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VIRTUAL REALITY INTERVENTIONS FOR WAR-RELATED PSYCHIATRIC DISORDERS: A REVIEW OF EXPOSURE, NON-EXPOSURE, AND MULTIMODAL APPROACHES

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ABSTRACT

Introduction: Armed conflict results in severe psychiatric disorders such as post-traumatic stress disorder (PTSD), depression, and anxiety, often associated with repeated trauma exposure. According to DSM-5 criteria, PTSD involves clusters of symptoms including intrusion, avoidance, and negative alterations in cognition and mood. As military populations frequently display resistance to standard evidence-based treatments like cognitive-behavioural therapy (CBT), alternative interventions are required.
Purpose: This review examines virtual reality (VR)-based therapies, categorising them into non-exposure (e.g., relaxation, biofeedback), exposure-based (VRET), and multimodal approaches, specifically Multi-modal Motion-assisted Memory Desensitisation and Reconsolidation (3MDR).
Methodology: A comprehensive search of PubMed was conducted to identify studies examining VR interventions for war-related psychiatric disorders, with a specific focus on more recent literature published up to 2025. Additional studies were identified through manual screening of relevant systematic reviews. The search incorporated keywords related to PTSD, military personnel, virtual reality and exposure therapy. We included randomized controlled trials, case reports, and meta-analyses, while articles not published in English were excluded.
Results: VR-based interventions demonstrate promising efficacy in reducing symptoms of war-related psychiatric disorders, particularly in treatment-resistant military populations, and when used as an adjunct to conventional therapies such as CBT. However, current evidence remains limited and heterogeneous, highlighting the need for more rigorous randomized controlled trials to establish long-term effectiveness, safety, and standardised clinical protocols.
Conclusions: VR offers immersive, controlled environments that may enhance emotional engagement and reduce dropout rates. While promising as an adjunctive or alternative tool for treatment-resistant cases, VR implementation requires careful clinical assessment and consideration of individual patient needs.

KEYWORDS

PTSD, Virtual Reality, 3MDR, Veterans and Military Personnel, Exposure Therapy

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Introduction

War is a source of exposure to traumatic events, which are strongly associated with symptoms of psychiatric disorders such as post-traumatic stress disorder (PTSD), depression and anxiety [1].

PTSD is a trauma- and stress-related condition defined by specific diagnostic criteria, as outlined in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5). Diagnosis necessitates exposure to a traumatic event, followed by symptoms across distinct clusters, including intrusive and persistent reliving of the experience, repeated avoidance of trauma-related stimuli, negative alterations in cognitions and mood, and marked alterations in arousal and reactivity [2]. Aside from experiencing traumatic events, the long-term separation of civilian combatants from family and social support networks may render them more vulnerable to mental health disorders, given their lack of preparation [3]. Exposure to traumatic events has also been linked to suicidal ideation [1] and concerningly, suicide rates in the military present an upward rise. An annual report on suicide in the U.S. Military states that suicide rates for Active Component Service members gradually increased from 2011 to 2023 – 18.7 per 100,000 in 2011 compared to 28.3 per 100,000 in 2023 (unadjusted rate). Although these rates were statistically similar to the general U.S. population, they were higher in 2020, revealing a persistent upward trajectory [4].

Cognitive-behavioural therapy (CBT), prolonged exposure (PE), and eye movement desensitization and reprocessing therapy (EMDR) are evidence-based interventions utilised in the treatment of PTSD. However, military and veteran populations display reduced responses to these psychotherapies as monotreatment, with a smaller fraction attaining loss of diagnosis compared to non-military groups [5]. This indicates that monotherapy might not address every aspect of combat-related PTSD, highlighting a need for alternative approaches.

Telemedicine is a rapidly developing field within healthcare, presenting remote and accessible treatment options. Virtual reality (VR)-based therapy is a promising aspect of it, offering immersive, controlled environments in which individuals can safely face trauma-related stimuli, enabling reductions in PTSD symptom severity, and possibly depression and anxiety symptoms [6]. VR-based therapy could potentially be a beneficial alternative for populations who are more technologically oriented and who may find the digitalised aspect appealing.

This review aims to outline current VR-based therapeutic methods in the treatment of war-related psychiatric disorders, assess their efficacy in unique patient populations such as military personnel and veterans, and propose directions for future research.

