-term declarative memory, as individuals in the GMT condition demonstrated a trending improvement in their ability to recall words from a list in comparison to those individuals in the WL condition. Future replications of this study in a larger sample size may further elucidate this finding.

Notably, the significant improvements in objective cognition following the GMT intervention support previous research. For example, following completion of GMT, patients diagnosed with obsessive compulsive disorder demonstrated significant improvements in measures of problem-solving, planning, impulsivity, attention, and processing speed in comparison to patients who were randomized to a WL condition [98]. In another study, Boyd et al. (2019) demonstrated improvements on measures of executive functioning, planning, attention, and short-term declarative memory following a modified GMT protocol for individuals receiving concurrent inpatient trauma treatment

[99]. Similarly, the current study found similar significant effects following the GMT intervention relative to the WL condition in tasks of executive functioning (e.g., verbal fluency, impulsivity, cognitive shifting, and discrimination of targets) and planning, as well as a trending improvement in short-term declarative memory. Critically, the findings of the current pilot RCT also demonstrate focused improvements in cognitive difficulties typically associated with PTSD, including executive functioning [26,29,30,31,32] and verbal learning, suggesting that GMT may be an effective intervention to help address these concerns among military personnel, veterans, and PSP with PTSD symptoms and symptoms associated with PTSD.

Although participants in the GMT condition did not experience significant improvements in their Stroop color, color–word, and interference scores relative to the WL condition, these specific findings also help to demonstrate support that the GMT intervention may improve executive functioning. GMT is designed to assist individuals with noticing attentional lapses and approaching tasks in a mindful manner, with the goal of reinstating executive cognitive control when there is a discrepancy between the individual's goal and behaviour [59,89,128]. Given that the Stroop Color and Word Test instructs participants to complete the tasks as quickly as possible within a time limit [110,111], the lack of improvements in these scores for those participants in the GMT condition suggests individuals may have been more mindful while completing the task. Specifically, individuals in the GMT condition may have been checking that their goal of completing the task accurately matched with their behaviour, thereby slowing their response time, which subsequently did not lead to score improvements. Relative to the

individuals in the GMT condition, the individuals in the WL condition did not receive such training and may have increased their speed on this task given their familiarity with it during the post-intervention testing.

This purposeful slowing of response time while completing tasks may also explain the significant increase in scores (i.e., worsening) for CPT 3.0 perseverations for those individuals in the GMT condition. Perseverations may be attributed to slowed responses to preceding stimuli, as well as random responses (e.g., errors), anticipatory responses (e.g., guesses), or repeated responses, suggesting impulsivity [114]. As impulsivity improved following GMT (measured by the outcomes on the DKEFS Tower Test), the results of the CPT 3.0 perseverations score suggests that participants in the GMT condition may have slowed their responding. Subsequently, this may have caused individuals to miss the original target and respond too quickly to the next target in the task. Alternatively, there may be several other possibilities that may explain these findings, including anticipatory responses, repeated responses, and that these cognitive functions may not demonstrate significant change over the duration of the study trial. Subsequently, future research should continue to explore these findings for additional clarification.

Improvements in the other neuropsychological measures may be attributable to practice effects. For example, although individuals in the GMT condition improved significantly on TMT part B, the findings for those in the WL condition also demonstrated a trend towards score improvement. A similar trend was also observed on the WAIS-IV Digit Symbol Coding Subtest, CPT 3.0 commissions, and CVLT Trial 5 Z

scores. Practice effects may also account for the improvements found on the DKEFS Tower Test rule violations measure for those in the WL condition, which was not found among those participants in the GMT condition. While there were no significant differences between the groups at baseline for this measure, the maximum score for rule violations in the WL condition was higher at baseline than the maximum score in the GMT condition (i.e., four errors versus two errors, respectfully). At the subsequent follow-up testing appointment, those individuals in the WL condition improved as they had a maximum score of two for rule violations, whereas those participants in the GMT condition continued to have a maximum score of two for rule violations. Consequently, this improvement in the WL condition's rule violations may be attributable to practice effects, as there was no intervention administered to this group and their improvement in this measure may be attributable to their previous experience and familiarity with the DKEFS Tower Test.

