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BASIC RESEARCH ARTICLE

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# Associations between moral injury, PTSD clusters, and depression among Israeli veterans: a network approach

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## ABSTRACT

**Background**: Moral Injury (MI) is one of the adverse consequences of combat. Following exposure to potentially morally injurious events (PMIEs)––events perceived as violations of deep moral beliefs by oneself or trusted individuals––a significant minority of veterans could develop posttraumatic stress disorder (PTSD) and depression.

**Objective**: The current study represents the first attempt to apply a network analysis model to examine an exploratory empirical conceptualization of a network of PMIEs during military service, post-traumatic stress disorder (PTSD) symptom clusters, depression, and combat exposure among Israel Defence Forces veterans.

**Method**: A volunteer sample of 191 Israeli combat veterans were recruited during 2017, and completed validated self-report questionnaires tapping PMIEs, PTSD, and depression in a cross-sectional design study. A regularized Gaussian graphical model was estimated.

**Results**: Network analysis revealed strong bridge associations between the PTSD nodes and most of the PMIEs nodes. The nodes of PMIE-betrayal and PTSD negative alterations in cognitions and mood (NACM) symptom cluster were found to have a bridging function between other PMIEs and PTSD. Depression was found to be connected to most of the PMIEs and PTSD nodes.

**Conclusions**: The study's findings offer an overview of the complex relationships between PMIEs and PTSD clusters among Israeli veterans. PMIEs––notably, betrayal-based experiences––are related to PTSD clusters directly and through depressive symptoms. Some possible mechanisms for the links between PMIEs and PTSD and the clinical implications related to specific interventions are discussed.

## Asociaciones entre daño moral, grupos de síntomas del trastorno de estrés postraumático y depresión entre veteranos israelíes: un enfoque de red

**Antecedentes**: el daño moral (DM) es una de las consecuencias adversas del combate. Después de la exposición a eventos potencialmente de daño moral (EPMs) –– eventos percibidos como violaciones de creencias morales profundas por uno mismo o por personas de confianza –– una minoría significativa de veteranos podría desarrollar trastorno de estrés postraumático (TEPT) y depresión.

**Objetivo**: El estudio actual representa el primer intento de aplicar un modelo de análisis de red para examinar una conceptualización empírica exploratoria de una red de EPMs durante el servicio militar, grupos de síntomas de trastorno de estrés postraumático (TEPT), depresión y exposición a combate entre veteranos de las Fuerzas de Defensa de Israel.

**Método**: una muestra voluntaria de 191 veteranos de combate israelíes fue reclutada durante 2017, y completaron cuestionarios de autoinforme validados respecto a EPM, TEPT y depresión en un estudio de diseño transversal. Se estimó un modelo gráfico gaussiano regularizado.

**Resultados**: El análisis de la red reveló fuertes asociaciones puente entre los nodos de TEPT y la mayoría de los nodos de EPM. Se descubrió que los nodos de la traición-EPM y las alteraciones negativas del TEPT en el grupo de síntomas cognitivos y del estado de ánimo (ANCA) tenían una función puente entre otros EPM y TEPT. Se encontró que la depresión estaba conectada a la mayoría de los nodos EPMs y PTSD.

**Conclusiones**: Los hallazgos del estudio ofrecen una visión general de las complejas relaciones entre los grupos PMIE y PTSD entre los veteranos israelíes. Los EPMs, especialmente las experiencias basadas en la traición, están relacionadas directamente con los grupos de TEPT y a través de los síntomas depresivos. Se discuten algunos posibles mecanismos para los vínculos entre EPMs y PTSD y las implicaciones clínicas relacionadas con intervenciones específicas.

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**PALABRAS CLAVE**
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**关键词**
道德伤害; 背叛; PTSD; 抑郁; 网络模型; 战争; 退伍军人

**HIGHLIGHTS**

- The study offers an overview of the relationships between potentially morally injurious events and PTSD.
- Betrayal-based experiences are related to PTSD directly and through depressive symptoms.
- Heavy combat is related to moral injuries and to PTSD symptoms.

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Supplementary data for this article can be accessed here.

## 以色列退伍军人中道德伤害, 创伤后应激障碍症状簇和抑郁之间的关联:网络方法

**背景**: 道德伤害 (MI) 是战争的不利后果之一。暴露于潜在道德伤害事件 (PMIE) 后——即认为自己或信任的他人违背了深层道德信念的事件，极少数的退伍军人可能会发展出创伤后应激障碍 (PTSD) 和抑郁症。
**方法**: 本研究是首次应用网络分析模型来考查以色列国防军退伍军人服役期PMIE，创伤后应激障碍 (PTSD) 症状簇, 抑郁和战争暴露网络的探索性实证概念化。
**结果**: 2017年期间招募了191名以色列退伍军人的志愿者样本, 并在横断面设计的研究中完成了有效的PMIE, PTSD和抑郁自评问卷。估计了正则化高斯图形模型。
**结论**: 网络分析揭示了PTSD结点与大多数PMIE结点之间的强桥连接。发现PMIE的背叛与PTSD的认知和情绪负向变化 (NACM) 症状簇中结点在其他PMIE和PTSD间具有桥接功能。发现抑郁与大多数PMIE和PTSD结点有连接。
结论: 该研究结果概述了以色列退伍军人中PMIE与PTSD症状簇之间的复杂关系。PMIE (尤其是基于背叛的经历) 直接或通过抑郁症状与PTSD症状簇相关联。讨论了PMIE与PTSD之间关联的可能机制以及特定干预相关的临床意义。