Non-Exposure Virtual Reality Therapy

One category among VR-based therapy is non-exposure VR therapy, which encompasses VR-based breathing or relaxation exercises, immersive 360° video nature environments, and biofeedback-enhanced VR training [7-9]. VR nature-based videos may function based on the attention restoration theory (ART) and stress reduction theory (SRT). ART proposes that nature scenery is restorative because natural environments encourage fascination rather than directed attention, which requires less mental effort and is thus less mentally fatiguing. SRT suggests that viewing natural environments after contact with a stressor can stimulate a positive affective reaction while reducing arousal and sustaining interest [7].

A study by Seiz et al. investigating the electroencephalography (EEG) responses in the frontal and parietal lobes to two VR stimulus environments (an urban, green vacant site versus the same site redesigned into a greenspace) theorised that alpha wave activity, which is responsible for an alert and wakeful mind, would be greater when viewing the redesigned site. Although this was not the case, the authors suggest that this may be because both scenes involved green spaces and express a need for further studies. However, participants did report a larger perceived restorativeness (PRS) for the redesigned site based on the 16-question PRS survey, implying that even minimally structured VR nature scenery can engage restorative mechanisms [7]. By offering realistic, immersive experiences in the form of natural scenery, these VR interventions facilitate mood improvement, cognitive distraction and relaxation [8].

Similarly, a study by Grassini et al. found that viewing videos with nature elements increased alpha activity in central and occipital-temporal sensors compared to urban and neutral videos – early alpha waves (8-11 Hz) in particular. Theta activity, which has been linked to cognitive control and error processing, specifically late theta (7-8 Hz) also increased over the mid-frontal brain areas, suggesting that natural environments could prompt stress reduction [10].

Recent work by Kukharuk et al. investigated immersive 360° VR sessions for veterans in Eastern Europe displaying stress-related symptoms. Participants (n = 69; VR group = 34; control = 35) were shown 5–8-minute videos depicting peaceful natural scenery as an adjunct to psychotherapeutic treatment during a 21-day programme. Upon assessment, there was an improvement in mood after each session, and after programme completion, there was a significant reduction in anxiety and depression on the Hospital Anxiety and Depression Scale (HADS) – up to 14.5% and 12.3% respectively. However, inclusion criteria required anxiety or depression as predominant symptoms, while individuals with PTSD as the primary diagnosis were excluded, limiting the generalisability of results [11]. A single-case study by Jensen (2021) related significant decreases in anxiety, vigilance, anger, and sadness in a Danish war veteran with a diagnosis of PTSD following an at-home 10-minute naturalistic 360° VR film of a Danish beach, despite the simulation lacking trauma exposure elements [12].

Riva et al. (2021) found that a self-help intervention in the form of an immersive 360° nature scene and a series of social exercises post-session in Italian civilians during the COVID-19 lockdown yielded significantly reduced levels of perceived stress, general distress and depressive symptoms over a two-week follow-up period. Curiously, participants could also watch this nature scene on a video platform without a head-mounted display (HMD) as a non-immersive modality, which provided similar outcome measures [13]. However, VR may offer additional advantages such as privacy and fewer distractions due to the use of an HMD. This report highlights that non-exposure VR environments can elicit emotional stabilisation and affective regulation, techniques which could be transferrable to trauma-affected military populations.

In settings where regular therapy sessions over an extended period of time are not feasible and access to specialists is limited, VRT could serve as a valuable tool for short-term, on-site symptom reduction, centred around stress-reduction and building emotional coping mechanisms. 360° video VR equipment is highly scalable, making it suitable for implementation across a variety of small-scale settings [11].

The inclusion of biofeedback could further enhance VRT. Biofeedback is the monitoring of physiological parameters such as heart rate variability (HRV), electrodermal activity, or brain activity, which is then reported back to the individual in real-time to encourage self-awareness and physiological regulation [9]. HRV, which measures the time fluctuation between adjacent heartbeats, reflects parasympathetic cardiac control. HRV biofeedback (HRV-BF) is commonly used to promote somatic awareness and self-regulation, and higher HRV is associated with better stress management. [9, 14]. Cardiac coherence, the degree of synchronisation between breathing and heart rate, forming sine-like oscillations around 0.1 Hz, is another possible biofeedback parameter, and it enhances autonomic nervous system efficiency, with heart rate, gas exchange and baroreflex all functioning harmoniously [9]. A randomised controlled trial by Blum et al. (n = 60) investigated the advantages of combining a VR environment depicting nature scenery with heart-rate variability (HRV) biofeedback (BF) over standard HRV-BF without the VR component. Results revealed better outcomes in the former group, with increased relaxation self-efficacy, improved ability to focus on the present, and fewer intrusive thoughts [9]. Cardiac coherence increased in both VR-based HRV-BF and standard HRV-BF, but there was no statistical difference between the two to suggest that VR-based HRV-BF was superior.