With respect to subjective cognition and self-reported functioning, participants in the GMT condition also experienced significant improvements from pre- to post-testing in both domains, whereas participants in the WL condition did not. Generally, PTSD is associated with poorer social and occupational functioning [129,130], as well as reduced quality of life [131]. More specifically, previous research has linked poorer subjective cognitive functioning to higher levels of psychological distress [36,38,39], poorer functioning [38], and poorer quality of life [36,39,132] among individuals with PTSD. Previous research also has found that objective measures of cognition are negatively associated with physical [40], social, and occupational functioning [40,41] among

military personnel and veterans with PTSD. Considering this previous research, the current study's findings demonstrate that not only may GMT prove to be beneficial in assisting individuals' objective and subjective cognitive functioning, but also that these improvements in cognition may translate to improvements in functioning for military personnel, veterans, and PSP. Future work should aim to examine the specific domains of functioning (e.g., social, occupational, daily, etc.) affected following participation in GMT, as well as whether quality of life also shows a similar improvement following the GMT intervention. Additional studies should also aim to examine whether GMT may be a useful intervention in assisting military personnel, veterans, and PSP during return-to-work following a medical leave of absence due to PTSD. Notably, this represents a significantly understudied area of clinical research as the factors that contribute to a successful return to work for military personnel, veterans, and PSP have remained largely unknown.

Improvements in psychological symptoms following participation in the GMT intervention relative to the WL condition were also found. Specifically, simple main effects demonstrated that participants experienced improvements in PTSD symptom severity, difficulties with ER, dissociative symptom severity, depressive symptoms, and anxiety symptoms in the GMT condition, but not in the WL condition. These findings also demonstrated a medium to large effect size, suggesting again that these findings may be replicated within a larger-scale clinical trial. These results may also suggest that along with improvements in objective and subjective cognitive difficulties, improvements in PTSD symptoms and symptoms associated with PTSD may be indirectly targeted through

a cognitive remediation intervention. This implies that GMT may be a useful adjunctive treatment for individuals experiencing PTSD and its related psychological symptoms. Importantly, these results support the use of a top-down cognitive remediation approach to address objective and subjective cognitive difficulties, as well as PTSD and PTSD-related psychological symptoms. Top-down cognitive remediation targets higher-order neurocognitive abilities, such as executive functioning, which can assist in the improvement of other cognitive functions and in the generalization of these improvements to various contexts [59,89,133,134]. By employing such an approach, the aim is to not only improve specific cognitive functions but to also ameliorate any downstream dysfunction associated with the neural regions and neural circuitry responsible for these cognitive functions. Specifically, indirect improvements in tasks of daily functioning and other psychological symptoms following the implementation of a top-down cognitive remediation intervention were expected given that previous studies have demonstrated similar findings [97,135]. Moreover, our results support previous meta-analytic findings, which suggest GMT is associated with small to medium improvements in objective and subjective measures of executive functioning, as well as improvements in tasks of daily living and other mental health symptoms [97].

A secondary objective of the study was to examine the trajectory of self-reported symptom change over the course of the GMT intervention for those individuals who were initially randomized to the GMT condition, as well as those individuals in the WL condition who elected to participate in GMT following their waiting period. Here, it was hypothesized that the trajectory of symptoms would significantly decrease over time.

Following level 1 HLM analyses, the results indicated that there were significant declines in self-reported cognitive difficulties, as well as PTSD symptom severity, difficulties with ER, dissociative symptom severity, depression symptom severity, and anxiety symptom severity. Notably, these findings further support the assertion that GMT may be a useful adjunctive treatment for PTSD, as well as for other psychological symptoms, given the significant decline in the severity of these symptoms across time. Future studies are needed to elucidate whether such symptom declines are comparable to those gained with current evidence-based treatments, such as cognitive processing therapy and prolonged exposure therapy.

Additional exploratory analyses were conducted to examine the effects of baseline self-reported symptoms (e.g., subjective cognitive difficulties, PTSD symptoms, and other psychological symptoms) on the trajectory of specific symptoms over time. Here, the results demonstrated that difficulties with ER significantly influenced the trajectory of dissociative symptoms across the GMT intervention, such that those participants with greater baseline difficulties with ER experienced significantly greater reductions in dissociative symptoms over time. Dissociative symptoms have been proposed as an ER strategy during and following traumatic events [15], as they allow individuals to detach from intense and distressing emotions. Subsequently, these findings lend support to this established relationship, as improvements in ER significantly influenced the trajectory of dissociative symptoms over time. Moreover, this also supports the notion that individuals with more severe difficulties with ER may still experience benefits from participating in

GMT and that these symptoms do not appear to interfere with other symptom improvements.