## 1. Introduction

Modern warfare and guerilla combat within a civilian setting are prone to expose combatants to severe moral and ethical challenges. Whereas most of these challenges are managed effectively, some potentially morally injurious events (PMIEs), such as direct perpetration, failing to prevent, and witnessing acts may not be managed effectively. Specifically, PMIEs are perpetration-based acts of self (e.g. killing) or others (e.g. failing to prevent others from inflicting atrocities) as well as witnessing perceived immoral actions, and experiencing the betrayal of trusted others (Drescher et al., 2011; Litz et al., 2009; Maguen & Litz, 2012). Indeed, studies among veterans in various militaries around the globe (e.g. Currier, Holland, Drescher, & Foy, 2015; Williamson, Greenberg, & Murphy, 2019; Zerach & Levi-Belz, 2018) have found that approximately 20–30% of veterans had experienced various PMIEs. In some cases, the PMIEs may transgress deeply held moral beliefs and thus, result in several deleterious psychological effects. This cause-and-effect process has been termed *moral injury* (MI; Litz et al., 2009; Yeterian et al., 2019).

The moral injury conceptual model (Litz et al., 2009) has proposed that PMIEs might severely shake a veteran's moral code and basic expectations of right and wrong. Nevertheless, veterans must be aware of the discrepancies between their morals and the actual moral violation, and this awareness may cause dissonance and inner conflict. During the PMIE or in the subsequent period, some veterans might attribute their moral violation to depressive attributions of global, internal, and stable deficits that could produce experiences of trauma-related guilt and shame. These experiences may, in turn, trigger significant moral dissonance, which, if left unresolved, could lead to the development of posttraumatic stress disorder (PTSD) symptoms along with deep psychological, behavioural, and spiritually aversive consequences (e.g. Jordan, Eisen, Bolton, Nash, & Litz, 2017; Neria & Pickover, 2019).

A growing body of empirical evidence has indicated a direct association between PMIEs and PTSD symptoms, which may explain some of the high variability in the prevalence of PTSD among combatants, such as disease course and response to therapeutic interventions (Barnes, Hurley, & Taber, 2019; Steenkamp, Litz, Hoge, & Marmar, 2015). For example, recent studies found associations between perpetration and betrayal-based PMIEs and PTSD among active-duty Marines deployed to Afghanistan (Jordan et al., 2017) and among veterans from military conflicts in Iraq and Afghanistan (Currier et al., 2015). Among Israeli veterans, it was found that, beyond general exposure to combat, PMIE of betrayal was associated with depressive attributions in addition to high PTSD levels (Levi-Belz & Zerach, 2018; Zerach & Levi-Belz, 2018, 2019). Other studies also emphasized the comorbidity of depression and PTSD (Afzali et al., 2017) as well as the role of depression in increasing the risk for PTSD following moral injury (Koenig, Youssef, & Pearce, 2019). Whereas these studies highlighted the link between various PMIEs and PTSD symptoms, the web of associations between PMIEs' specific domains and PTSD specific symptom clusters and depression has been understudied. We believe this question can be resolved more precisely by adopting a network modelling strategy.

The emerging network perspective offers a novel way of understanding the dynamics of psychopathology (Borsboom, 2017; McNally, 2016). According to this framework, symptoms do not arise primarily as passive consequences of underlying mental disorders. Rather, connected symptoms may interact, potentially producing mental disorders as emergent phenomena. The new field of network psychometrics has been applied in recent years to the investigation of the complex structure of various psychiatric disorders (Fried et al., 2017), including depression (Fried, Epskamp, Nesse, Tuerlinckx, & Borsboom, 2016), psychosis (Isvoranu, Borsboom, van Os, & Guloksuz, 2016), schizophrenia (Levine & Leucht, 2016), and anxiety (Beard et al., 2016).

Several studies have recently used network analysis to examine the symptom-level structure of PTSD (e.g. Armour, Fried, Deserno, Tsai, & Pietrzak, 2017; Birkeland, Greene, & Spiller, 2020; Bryant et al., 2017; Greene, Gelkopf, Epskamp, & Fried, 2018; Knefel, Tran, & Lueger-Schuster, 2016; Mitchell et al., 2017; Spiller et al., 2017; Sullivan, Smith, Lewis, & Jones, 2018). These studies emphasized the central roles that various symptoms and clusters may play in driving PTSD networks by being highly connected to other PTSD symptoms. For example, a network approach to DSM-5 PTSD symptoms among U.S. veteran samples found close connectivity between various symptoms from the intrusion cluster and the avoidance cluster (e.g. Armour et al., 2017; Phillips et al., 2018). It is noteworthy that due to methodological consideration, such as cross-sectional designs, various types of trauma, time since exposure, full diagnosis vs., sub-syndrome and so on- it seems that stability within PTSD clusters, but high lack of consistency of between-clusters connectivity of network model (e.g. Ross, Murphy, & Armour, 2018) is the norm.