Another study (n= 107) compared HRV-BF and standardised paced breathing (sPB), delivered using a desktop screen or HMD. All four conditions reduced perceived stress and increased HRV, but HRV-BF led to a greater cardiac coherence than sPB. The HMD also yielded greater cardiac coherence and immersion compared to the desktop screen [14]. These findings combined suggest that VR-based HRV-BF may increase autonomic control and reduce stress.

Although there are no studies combining HRV biofeedback together with VR in military populations yet, a recent meta-analysis on HRV biofeedback for military service members with PTSD offers a promising outlook, with high treatment retention, adherence, and acceptability among a group who frequently exhibit high attrition rates relative to traditional psychotherapy [15].

This evidence suggests benefits of biofeedback implementation in a VR setting, creating an opportunity for PTSD symptom reduction by increasing self-assessment and response modulation, but direct evidence is still required to confirm this. It could thus be tentatively suggested that biofeedback and VRT could be a prophylactic tool used for pre-deployment resilience training in the future. Exposure to calming environments paired with real-time feedback could teach military troops cognitive control and emotional stabilisation to prepare for active duty, aiming to prevent the incidence of PTSD and other stress-induced mental disorders.

Virtual Reality Exposure Therapy

Imaginal exposure, which is part of therapies such as CBT or EMDR, relies on the patient's ability to vividly imagine the traumatic scenario. The inability to recall the traumatic event may render these imaginal exposure therapies less effective. Avoidance (of trauma-associated thoughts, emotions and reminders) is one of the key diagnostic symptom clusters of PTSD [2]. Avoidant coping and poor emotional engagement decrease treatment efficacy [16]. Virtual reality exposure therapy (VRET) circumvents avoidance by engaging the patient in a controlled simulation which enhances emotional engagement, sensory realism, and allows for therapist-controlled, gradual exposure aligned with the user's individual needs [17].

VRET is largely founded on the two complementary theories which underlie effective exposure-based therapies: the theory of memory reconsolidation, and the emotional processing theory [18, 19]. The memory reconsolidation theory posits that traumatic memories can be reactivated after they have been formed, at which point they are rendered malleable, and must be restabilised before they are re-stored. In this reconsolidation window, they can be reorganised using new information to weaken or update maladaptive fear memories [18,20]. The emotional processing theory holds that PTSD is caused by disorganised fear schemas which extend beyond specific stimuli to become excessively generalised, and that improvement happens when these structures are activated and amended through exposure [19,21].

From a neurobiological standpoint, memory destabilisation or extinction occurs when NMDA (N-methyl-D-aspartate) receptors are activated, which in turn activates L-type voltage-gated calcium channels, endogenous cannabinoid receptors and calcineurin, ultimately causing proteasome-dependent protein degradation. For memory reconsolidation and long-term extinction to take place, NMDA receptor activation triggers cAMP (Cyclic adenosine monophosphate) and calcium signalling, which activates extracellular signal-regulated kinase/ mitogen-activated protein kinase, protein kinase A and/ or $Ca2+$/calmodulin-dependent protein kinase IV, resulting in CREB (cAMP response element-binding protein) phosphorylation and new gene expression [18].

Applying these frameworks to VRET, reactivating traumatic memories in a controlled, safe environment allows for adaptive modification of fear-related neuronal pathways, contributing to their extinction. Throughout the VR session, the patient wears an HMD, and is exposed to customisable environments akin to those associated with the traumatic event, such as specific daytime duration, atmospheric conditions and ambient sounds [22]. The interface is gradually manipulated to include triggering stimuli such as sounds of explosions and gunfire [22]. This exposure modifies the traumatic memory through the process of habituation and fear extinction, enabling virtual confrontation of trauma and striving to reduce avoidance. This is precisely what VRET seeks to do, using interactive features such as auditory and visual cues, possibly assisting individuals who struggle to accurately visualise their trauma [22].