The analyses also explored whether baseline dissociative symptoms influenced the trajectory of self-reported cognitive difficulties over the course of the GMT intervention. Although these results did not reach the significance threshold (i.e., $p = 0.05$), they trended towards significance. Notably, previous research suggests a strong relation between dissociative symptoms and cognitive functioning [33,34,35,136], such that increased dissociative symptom severity is associated with heightened difficulties with verbal memory [34], visual memory [34,35], attention [35], executive functioning, and autobiographical memory. Further studies involving larger sample sizes are required to confirm the specificity of these effects.

Additional analyses examined whether baseline anxiety symptom severity influenced the trajectory of subjective cognitive difficulties over the course of the GMT intervention. Notably, these results were significant, such that those participants who began the GMT intervention with higher anxiety scores showed greater reductions in subjective cognitive difficulties over the duration of GMT. Numerous studies document the relation between anxiety and cognitive difficulties, where anxiety symptoms, such as worry, can impair executive functions such as problem-solving [137] and inhibition [138,139], as well as impair attention [140] and working memory [138]. Clinician-rated severity of difficulties with concentration associated with anxiety symptoms appears further to mediate the relation between subjective reports of worry and clinician-rated severity of anxiety symptoms [141]. Here, it is thought that anxiety increases cognitive

demand, thereby interfering with other cognitive functions, including executive functioning and attention [142,143,144]. In line with previous work, the current findings suggest that improvements in reported anxiety symptoms reduce subjective cognitive difficulties over time.

Exploratory analyses also examined the effects of baseline symptoms on the trajectory of change in subjective cognition, as well as the severity of other psychological symptoms. Specifically, we examined whether difficulties with ER influenced the trajectory of self-reported cognitive difficulties, as well as PTSD, depression, and anxiety symptom severity. We also explored whether PTSD symptom severity and depression symptom severity influenced the trajectory of self-reported cognitive difficulties. No such relations emerged. These findings were somewhat unexpected given the reported associations between difficulties with ER and cognitive dysfunction [15,50,51,60,61,62], difficulties with ER and psychological symptoms [10,16,17,145], PTSD symptom severity and self-reported cognitive difficulties [28,32], and depression and self-reported cognitive difficulties [146]. Additional research with a larger sample is clearly warranted. This work is ongoing in our laboratory.

The results of the study must be interpreted with caution. As this is a pilot study, it involved a relatively small sample size. The large number of analyses conducted may have increased the probability of type I error leading to erroneous conclusions. To mitigate this potential error, the analyses chosen were based on previous findings within the literature and specific hypothesis were explored. Analyses also were limited to pre- and post-intervention to ensure the retention of the largest possible sample size. An

additional limitation of the study is that the ANOVA analyses were followed up with simple main effects, not only when there were significant interactions, but also if there were significant main effects or inspection of the effect sizes and means and SDs between the GMT and WL conditions suggested further exploration. Accordingly, despite very promising signals, the results of the study should be interpreted with caution. Analyses also were conducted on data in which there were several violations of homogeneity of variance and normality. Transformation of these data did not improve the normality or homogeneity of variance, and parametric analyses were conducted on the non-transformed variables.

With respect to the study design, the repeated use of certain neuropsychological assessment measures (e.g., DKEFS Tower Test, WAIS-IV Digit Symbol Coding Subtest, TMT, etc.) may have positively influenced the test outcome due to practice. Where appropriate, outcomes which may be attributable to practice effects were indicated. Critically, these practice effects would be expected to be equivalent across the active treatment and wait-list groups. An additional limitation of the study design is that individuals could have been administered the same self-report measures as those in the GMT condition during the WL condition's nine-week waiting period. Doing so would have allowed for comparisons between the WL and the GMT conditions using HLM analyses. Future work should consider implementing this methodology.