In recent years, studies utilizing network analysis to examine the relationships between PTSD symptoms and external constructs began to emerge (e.g. Armour et al., 2017; Greene, Gelkopf, Fried, Robinaugh, & Lapid Pickman, 2019). By entering other variables into the PTSD network, it becomes feasible to identify the PTSD symptoms that are more central and most strongly related to these external psychosocial constructs. Central symptoms may be potentially more influential than others (i.e. peripheral symptoms), and once activated, these central symptoms will rapidly spread the activation throughout the network, thus, giving rise to other PTSD symptoms (Borsboom & Cramer, 2013). As such, studies of cross-sectional networks can generate valuable exploratory insights into the predictive effects of different variables (Epskamp, Waldorp, Mõttus, & Borsboom, 2018).

Recently, studies have examined the network relationships of PTSD symptoms with depression (Afzali et al., 2017; Choi, Batchelder, Ehlinger, Safren, & O'Cleirigh, 2017), alcohol use disorder (Afzali et al., 2017), sexual risk behaviour (Choi et al., 2017), and a mixture of various constructs, such as psychological symptoms, suicidal ideation, anxiety, physical and mental functioning, gender, and age (e.g. Armour et al., 2017; Birkeland & Heir, 2017). For example, Afzali et al. (2017) found that feeling sad and feeling guilt were bridge symptoms between PTSD and depressive symptoms, thus, indicating a link between depressive symptoms and the negative alterations in cognitions and mood (NACM) cluster. However, to the best of our knowledge, no studies to date have examined the network model of PTSD clusters with the moral injury experience generally, and among veteran populations, specifically. The prevalence of veterans who have been traumatized due to MI and the close relationship between MI and PTSD highlight the need to understand how PMIEs among veterans are related to the network of PTSD clusters.

In other words, the use of a network approach in studying the PMIE/PTSD relationship could facilitate our understanding of the dynamics of the connections between the variables with a focus on the role of PMIEs, depression, and combat exposure in the manifestation of different PTSD clusters. Moreover, the network approach could enhance our understanding of the specific ways these variables interact to produce psychopathology, such as PTSD (Borsboom, 2017). For example, it is not yet clear if any of the PTSD clusters are more closely associated with specific PMIEs than are others. Recognizing PMIEs that are closely connected to PTSD symptom groups could ultimately help clinicians identify specific moral injury events that might facilitate PTSD in its early stages.

### 1.1. The present study

The primary goal of the current study was to explore the network structure and centrality of DSM-5 PTSD clusters and PMIE clusters in a cross-sectional sample of combat veterans. Items in a network that are highly related to items from another construct have been described as *bridge nodes*, whereas strong network associations between pairs of items from two different constructs have been termed *bridge edges* (Greene et al., 2019; Jones, Ma, & McNally, 2019). In this study, we aimed to identify bridge nodes and bridge edges in order to clarify how PTSD, depression, and PMIEs are associated. Following the theoretical assumptions (Litz et al., 2009) and empirical evidence (e.g. Zerach & Levi-Belz, 2018) relating to the role of depressive attributes and symptoms in MI process and outcomes, as well as in PTSD, we also examined this additional construct in the network model. Furthermore, by examining the network structure of PTSD and PMIEs, the current study sought specifically to identify those PTSD and depressive symptoms that are most strongly related to different domains of PMIEs and 'traditional' threat-related combat experiences.

Although network analyses are somewhat exploratory by nature, we posit the following hypotheses, based on the literature review of network mode among samples of veterans:

H1 – Whereas PMIEs of self and other are more closely related to depressive symptoms, betrayal-based PMIEs will be more closely related to the PTSD NACM cluster.

H2 – Whereas combat exposure is related to the intrusions cluster, PMIEs will be more closely related to the NACM cluster.

H3 – Depressive symptoms will be most closely related to the NACM and arousal clusters.

## 2. Method

### 2.1. Participants

Participants included 191 Israeli combat veterans of the Israel Defence Forces (IDF). Inclusion criteria are aged 20 and above, previous military service in combat units, and having been discharged from the military within the previous 10 years. Of all the participants who gave their consent ($n$ = 220), 22 (10%) failed to complete the questionnaires, and seven (3.1%) participants were excluded for not meeting the inclusion criteria. In sum, 191 veterans (86.8%) participated in the study. As presented in Table 1, most of the participants were male (85.4%), Israeli-born (88.9%), and reported having below-average income (81.5%). Regarding military service features, the average time since discharge was 4.36 years ($SD$ = 2.27), and most of the veterans were still being called up periodically for reserve duty (81.7%). For full demographic details, see Zerach and Levi-Belz (2018).

### 2.2. Procedure

All participation in the current study was voluntary. Potential participants were recruited between March and July 2017 by several means. These included approaching active contributors on combat veterans' websites and online communities, students from two academic centres located in central Israel, and those responding positively to an online invitation to participate in the study.

The investigators' research assistants posted a message briefly describing a research project focusing on 'military service experiences' and invited the participation of volunteers. Those agreeing to participate received an explanation of the study's aims and a link to the related online survey through an online data-gathering website. Participants were required to confirm their willingness to participate, with their active participation comprising their informed consent. All the questionnaires were administered in Hebrew. Following the completion of the survey, participants were sent a letter of thanks and were compensated with a voucher for coffee and pastry (approximate value: US $5). Approval for this study was granted by the internal review boards at Ariel University and Ruppin Academic Centre.