In a 2022 trial for PTSD **(**D-cycloserine (DCS) vs. placebo, and virtual reality exposure (VRE) vs. prolonged imaginal exposure (PE)), Difede et al. found the lowest dropout rate in the VRE + D-cycloserine arm relative to the other three treatment arms. The authors suggested this is a potential synergistic effect between VRE and pharmaceutic intervention, expressing that it would be beneficial if these fewer dropouts could be attributed to VRE, since treatment completion is presumably correlated with more satisfying outcomes. However, more studies are required to verify that lower dropout rates independently correlate with VRE. The same trial revealed that patients with major depressive disorder (MDD) comorbidity fared better in VRE (effect size (ES)=0.14), while those without MDD improved more in PE (ES=0.44), suggesting that comorbid depression may play an important factor in terms of treatment selection, and could be an important factor when selecting or tailoring interventions [23].

A recent meta-analysis by van Loenen et al. (2022) examined the effectiveness of Virtual Reality Exposure-Based Cognitive Behavioural Therapy (VRE-CBT) for Severe Anxiety Disorders and discovered that the dropout rates for VRE-CBT were statistically comparable to CBT. They also found that VRE-CBT was comparable in efficacy to CBT, suggesting that VRE-CBT could be a promising alternative to CBT for more severe anxiety disorders, particularly when in-vivo exposure is challenging, or when patients prefer VRE-CBT over CBT [24].

VRET could be a preferred treatment option for individuals who would rather not interact directly with a professional on account of the intervention's semi-anonymous nature. This could be particularly relevant in settings where stigma surrounding mental health inhibits help-seeking, although efforts to educate the population and build trust in the treatment are necessary first [11].

Another possible future direction for VRET is the inclusion of neuromodulation techniques, such as transcranial direct current stimulation (tDCS), in order to enhance it. A 2024 randomised controlled trial revealed that pairing the two increased habituation and reduced PTSD symptom severity more than standalone VRET, suggesting that neuroplasticity-enhancing methods may further supplement treatment efficacy, and that VRET could potentially be a flexible platform allowing for enhancement [25].

Multimodal Motion-assisted Memory Desensitisation and Reconsolidation

Multimodal Motion-assisted Memory Desensitisation and Reconsolidation (3MDR) is an innovative treatment modality developed in the Netherlands to address treatment-resistant post-traumatic stress disorder (TR-PTSD) [26]. This intervention combines components of well-known evidence-based psychotherapies, including eye movement desensitisation and reprocessing (EMDR) therapy, and virtual reality exposure therapy (VRET) [27]. During a typical session, the user walks on a treadmill while donning a safety harness and the appropriate VR equipment, accompanied by self-selected, personally relevant images together with personalised music cues, giving the participant the impression that they are walking through a tunnel or corridor [28]. Although the exact mechanism for 3MDR's therapeutic effect remains uncertain, 3MDR likely draws upon memory reconsolidation, much like traditional VRET, but further expands on it by including movement, multisensory cues and guided emotional immersion [29].

The brain-derived neurotrophic factor (BDNF) hypothesis is another theory on which 3MDR could be founded on. Physical activity is known to increase BDNF levels, encouraging neuroplasticity in the amygdala, suggesting that BDNF may play a major role in learning and memory, and therefore contribute to new learning and fear extinction. The additional activity in the form of walking (an inseparable component of 3MDR) also promotes divergent thinking, which may increase associations and therefore provide greater trauma memory accessibility. Moreover, the physical act of approaching a fear-inducing stimulus results in a more positive reassessment of it, diminishing negative associations [30].

During the session, the patient is encouraged by the therapist (who remains by the participant's side as they approach trauma-inducing images), to describe what they can see and the memory associated with it, and to communicate their emotions in the present moment [30]. This active presence of the therapist helps patients feel supported and validated in their experiences, allowing for greater emotional openness, which may foster a sense of empowerment and strength to confront traumatic content.

3DMR may also target neurobiological systems such as the amygdalar-prefrontal feedback loop. Individuals with PTSD display lower connectivity between white matter of the prefrontal cortex (responsible for self-regulation) and the amygdala (which fulfils a role in threat detection, fear conditioning and emotional intensity). 3MDR is thought to result in upregulation of the medial prefrontal cortex specifically, facilitating emotional regulation, reduced intensity and fear extinction [31]. 3MDR appears to have promising outcomes among treatment-resistant military populations. Bisson et al. conducted a randomised controlled trial among British veterans suffering from treatment-resistant (TR)-PTSD, demonstrating a 37% reduction in Clinician-Administered PTSD Scale for DSM5 (CAPS5) scores after six weekly sessions at a 26-week follow-up compared with the baseline mean [32]. Another study by Jones et al. involving 11 Canadian active-duty military members and veterans found not only substantial reductions in self-administered and clinically implemented PTSD scores, but also generalised anxiety disorder and major depressive disorder, which is postulated to correlate with PTSD [33]. These findings are corroborated by Tang et al. (2021), who documented clinically significant reductions in the Difficulties in Emotional Regulation Scale (DERS-18) in military service workers with TR-PTSD after an eight-week period of eight 3MDR sessions, reinstating the reproducibility of 3MDR's therapeutic effect in treatment resistant cases [31].