A strength of this study, however, was its status as an effectiveness pilot RCT designed to be inclusive of participants with a spectrum of PTSD and co-morbid psychological symptoms to mimic the diversity of symptom presentation found within

clinical settings. This factor coupled with the strong study findings suggest that improvements associated with GMT may generalize to military personnel, veterans, and PSP seen under real-world conditions with varying symptom severity of PTSD and other psychological comorbidities and symptoms. Future work should aim to replicate these findings within a larger sample size to determine whether these preliminary findings regarding the effectiveness of GMT continue to hold. A larger sample size would allow analyses to determine the durability of these findings. Future research may also compare GMT to an active WL condition (e.g., psychoeducation group discussing brain and cognitive changes associated with PTSD; this work is underway in our laboratory). This design would assist in determining whether GMT or the process of being in a treatment group with clinicians and other group members with similar symptoms contributes to the improvements found following participation in the GMT intervention. Finally, given that GMT targets objective cognitive difficulties and that PTSD is associated with alterations in cognitive functioning that may stem from altered neural functioning and circuitry, it would be helpful to conduct a RCT that includes neuroimaging pre- and post-treatment and in comparison, to a matched control condition. This design would allow us to assess any functional or structural brain changes associated with participation in GMT.

Conclusions

On balance, this pilot RCT is the first to examine whether GMT is an effective cognitive remediation intervention among military personnel, veterans, and PSP with symptoms of PTSD and co-symptoms commonly associated with this condition. The findings of the study suggest that not only do objective and subjective measures of

cognition improve following GMT, but also that functioning and symptoms of PTSD, difficulties with ER, dissociation, depression, and anxiety also show improvement. Given that cognitive difficulties persist for approximately 25% of patients following treatment of PTSD [46], as well as the devastating functional impacts associated with PTSD and cognitive dysfunction [40,41], these findings are promising, suggesting the potential utility of GMT as an adjunctive treatment for this condition

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Chapter 5: Conclusions

Military personnel, veterans, and PSP experience a significantly elevated risk for the development of PTSD and other psychiatric disorders relative to the general Canadian population (Boulos & Zamorski, 2013; Thompson et al., 2016; Carleton et al., 2018; Afifi et al., 2014; Afifi et al., 2016; Turner et al., 2018; Groll et al., 2020; Sareen et al., 2021). Research has examined several risk factors contributing to military personnel, veterans, and PSP's susceptibility to PTSD, including ACEs (Afifi et al., 2014; Afifi et al., 2016; Turner et al., 2018) and difficulties with ER (Boden et al., 2013; Seligowski et al., 2015; Klemanski et al., 2012; Miles et al., 2015). An emerging area of research inquiry among military personnel, veterans, and PSP is MI and its relations to psychiatric symptoms, including PTSD (Williamson et al., 2018); however, relatively little work has been undertaken to examine risk factors that may, in part, explain the relations between MI and psychiatric symptoms. Given the plethora of evidence demonstrating relations between ACEs, difficulties with ER, PTSD, and other psychiatric disorders, among military personnel, veterans, and PSP, one of this thesis's central aims was to examine whether ACEs and difficulties with ER were associated with MI among military personnel and veterans. Here, it was hypothesized that ACEs (Battaglia*, Protopopescu*, et al., 2019 (chapter two)) and difficulties with ER (Protopopescu et al., 2021 (chapter three)) would be associated with MI among a sample of CAF military personnel and veterans.

An additional aim of this thesis was to determine whether GMT would be an effective intervention to assist with the amelioration of objective and subjective cognitive difficulties and functioning among military personnel, veterans, and PSP with symptoms

of PTSD. Specifically, evidence demonstrates the interplay among cognitive functioning, difficulties with ER, PTSD symptoms, and symptoms associated with PTSD (e.g., dissociation, depression) (Lanius et al., 2010; Lanius et al., 2012; Lanius et al., 2015; Nicholson et al., 2017; Breukelaar et al., 2021; Akiki et al., 2017; Patel et al., 2012; Weber et al., 2005; Levine et al., 2011; Jak et al., 2016; Aupperle, Allard et al., 2012; Aupperle, Melrose et al., 2012; Polak et al., 2012; Woon et al., 2016; Boyd et al., 2019). Therefore, in chapter four (Protopopescu et al., 2022), it was hypothesized that participants in GMT would subsequently experience improvements, not only among areas of cognitive functioning and functioning, but also in difficulties with ER, PTSD symptom severity, and clinical symptomatology associated with PTSD.