### 2.3. Measurements

#### 2.3.1. Moral injury event scale (MIES; Nash et al., 2013)

The Moral Injury Event Scale is a 9-item self-report scale, tapping exposure to perceived transgressions committed by the respondent or others, and perceived betrayals by other military and non-military individuals (e.g. 'I acted in ways that violated my own moral code or values'). Items were presented on a 6-point Likert-type scale, ranging from 1 (*strongly disagree*) to 6 (*strongly agree*). We used the three subscales of 'self,' 'other,' and 'betrayal.' In two U.S. military samples, Bryan et al. (2016) found that the three-factor solution (transgressions

**Table 1.** Demographic and clinical information of the sample (N = 191).

| | *N* (%) | Mean | *SD* | Range | *N* |
|---|---|---|---|---|---|
| Age at study | | 25.39 | 2.37 | 20–37 | 191 |
| Years of education | | 12.46 | 1.15 | 8–19 | 191 |
| Time since deployment (years) | | 4.36 | 2.27 | 1–10 | 191 |
| Male gender | 163 (85.4%) | | | | 191 |
| Place of birth-Israel | 170 (88.9%) | | | | 191 |
| Marital status- Single | 133 (70.1%) | | | | 191 |
| Income- Below average | 155 (81.3%) | | | | 191 |
| Performing reserve duty | 156 (81.7%) | | | | 191 |
| Army rank- *Enlisted* | 157 (82.1%) | | | | 191 |
| Branch of military- Infantry units | 139 (72.7%) | | | | 191 |
| Branch of military- Armoured Corps | 11 (5.7%) | | | | 191 |
| Branch of military- Engineering Corps | 11 (5.7%) | | | | 191 |
| Branch of military- Artillery Corps | 8 (4.7%) | | | | 191 |
| Branch of military- Other combat units | 21 (10.9%) | | | | 191 |
| PMIE- self | | 6.73 | 4.18 | 4–24 | 186 |
| PMIE – other | | 4.84 | 2.77 | 2–12 | 186 |
| PMIE – betrayal | | 6.42 | 3.65 | 3–18 | 186 |
| Intrusion | | 2.66 | 4.37 | 0–20 | 159 |
| Avoidance | | 1.10 | 1.91 | 0–8 | 159 |
| NACM | | 4.52 | 5.58 | 0–28 | 159 |
| Arousal | | 5.83 | 5.83 | 0–24 | 159 |
| Depression | | 4.06 | 4.18 | 0–24 | 158 |
| MI- Causes | | 18.72 | 4.82 | 13–52 | 188 |
| Combat exposure | | 5.10 | 3.86 | 0–18 | 191 |

PMIE = Potential moral injury events; NACM = Negative alterations in cognitions and mood. MI = Moral injury.

by oneself, witnessed transgression by others, and betrayal) best fit the data. The MIES has demonstrated good preliminary factor structure and reliability. Moreover, it presents only small to moderate correlations with other indicators of psychopathology, indicating that it is a relatively distinct construct. For the current sample, good internal consistency characterized the subscales of *self* (α =.90), *others* (α = .85), and *betrayal* (α = .83).

#### 2.3.2. Posttraumatic stress disorder checklist

(PCL-5; Blevins, Weathers, Davis, Witte, & Domino, 2015) for DSM-5 Participants' PTSD levels were assessed with the PCL-5, a 20-item self-report measure that taps PTSD's 20 symptoms (e.g. 'I have recurrent dreams and nightmares about stressful experiences from my service'), as they appear in the four clusters of symptoms in the DSM–5 (i.e. intrusions, avoidance, negative alterations in cognitions and mood, and arousal). Participants were asked to rate how often they bothered from each symptom in relation to stressful experiences in their military service. The symptoms were presented on a 5-point Likert-type scale, ranging from 0 (not at all) to 4 (extremely). The PCL-5 Cronbach's α reliability of the PTSD subscales for the current sample ranged from .85 to .93.

#### 2.3.3. The depressive attributions questionnaire (DAQ; Kleim, Gonzalo, & Ehlers, 2011)

The DAQ is a 16-item scale based on the hopelessness theory of depression (Abramson, Metalsky, & Alloy, 1989) and captures the tendency to attribute negative events to internal, stable, and global causes (e.g. 'When bad things happen, I think it is my fault'). The DAQ is presented on a 5-point Likert-type scale, ranging from 0 (*not at all*) to 4 (*very strongly*). Items are summed into a total score. Earlier research has shown good psychometric properties (Kleim et al., 2011) for the scale. For the current sample, internal consistency proved excellent (α = .92).

#### 2.3.4. Combat experiences scale (CES; Hoge et al., 2004)

Combat experiences were examined with the CES, an 18-item scale, tapping a range of conventional modern combat-related experiences to which an individual may have been exposed (e.g. being attacked or ambushed, shooting or directing fire at the enemy, handling or uncovering dead bodies or body parts). Respondents were asked to indicate which events they had experienced at any time during a deployment, resulting in a total number of combat experiences, with scores ranging from 0 to 18. For the current sample, Cronbach's α on the CES items was .84.

### 2.4. Data analysis

For the current study, we estimated a network model comprising nine variables: three variables representing aspects of moral injury (self, other, and betrayal); four variables representing the DSM-5 PTSD subscales (intrusions, avoidance, negative alterations in cognitions and mood, and arousal); and two additional variables (depression and combat exposure). We rescaled all of the variables so that each presented on a 0–1 scale.