Discussion

VR-based treatment modalities represent promising tools in the future treatment of war-related psychiatric disorders such as PTSD, anxiety and depressive symptoms, offering immersive, multisensory stimulation within a controlled environment, and allowing individuals to confront trauma-related material [11, 13, 16].

Avoidance, which can be a hindrance to treatment efficacy in conventional trauma-focussed therapies, may be mitigated using VR exposure by providing gradual, controlled and personalised exposure to trauma-related stimuli, potentially reducing emotional disengagement and dropout rates [17, 23].

VR also provides a viable alternative to exposure-based therapies, presenting relaxing, naturalistic environments enhanced by biofeedback. This calming imagery combined with biofeedback-supported physiological control may offer a means of emotional regulation and stress reduction [9, 14]. This could prove especially useful for individuals who are not yet prepared to engage with trauma-related stimuli directly, and may warrant the examination of VR-based therapies as a potential preventative measure for the presentation of psychiatric symptoms in at-risk military personnel.

More complex interventions such as 3MDR – where physical movement, tailored trauma-related stimuli, and therapist-guided emotional processing are the basis of treatment – may enhance emotional engagement and memory reconsolidation [28, 29]. This approach may be especially useful in treatment-resistant populations, who do not present symptom reduction with standardised treatments [27].

However, there are several limitations inhibiting widescale implementation of VR-based therapy at the moment. Research on such therapies is often limited by small sample sizes [12, 31, 33], heterogeneity in study design and the type of VR systems used, as well as self-reported measures [11, 12, 25]. Additionally, many studies investigate predominantly or exclusively men, limiting generalisability [11, 23, 32]. Some of these modalities may not be appropriate for certain individuals. For example, 3MDR may not be the optimal treatment intervention for those who do not have TR-PTSD, as they may find 3MDR overwhelming if they have not tried other exposure-based therapies prior, potentially worsening their condition [28, 30]. The heterogeneity of treatment protocols across studies poses an additional challenge when comparing between studies and establishing clinical use guidelines [16].

Therefore, due to its relative novelty, VR should be implemented into clinical practice cautiously. VR-based interventions could potentially be used as a valuable adjunct to established interventions, or otherwise used as an alternative when other treatment methods fail to achieve symptom reduction. Careful assessment of patient eligibility and risk-benefit consideration is essential prior to its implementation, as treatment response may vary significantly between individuals. A summary on characteristics of selected studies in the treatment of PTSD is shown (Table 1).

Table 1. A summary on characteristics of selected studies in the treatment of PTSD

Study (year)	Country	Population	Study Design	Type of VR treatment	Results	Main limitations
Kukharuk et al. [11] (2025)	Ukraine	69 veterans	Randomised Clinical Trial	360° VR nature video + standard rehabilitation (psychotherapeutic interventions)	Significant reduction in anxiety immediately after each session of an average 25.8% in the Mood and Anxiety Express Assessment Scale (MAEAS). Significant reductions in anxiety (up to 14.5%) and depression (up to 12.3%) assessed in HADS after treatment for 21 days.	All male sample group, lack of long-term follow-up, self-reported measures, placebo effect due to novelty of treatment.
Jensen et al. [12] (2021)	Denmark	1 veteran	Case report	360° VR nature film + setraline	Reduced feelings of anxiety, vigilance, anger and sadness in a PTSD case after 2 months of treatment ($p < 0.05$), based on a self-report questionnaire. The feeling of stress increased, but this was not statistically significant.	Single participant, no control, self-reported measures.
Difede et al. [23] (2022)	USA	192 military personnel	Randomised clinical trial	VRET + DCS	Both VRET and PE reduced PTSD severity on the Clinician Administered PTSD Scale (CAPS-IV) after 9 sessions. VRET was more effective for depressed participants ($p=0.004$, ES=0.14), PE was more effective for nondepressed participants $p<0.001$, ES=0.44).	Majority male sample group, treatment was planned to be completed in 9 weeks but was completed in 16 on average.