5.1 Summary of Findings

Study one (Battaglia*, Protopopescu*, et al., 2019 (chapter two)) of this dissertation is one of the first studies to investigate the relations between ACEs and MI among an inpatient sample of CAF military personnel and veterans. Here, it was found that the sample of CAF military personnel and veterans in the study endorsed experiencing childhood emotional abuse most frequently relative to other types of ACEs. This is consistent with previous research demonstrating similar rates of childhood emotional abuse (Blosnich et al., 2014). Critically, it was found that childhood emotional abuse was significantly correlated with MI, as well as with the betrayals and transgressions subscales of the MIES. These results were maintained even after controlling for age and sex. Previous research has demonstrated that childhood emotional abuse may contribute to altered schemas and core beliefs about the self, others, and the

world, such as schemas about defectiveness/shame, vulnerability to harm/illness, and self-sacrifice (Wright et al., 2009; Young et al., 2003). Importantly, these altered schemas may contribute to internalized guilt, shame, anger, worthlessness, and emotional inhibition (Young et al., 2003; Harper & Arias, 2004; Krause et al., 2003; Webb et al., 2007; Wright et al., 2009). Moreover, ACEs, such as childhood emotional abuse, may also be associated with alterations in the ability to regulate emotions (Alink et al., 2009; Cloitre et al., 2005; van der Kolk et al., 2005; Pollak & Sinha, 2002; Shipman et al., 2000). Consequently, it is proposed that these schemas may be reactivated within the operational theatre, leading to difficulties with managing emotional distress, and contributing to an increased risk of experiencing adult-onset MI. Consistent with this prediction, this study demonstrated that childhood emotional abuse may be a risk factor for the development of MI among CAF military personnel and veterans.

A mechanism by which ACEs may be linked to psychopathology includes difficulties with ER (Burns et al., 2010). Specifically, research has demonstrated significant relations between difficulties with ER, PTSD, and other psychiatric disorders (Klemanski et al., 2012; Miles et al., 2015; Godfrey et al., 2022; Lukas et al., 2017; Sloan et al., 2017). Given the burgeoning interest in examining the relations between MI and psychiatric disorders, in study two (Protopopescu et al., 2021, (chapter three)), we examined whether difficulties with ER were associated with MI along with symptoms of PTSD and symptoms associated with PTSD among CAF military personnel and veterans. In this study, we found that MI was associated with the avoidance and alterations in cognition and mood PTSD symptom clusters, which has also been found in previous

research (Nazarov et al., 2018; Williamson et al., 2018). Consistent with previous studies, difficulties with ER also were significantly associated with symptoms of PTSD, depression, anxiety, and stress (Ehring & Quack, 2010; Lanius et al., 2010; Joormann & Stanton, 2016; Amstadeter, 2008; Sloan et al., 2017; Lukas et al., 2017). Contrary to our hypothesis, however, the association between difficulties with ER and MI approached the significance threshold but was not significant. This may be due, in part, to the relatively small sample size, which may have made the study underpowered.

Finally, in chapter four (Protopopescu et al., 2022), we conducted a pilot, RCT to determine the effectiveness of GMT compared to a WL condition in reducing difficulties with cognitive functioning (objective and subjective cognitive functioning) and daily life functioning among a sample of military personnel, veterans, and PSP. Symptoms of PTSD and symptoms associated with PTSD, including difficulties with ER, were also assessed as outcomes within this study, given the documented interplay among cognition, ER, and symptoms of PTSD (Storbeck & Clore, 2007; Lanius et al., 2010; Lanius et al., 2012; Lanius et al., 2015; Liberzon & Sripada, 2007; Nicholson et al., 2017; Patel et al., 2012). It was found that individuals who participated in GMT compared to the WL condition demonstrated significant improvements in measures of objective and subjective functioning. Specifically, there were noted improvements in executive functioning, such as verbal fluency, planning, impulsivity, cognitive shifting, and discrimination of targets. Here, these simple main effects were medium to large and significant. There also was a trending improvement in short-term declarative memory as measured by the CVLT. Notably, these trending findings in short-term declarative memory may in part be

explained by improvements in executive functioning, as the CVLT also requires individuals to recall items in categorical clusters. Critically, these findings are supported by previous research. For example, in a study by Boyd et al. (2019), the researchers also found significant improvements in tests of executive functioning, planning, attention, and short-term memory following a modified GMT protocol with an inpatient sample experiencing PTSD, trauma-related symptoms, and other psychiatric comorbidities. Our findings from this study also demonstrate improvements in cognitive functioning in areas in which individuals with PTSD typically experience cognitive difficulties (Jak et al., 2016; Samuelson, 2011; Scott et al., 2015; Aupperle, Allard, et al., 2012; Aupperle, Melrose, et al., 2012; Polak et al., 2012; Woon et al., 2016), suggesting that GMT may be an effective intervention to address difficulties with cognitive functioning among military personnel, veterans, and PSP.