To conduct the network analyses, we used the bootnet and qgraph packages in R to estimate a Gaussian graphical model, which is a regularized partial correlation network (R code available in the supplementary material; Epskamp & Fried, 2018). This method estimates the correlations between each pair of nodes, controlling for the other edges in the network. In the current study, we used Spearman correlations in light of the data's non-normal distribution. We employed a graphical *least absolute shrinkage and selection operator* (LASSO; Tibshirani, 1996) and an extended Bayesian information criterion to select the optimal regularization parameter. This approach sets very weak edges to zero, which reduces the chance of finding spurious correlations. Networks were estimated using all pairwise observations (i.e. all available data).

#### 2.4.1. Visualization

The network is comprised of variables known as 'nodes,' which are connected by links, known as 'edges.' The thickness of the edges represents the strength of the association between node pairs, having controlled for other pairwise associations, with thicker edges denoting stronger associations. Blue edges indicate positive associations, whereas red edges indicate negative associations. The network layout is based on the Fruchterman-Reingold algorithm that forces strongly correlated nodes closer together (Fruchterman & Reingold, 1991).

#### 2.4.2. Robustness testing

Before interpreting a network, it is important to first investigate the accuracy and stability of the estimated network and the centrality indices. Following recommendations set out by Epskamp, Borsboom, and Fried (2018) to estimate the accuracy of the network edges, we bootstrapped the 95% confidence intervals of the edge weights. We also conducted a bootstrapped difference test, which compares edges, to check whether each given edge is significantly larger than the other edges within the network.

Strength centrality refers to the sum of the absolute strength of all the connections a given symptom has with all other symptoms in the network. To investigate the stability of the strength centrality estimate, we used

subsetting bootstrap, which resamples progressively smaller samples from the original data and then re-estimates the network. The order of the strength centrality estimates of the original network was then compared with the order of strength centrality estimates in the subset networks. Following this, we estimated the centrality stability coefficient (CS coefficient), which refers to the maximum proportion of the cases that can be dropped from the original sample while retaining a correlation of at least 0.7 (95% probability) between the original network strength centrality and the strength centrality indices of the networks from the subset samples. The CS coefficient should be at least 0.25–preferably above 0.5–to be considered stable (Epskamp et al., 2018).

## 3. Results

Means, standard deviations, range (all before rescaling the variables), and the number of valid responses for each of the study variables are presented in Table 1. Moreover, we examined the frequencies of combat experiences in our samples, which indicated that 'Knowing someone seriously injured or killed' was the single most common experience reported by the veterans (71% responded 'yes'). As can be seen in Table 2, the other frequently endorsed items on the CES included 'Shooting or directing fire at the enemy' and 'Being attacked or ambushed,' reported to be experienced by 49% and 46% of the veterans, respectively. As can be seen in Table 3, relating to PMIEs, the most commonly endorsed items from the MIES were 'I saw things that were morally wrong' (29.6%), and 'I feel betrayed by leaders who I once trusted' (25.2%). More generally, 21.9% of our sample endorsed at least one of the MIES's perpetration-by-self items, and 33.7% of the participants endorsed at least one of the MIES's by others items, findings consistent with recent reports from other Western armies (Jordan et al., 2017).

For the PCL-5, 15 participants (9.6%) exceeded the cut-off score of 38 following stressful experiences in military service according to the DSM-5 (American Psychiatric Association [APA], 2013) criteria. Forty-one (25.8%) respondents reported one or more intrusion symptoms, 29 (18.2%) reported one or more avoidance symptoms, 43 (27.1%) reported two or more NACM symptoms, and 65 (40.9%) reported two or more hyper arousal symptoms. Scores on the PCL- 5 ranged from 0 to 76, with a mean of 14.13 (*SD* = 15.45).

**Table 2.** Frequencies of Yes/No answers of the combat exposure scale among Israeli combat veterans (N = 191).

| | Frequencies | |
|---|---|---|
| *Combat exposure scale items* | Yes | No |
| Being attacked or ambushed | 46% | 54% |
| Receiving incoming artillery, rocket, or mortar fire | 39% | 61% |
| Being shot at or receiving small-arms fire | 20% | 80% |
| Shooting or directing fire at the enemy | 49% | 51% |
| Being responsible for the death of an enemy combatant | 14% | 86% |
| Being responsible for the death of a noncombatant | 4% | 96% |
| Seeing dead bodies or human remains | 39% | 61% |
| Handling or uncovering human remains | 17% | 83% |
| Seeing dead or seriously injured IDF soldiers | 26% | 74% |
| Knowing someone seriously injured or killed | 71% | 29% |
| Participating in demeaning operations | 12% | 88% |
| Seeing ill or injured women or children whom you were unable to help | 16% | 84% |
| Being wounded or injured | 22% | 78% |
| Had a close call, was shot or hit, but protective gear saved you | 13% | 87% |
| Had a buddy shot or hit who was near you | 20% | 80% |
| Clearing or searching homes or buildings | 60% | 40% |
| Engaging in hand-to-hand combat | 17% | 83% |
| Saved the life of a soldier or civilian | 25% | 75% |

### 3.1. Network stability

The CS coefficient = .67. The standardized estimates of node strength centrality are presented in the supplementary material. These findings indicated that the strength centrality index was sufficiently stable to allow for interpreting the centrality differences between variables.