Concerning subjective cognitive functioning and daily functioning, individuals in the GMT condition experienced significant improvements from pre- to post-testing, while those in the WL condition did not. Importantly, these findings highlight that an intervention targeted toward improving cognition may translate to functional improvements. There also were improvements in PTSD symptom severity, difficulties with ER, and symptoms associated with PTSD, including dissociation, depression, and anxiety symptoms for individuals in the GMT condition, but not in the WL condition. These findings demonstrated medium to large effects.

Additionally, the trajectory of self-reported symptoms was assessed for all individuals who participated in GMT. Here, it was found that there were significant

declines in self-reported symptoms of cognitive dysfunction, difficulties with ER, PTSD symptoms, dissociative symptoms, depressive symptoms, and anxiety symptoms across the GMT intervention. Based upon the literature demonstrating the interplay among several of the study's variables, exploratory HLM analyses also investigated whether self-reported symptoms at the beginning of the GMT intervention influenced the trajectory of specific symptoms throughout GMT. Here, it was found that baseline difficulties with ER influenced the trajectory of dissociative symptoms across GMT. These results suggest that individuals with greater difficulties with ER at baseline experienced greater reductions in dissociative symptoms through their participation in GMT, which is in keeping with the assertion that dissociative symptoms are an ER strategy (Lanius et al., 2010).

Moreover, it was found that baseline anxiety symptoms influenced the trajectory of self-reported cognitive dysfunction over time, such that individuals with greater baseline anxiety symptom severity experienced greater reductions in self-reported cognitive dysfunction. Evidence also supports the relations between anxiety and difficulties with cognitive functioning, where research has found associations between anxiety and impairments in executive functioning (Hallion et al., 2014; Hallion et al., 2017), attention (Stefanopoulou et al., 2014) and problem-solving (Llera & Newman, 2020).

Although it did not reach the threshold for significance, the exploratory HLM analyses also demonstrated a trend in which baseline dissociative symptoms influenced the trajectory of subjective cognitive dysfunction over the course of GMT. Previous

research suggests dissociative symptoms can also influence cognitive functioning (McKinnon et al., 2016); however, additional evidence is needed to support our preliminary findings and is an avenue for future research.

Finally, exploratory HLM analyses were conducted to determine whether baseline difficulties with ER affected the trajectory of subjective cognitive difficulties, PTSD symptom severity, depression symptom severity, and anxiety symptom severity over GMT. The analyses also examined whether baseline PTSD symptom severity and depression symptom severity influenced the trajectory of subjective cognitive difficulties. Notably, none of these relations were significant. Given the literature demonstrating relations among these variables (e.g., Lanius et al., 2010; Seligowski et al., 2015; Joormann & Vanderlind, 2014), these findings were unexpected. Additional work with a larger sample size is needed to further elucidate these findings.

5.2 Limitations

The results of these studies should be interpreted in the context of their limitations. Specifically, all three studies (Battaglia*, Protopopescu*, et al., 2019 (chapter two); Protopopescu et al., 2021 (chapter three); Protopopescu et al., 2022(chapter four)) had small sample sizes. Notably, this may reduce the generalizability of our findings. Moreover, the small sample sizes may have contributed to the non-normal distribution of the variables (Battaglia*, Protopopescu*, et al., 2019 (chapter two); Protopopescu et al., 2021 (chapter three); Protopopescu et al., 2022 (chapter four)) and violations of homogeneity of variance (Protopopescu et al., 2022 (chapter four)). Subsequently, in studies one (Battaglia*, Protopopescu*, et al., 2019 (chapter two)) and two (Protopopescu

et al., 2021(chapter three)), non-parametric analyses were conducted, which may have reduced the studies' power (Siegel & Castellan, 1988) and contributed to the non-significant findings. Given the pilot nature of study three (Protopopescu et al., 2022 (chapter four)), parametric tests were utilized for clarity of interpretation; however, given the noted deviations from normality and homogeneity of variance, caution is warranted regarding the study's findings. Additionally, the studies' small sample sizes combined with multiple analyses (e.g., the use of simple main effect analyses in Protopopescu et al., 2022 (chapter four)) may have inflated the probability of Type I errors leading to erroneous conclusions.