### 3.2. Network visualization

Figure 1 presents a visualization of the network structure (the partial correlation matrix is available in the supplementary material together with the figures

**Table 3.** Frequencies of 'slightly agree' to 'strongly agree' answers on the moral injury event scale among Israeli combat veterans (N = 191).

| MIES Item | Frequency of 'Slightly agree', 'agree' and 'strongly agree'. |
|---|---|
| *MIES-Self dimension* | |
| 1. I saw things that were morally wrong | 29% |
| 2. I am troubled by having witnessed others' immoral acts | 22% |
| 3. I acted in ways that violated my own moral code or values | 12% |
| *MIES-Other dimension* | |
| 4. I am troubled by having acted in ways that violated my own morals or values | 13% |
| 5. I violated my own morals by failing to do something that I felt I should have done | 10% |
| 6. I am troubled because I violated my morals by failing to do something I felt I should have done | 12% |
| *MIES-Betrayal dimension* | |
| 7. I feel betrayed by leaders who I once trusted | 25% |
| 8. I feel betrayed by fellow service members who I once trusted | 17% |
| 9. I feel betrayed by others outside the IDF who I once trusted | 15% |

MIES = Moral Injury Event Scale.

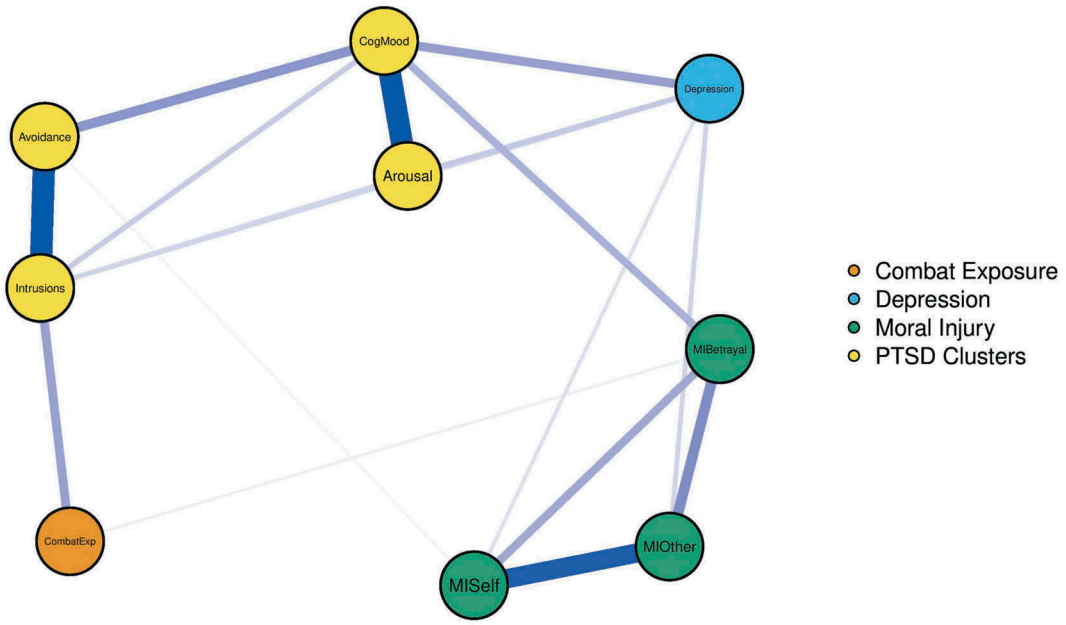


**Figure 1.** Visualization of the network structure.

depicting the significant differences between the edge weights and the bootstrapped edge weight CIs). All the network connections were positive; thus, the expected influence index is not presented here, as it is identical to strength centrality in the current case. The strongest associations were within-constructs, rather than between-constructs. As hypothesized, particularly strong connections were yielded between the PTSD intrusions and PTSD avoidance nodes (.55) as well as between the PTSD arousal and the PTSD negative alterations in cognitions and mood nodes (0.54). There were also strong connections between the MI-other and MI-self nodes (0.46). The noted three edges were significantly stronger than most other edges in the network (see the supplementary material for results of all edge-weight difference tests).

Regarding the bridge edges (cross-construct connections), our second and third hypotheses were partially confirmed: PMIE-other was connected with depression (0.08), but not with any of the PTSD nodes, whereas PMIE -self was connected with both depression (0.05), and, weakly, with avoidance (.01). The PMIE-betrayal node, in contrast, was connected with the negative alterations in cognition and mood (NACM) PTSD node (.15), but not with any of the other PTSD nodes, nor with depression. Combat exposure was associated with intrusions (.19) and MI-betrayal, but not with any other variables in the network. Finally, our last hypothesis was partially confirmed; Depression was connected to NACM (.19), arousal (.10), and intrusions (.07), but not to avoidance. With regard to strength centrality (see Figure 1), the NACM node was the most central, followed by the intrusions, avoidance, and PMIE-other nodes. Centrality difference tests (see the supplementary material) indicate that the NACM node was significantly stronger than most of the other nodes, while combat exposure was significantly weaker than all the nodes, except for depression.