Studies one and two also utilized data collected from retrospective chart reviews (Battaglia*, Protopopescu*, et al., 2019 (chapter two); Protopopescu et al., 2021 (chapter three)). The retrospective nature of these studies did not allow for the administration of standardized clinician-administered interviews to assess for a diagnosis of PTSD or other mental health disorders. Therefore, self-reports were used to establish a probable diagnosis of PTSD, depression, and anxiety, which may be inaccurate or associated with inflated symptom severity. Additionally, studies one and two were cross-sectional. Here, the direction of causality cannot be established, as the data were collected simultaneously. For example, whether MI preceded symptoms of PTSD or if symptoms of PTSD preceded MI cannot be established. Similarly, in study two, it cannot be determined whether difficulties with ER preceded symptoms of PTSD, depression, anxiety, or stress or whether these symptoms preceded difficulties with ER (Protopopescu et al., 2021 (chapter three)).

Although studies one and two controlled for age and sex, difficulties with ER and ACEs were not controlled in study one (Battaglia*, Protopopescu*, et al., 2019 (chapter two)) or two (Protopopescu et al., 2021 (chapter three)), respectively. These studies were conducted in parallel, and these statistical controls were not initially accounted for. Additionally, in study three (Protopopescu et al., 2022 (chapter four)), we did not control for any variables due to the pilot nature of the study. Future studies with larger sample sizes, which account for these statistical controls, would address these concerns.

A final limitation of studies one (Battaglia*, Protopopescu*, et al., 2019 (chapter two)) and two (Protopopescu et al., 2021 (chapter three)) was the use of the MIES (Nash et al., 2013). Specifically, the MIES has been criticized for confounding exposure to morally injurious events and the effects of encountering morally injurious events (Frankfurt & Frazier, 2016). Future work should aim to distinguish between these variables and aim to replicate these findings using alternative assessments of MI (Koenig et al., 2019).

5.3 Implications and Future Directions

The findings from chapters two (Battaglia*, Protopopescu*, et al., 2019) and three (Protopopescu et al., 2021) are an initial step in determining risk factors for MI among military personnel and veterans and have provided the groundwork for examining MI and its risk factors in other populations, such as PSP (Roth et al. 2022a; Roth et al., 2022b) and front-line healthcare workers (D'Alessandro et al., 2022). For example, following this thesis' initial studies, work from our research group has explored additional risk factors that may contribute to MI in military personnel and veterans (Easterbrook et al., 2022).

Specifically, utilizing data obtained from the 2018 Canadian Armed Forces Members and Veterans Mental Health Follow-up Survey, Easterbrook et al. (2022) found that among a representative sample of CAF deployed military personnel, low military rank (i.e., junior non-commissioned member), military-related sexual trauma, ACEs (i.e., physical abuse, emotional abuse, and neglect), and stressful deployment experiences (e.g., knowing someone who had been seriously injured or killed in combat) were predictors of increased MI severity. Among non-deployed CAF personnel, low military rank, sexual trauma, years of military experience, and childhood neglect predicted increased MI scores. Notably, among this representative sample of CAF military personnel and veterans, ACEs continue to confer risk for MI which supports our proposed relations and preliminary findings (Battaglia*, Protopopescu*, et al., 2019 (chapter two)).

In another study from our research group, a MI scale for PSP was developed (Roth et al., 2022b). Using this scale, work in our lab examined the relations among ACEs, difficulties with ER, MI, symptoms of PTSD, and symptoms associated with PTSD among a PSP sample (Roth et al., 2022a). Here, it was found that ACEs were significantly associated with psychiatric symptoms, including symptoms of PTSD, dissociation, depression, anxiety, and stress. Critically, it was found that MI mediated the relations between ACEs and psychiatric symptoms. This relation was moderated by difficulties with ER, suggesting that ACEs, MI, and difficulties with ER play an important role in the development and maintenance of psychiatric symptoms among PSP. Again, these findings support our proposed hypothesis that difficulties with ER may be a risk factor for MI (Protopopescu et al., 2021 (chapter three)).

Additionally, work among our research group has begun expanding MI research to front-line healthcare workers who have worked during the COVID-19 pandemic (D'Alessandro et al., 2022). In the study by D'Alessandro et al. (2022), the researchers conducted a narrative review of the literature to examine how factors such as social cognitive and interpersonal factors (e.g., perceived social support, social acknowledgment, and social exclusion) may contribute to the onset of MI and how these may be important areas for treatment intervention.