## 4. Discussion

MI is one of the adverse consequences of combat, representing a shame- and guilt-related syndrome following exposure to events perceived as violations of deep moral beliefs, perpetrated by oneself or by trusted individuals (Jinkerson, 2016; Litz et al., 2009; Zerach & Levi-Belz, 2018). In this study, we sought to conduct a network analysis of aspects of moral injury, together with the DSM-5's PTSD clusters and depression, in order to explore the links between these phenomena among combat veterans. As the current study represents the first network analysis study of MI and PTSD symptoms, we believe it can provide novel insights into the complex relationships between PMIEs and their possible consequences in the form of PTSD clusters and depression among veterans.

All connections were positive, and the strongest connections were within, rather than between, PMIE and PTSD constructs. Some bridge connections were evident, notably, while the PMIE-betrayal node was connected to the PTSD NACM node and PMIE-self was connected to avoidance, the PMIE-self and PMIE-other were connected to depression, indicating differential associations between PTSD and depression to different aspects of moral injury. The NACM node was the most central, indicating its having the strongest connection with other nodes in the network.

Our results showed that the bridge edge between the PMIE-betrayal and the negative alterations in

cognition and mood (NACM) PTSD cluster is most likely to serve as the link between moral injury and PTSD. Furthermore, MI-self and MI-other nodes had significant bridge edges with depression, whereas MI-betrayal did not, thus, providing a differential effect pattern across syndromes. As anticipated from their well-established empirical comorbidity (e.g. Nichter, Norman, Haller, & Pietrzak, 2019), the depression node had bridge edges to all of the PTSD symptom clusters except avoidance. Lastly, combat exposure was associated with the intrusion cluster, but with none of the other PTSD clusters, nor with depression or the moral injury subscales.

These findings provide an overview of the complex comorbid relationships between PMIEs and PTSD symptoms. Whereas controversy regarding the relationships between PMIEs and PTSD (Barnes et al., 2019) remains, in our sample, MI-betrayal was found to be associated with the PTSD network through the NACM cluster. The strongest bridge edges were manifested between the MI-betrayal experience and the NACM cluster (See the bootstrapped centrality stability in the supplementary material). Furthermore, the most central node was the NACM cluster. Together, these findings are consistent with several studies that highlighted the critical effect of the betrayal experience in its association with psychologically adverse consequences, even years after deployment (e.g. Bryan et al., 2015; Jordan et al., 2017; Zerach & Levi-Belz, 2018).

Betrayal represents a high magnitude moral injury, as it relates to a fault activity performed by a trusted authority figure (Frankfurt & Frazier, 2016). Shay (1994) even speculated that betrayal by commanding authorities corrodes the cohesion and effectiveness of their military units as well as the safety and security of combat personnel. Thus, it can be postulated that experiences of betrayal may place combatants at risk of perpetrating other transgressive acts (e.g. committing atrocities) and increase their vulnerability to adverse consequences, such as the NACM cluster. Specific symptoms within this cluster, such as a persistent negative emotional state of shame and guilt or persistent distorted cognitions concerning self-blame, might trigger the process leading to PTSD as a chronic syndrome.

How can the central role of the PTSD's NACM cluster of symptoms in our sample and, more importantly, its bridging role to PMIEs through betrayal, be explained? To resolve these questions, it is important to review some of the modifications of the PTSD criteria introduced in the DSM-5. First, the DSM-IV Criterion C (avoidance and numbing) was split into two clusters: avoidance (Criterion C) and negative alterations in cognitions and mood (NACM [Criterion D]; APA, 2013). Second, two new symptoms (blaming self or others for the trauma and persistent negative emotions, such as fear, anger, guilt, and shame) were added to the NACM cluster, which expanded into strong negative beliefs about self, other people, and the world (APA, 2013). These changes appear to claim that the NACM cluster taps experiences of shame and blame subsequent to the traumatic event. These experiences may comprise some of the substantial encounters that veterans having had PMIE-betrayal experiences may have endured during and after the MI event (e.g. Frankfurt & Frazier, 2016; Litz et al., 2009). Thus, this can explain that the shame and blame after PMIE-betrayal comprised the experiences that play a role in its connectedness to the NACM cluster, but not to the other clusters. Future studies with larger samples could examine an expanded network with all 20 PTSD symptoms and the PMIE subscales to determine which discrete PTSD symptoms are highly associated with PMIEs.

Interestingly, PMIEs of self and others were found to be strong connected to one another, but not directly related to the PTSD clusters, other than a very weak connection between MI-self and avoidance. Whereas these transgressive acts result in guilt and shame experiences among veterans (Litz et al., 2009; Zerach & Levi-Belz, 2018), the complex and intense nature of the veterans' military service (routine exposure to urban environments and proximity to civilians) may have calloused the veterans to these self- or other-perpetrated transgressive acts, thereby diminishing their astonishment and, and in turn, lessening their traumatic effect. Thus, although the different dimensions of PIMEs are associated in some fashion, suggesting that it may be a unitary construct, PIMEs are primarily related to PTSD via the betrayal-NACM connection, and indirectly through depression (via PMIE of self and other), which in turn, are related to PTSD clusters. However, future studies should examine these network connection findings with different samples (e.g. active combatants having ongoing PMIE experiences) to determine the general nature of connectedness of the MI-PTSD clusters.