Taken together, future work in this area may consider utilizing longitudinal, prospective studies to examine ACEs, difficulties with ER, and MI among military personnel, veterans, PSP, and front-line healthcare workers, to begin establishing temporality. For example, future work may examine the severity of MI before deployment or before beginning employment as a PSP/front-line healthcare worker to ascertain how risk factors, such as ACEs and difficulties with ER, may contribute to the onset of MI. Future research may also consider examining how other proposed symptoms of MI, such as guilt, shame, and avoidance/withdrawal, are associated with the onset and development of MI. This work is important as it can assist with further delineating MI from PTSD, which remains an area of debate and ongoing research (Farnsworth, 2019; Frankfurt & Coady, 2019). Additionally, future research may examine whether evidenced-based treatments for PTSD assist with the treatment of MI and its associated symptoms, such as difficulties with ER, among military personnel, veterans, PSP, and front-line healthcare workers.

Study three (Protopopescu et al., 2022 (chapter four)) provided preliminary evidence to establish that in comparison to a WL condition, GMT may be an effective intervention to assist with the reduction of objective and subjective cognitive difficulties, as well as improve daily functioning, symptoms of PTSD, difficulties with ER, dissociation, depression, and anxiety among military personnel, veterans, and PSP. Critically, difficulties with cognition and ER are usually not the primary targets of treatment in evidence-based treatments for PTSD (Resick et al., 2016; Resick et al., 2021; Foa & Rothbaum, 1998; Samuelson et al, 2021). Subsequently, this work suggests that it is feasible to improve PTSD symptom severity by targeting other symptoms of PTSD, such as difficulties with cognition and ER, using a neuroscientifically-informed approach. Future work should aim to examine the effectiveness of GMT among a larger sample of military personnel, veterans, and PSP, as well as extend the study of its effectiveness among other populations, such as civilians. Given the study design, additional research may consider investigating the durability of these findings at three months to one-year post-GMT. Future work should also examine the effectiveness of GMT as compared to an active WL control, such as a psychoeducation group discussing the effects of PTSD on cognition. Finally, follow-up research should consider examining the effectiveness of GMT via different treatment modalities, such as internet-based GMT, and whether GMT assists with improving return-to-work outcomes among individuals who have experienced a workplace injury. Research is currently underway among our research group to examine these questions.

5.4 General Conclusions

This dissertation has provided initial foundational work in examining risk factors for MI among CAF military personnel and veterans. By drawing upon the extensive literature examining risk factors for PTSD, and the early investigations examining the relations between PTSD and MI, it was proposed that ACEs and difficulties with ER may also be risk factors for MI. Here, we found among a sample of CAF military personnel and veterans that childhood emotional abuse was associated with adult MI (Battaglia*, Protopopescu*, et al., 2019 (chapter two)). We also found trending associations between difficulties with ER and MI in a subsequent study (Protopopescu et al., 2021 (chapter three)). As discussed, these studies formed the basis for additional work among our research group (e.g., Roth et al., 2022a; Roth et al., 2022b; Easterbrook et al., 2022; D'Alessandro et al., 2022) and thereby contributed to the field's overall advancement.

Moreover, we also explored the remediation of cognitive difficulties among military personnel, veterans, and PSP with symptoms of PTSD (Protopopescu et al, 2022 (chapter four)). Specifically, we found that when comparing GMT, a top-down cognitive remediation approach, to a WL condition, participants in the GMT condition experienced improvements in objective and subjective measures of cognitive functioning, daily functioning, symptoms of PTSD, difficulties with ER, dissociative symptoms, depressive symptoms, and anxiety symptoms. Additionally, self-reported symptoms of difficulties with cognition, PTSD symptom severity, difficulties with ER, dissociative symptoms, depressive symptoms, and anxiety symptoms, improved over the course of GMT. Further analyses identified that baseline symptoms could significantly influence the trajectory of

other self-report symptoms over time. For example, difficulties with ER significantly influenced the trajectory of dissociative symptoms over the course of GMT. Together these findings demonstrate that integrating and applying a neuroscientifically-informed intervention to military personnel, veterans, and PSP experiencing PTSD symptoms, not only improved challenges with cognitive functioning but also translated to other symptomatic and functional improvements among this sample of participants.

Overall, we believe that these studies have provided a significant contribution to the literature and have furthered our understanding of PTSD and its associated clinical symptomatology among military personnel, veterans, and PSP.

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