Our findings revealed that depressive symptoms comprised the primary bridge between MI-self and MI-other transgressive acts and PTSD. Whereas other studies have shown depressive attribution style to be positively correlated with PTSD symptom severity (e.g. Kleim et al., 2011; Wild et al., 2016), this is the first study to highlight the crucial role of these depressive attributions in the relationships between PMIEs and PTSD. Thus, these findings may ultimately lead researchers to identify a possible intervention point, as will be discussed below. Abramson et al. (1989) asserted that the experience of hopelessness is one of the primary facilitators of depression. Veterans who have perpetrated or witnessed transgressive acts may have adopted a pessimistic worldview that is the core of hopelessness (Beck, Weissman, Lester, & Trexler, 1974; Horesh, Levi, & Apter, 2012; Levi-Belz, Gvion, Grisaru, & Apter, 2018; Levi-Belz et al., 2014), a condition that may

facilitate depression attributions. These attributions, in turn, could have connected to the NACM cluster, the central cluster of PTSD symptoms in our sample.

Including negative belief symptoms within the NACM cluster in DSM-5 may explain the significant node between it and depressive attribution that was found in our sample. Other studies have also found associations between the NACM cluster and depression, suicide ideation, and suicide risk (Brown, Contractor, & Benhamou, 2018; Hurlocker, Vidaurri, Cuccurullo, Maieritsch, & Franklin, 2018; Spitzer, Zuromski, Davis, Witte, & Weathers, 2018). Thus, whereas depression was related to three of the four PTSD clusters, the facilitation of PTSD, mainly through the NACM cluster, may have occurred because they both reflect the negative changes in the veterans' mood after their experiencing PMIEs in combat.

Another noteworthy finding in the current study was that combat exposure was found to bridge PMIEs and PTSD by its significant relationship with the PTSD intrusion cluster. Upon scrutinizing the CES items, one can regard high combat exposure as including numerous combat patrols, high exposure to enemy fire, witnessing unit soldiers killed, wounded, or missing in action, and being in danger of injury or death during deployments (Keane et al., 1989).

Combat exposure has previously been shown to predict posttraumatic stress (Armistead-Jehle, Johnston, Wade, & Ecklund, 2011). Numerous near-death experiences clearly leave a profound impact on psychopathology in general and on the intrusion cluster, specifically. Intrusive thoughts typically arise when an individual is focused on a particular task but experiences unwanted memories unrelated to the current task. Although our data are cross-sectional, our findings represent a preliminary step towards understanding that high combat exposure may be related to higher levels of moral injury events. In other words, these findings may suggest that veterans exposed to heavy combat for lengthy periods are more likely to be subjected to MI-betrayal experiences and develop PTSD. The lack of directionality in our networks may be addressed in future longitudinal studies exploring mechanistic pathways between the stress of combat, intrusive thoughts, and morally injurious events.

It is important to note that the extent to which central symptoms are suitable targets for interventions (Bringmann et al., 2019; van Borkulo et al., 2015) remains unclear. Future studies should examine whether targeting the negative cognitions and mood that often follow PMIEs would be an effective intervention for veterans. Such interventions could resemble, for example, cognitive processing therapy (CPT; Monson et al., 2006; Resick, Monson, & Chard, 2016), which targets the patient's thoughts, feelings, and beliefs concerning the traumatic events as well as the patient's PTSD symptoms. CPT is regarded as a highly effective way of treating PTSD in veterans (Monson et al., 2006) and aimed to specifically targets thoughts, feelings, and beliefs about the PTSD-precipitating traumatic event. Thus, if these symptoms are revealed to be central to a PTSD network and comprise one of the bridges between PTSD and PMIEs and depression among veterans, targeting these symptoms in treatment could be particularly effective and promising, even in group settings (Morland, Hynes, Mackintosh, Resick, & Chard, 2011).

## 5. Limitations

This study has several significant limitations. First, the cross-sectional nature of our data is a primary drawback and precludes making causal inferences. Second, the data regarding MI experiences were obtained using retrospective self-report measures, which can introduce a well-acknowledged range of biases caused by factors such as mood dependent recall, forgetting, cathartic effect, and social desirability. Third, we capitalized on a non-representative, volunteer sample that may not represent accurate rates of PMIEs among veterans, thus, limiting generalization to other populations and settings. Fourth, given the sample size, our conclusions were limited to considering PTSD symptom clusters rather than being able to estimate an expanded network with individual PTSD symptoms. Replicating this study with a larger sample and with a longitudinal design could provide more insight into the bridge associations between PTSD and depression symptoms with aspects of moral injury. Fifth, some studies have called into question the replicability of network studies (e.g. Forbes, Wright, Markon, & Krueger, 2017). Given this critique and the noted limitations, replicating this study with other larger samples and with a longitudinal design could provide more insight into the bridge associations between PTSD and depression symptoms with various aspects of moral injury.

Our findings showed that all PMIEs were connected, suggesting that they can be viewed as a unified construct of MI. The edge between MI-betrayal and the NACM-PTSD cluster was found to have a bridging role between these two constructs. The pathway from moral injury to PTSD may proceed through this association. Moreover, we found that PMIEs and several PTSD clusters may be indirectly associated through depression. As the first study to examine the MI-PTSD network among veterans, we believe it represents a step forward in our ability to assess and treat those veterans who suffer from PTSD after enduring moral injury in combat.

## Disclosure statement

No potential conflict of interest was reported by the authors.

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