Study (year)	Country	Population	Study Design	Type of VR treatment	Results	Main limitations
van 't Wout-Frank et al. [25] (2024)	United States	54 veterans	Randomised clinical trial	VRET + active tDCS	VRET and active tDCS led to significant reductions in PTSD symptom severity (assessed using the PTSD Checklist For DSM-5 (PCL-5) after 6 sessions at the 1-month follow up (p=0.023) compared to VRET + sham tDCS (placebo). PTSD improvement was maintained at the 3-month follow-up (p=0.07) but revealed no statistically significant group differences.	Self-reported PTSD symptom severity, high attrition rate at 1- and 3-month follow-up, patients used concurrent treatments, no separate control for VR.
Tang et al. [31] (2021)	Canada	9 military members and veterans	Mixed-methods study	3MDR	Mean DERS-18 score was reduced at 1 week (p=0.021), 1 month (p=0.028), and 3 months (p=0.027) post-treatment compared to baseline preintervention.	Small sample, lack of control group.
Bisson et al. [32] (2020)	United Kingdom	42 veterans	Randomised Clinical Trial	3MDR	Clinically significant PTSD symptom reduction of 37% on the CAPS5 from presentation to 26-week follow-up. 3MDR likely has a moderate treatment effect (ES=0.65).	All male sample group.
Jones et al. [33] (2022)	Canada	11 military members and veterans	Mixed-methods study	3MDR	Multiple improved scores, including PCL-5 and DERS-18 Scores, which were maintained at the 6-month follow-up (DERS-18 Score was only studied until the 3-month follow-up (p=0.00003)).	Small sample, missing control data

VR – Virtual Reality; VRET – Virtual Reality Exposure Therapy; 3MDR – Motion-Assisted, Multi-Modular Memory Desensitization and Reconsolidation; PE – Prolonged Exposure; tDCS – transcranial Direct Current Stimulation; DCS – D-cycloserine; HADS – Hospital Anxiety and Depression Scale; DERS-18 – Difficulties in Emotional Regulation Scale; PTSD – Post-Traumatic Stress Disorder; ES – Effect Size

Conclusions

VR-based therapy appears to be a promising treatment modality for war-related psychiatric disorders, especially as an adjunct to conventional treatment interventions, offering a new and versatile approach. However, considering that VR-based therapy is still a relatively new modality compared to other more standardised treatments such as CBT, there is still a paucity of information, and more studies are required to assess its efficacy and safety. Rigorous randomised controlled trials are essential to comprehensively evaluate effectiveness, patient suitability and individualised therapeutic approach, and to establish standardised clinical use protocols. Future research should focus on diversifying participant samples and assessing long-term clinical effects of VR-based therapy. The decision to treat disorders using VR should be made on an individual basis, acknowledging patient needs and practicality.

REFERENCES

1. Williamson, V., Murphy, D., Stevelink, S. A. M., et al. (2021). The impact of moral injury on the wellbeing of UK military veterans. *BMC Psychology, 9*(1), Article 73. https://doi.org/10.1186/s40359-021-00578-7
2. American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed., pp. 271–272). American Psychiatric Association.
3. Bryant, R. A., Schnurr, P. P., Pedlar, D., & 5-Eyes Mental Health Research and Innovation Collaboration in Military and Veteran Mental Health. (2022). Addressing the mental health needs of civilian combatants in Ukraine. *The Lancet Psychiatry, 9*(5), 346–347. https://doi.org/10.1016/S2215-0366(22)00097-9
4. U.S. Department of Defense. (2024). *Calendar year 2023 annual report on suicide in the military: Including the Department of Defense Suicide Event Report (DoDSER).* DoD Office of the Under Secretary of Personnel and Readiness. https://www.dspo.mil/Portals/113/2024/documents/annual_report/ARSM_CY23_final_508c.pdf
5. Milligan, T., Smolenski, D., Lara-Ruiz, J., et al. (2025). Loss of PTSD diagnosis in response to evidence-based treatments: A systematic review and meta-analysis. *JAMA Psychiatry, 82*(7), 718–727. https://doi.org/10.1001/jamapsychiatry.2025.0695
6. Heo, S., & Park, J. H. (2022). Effects of virtual reality-based graded exposure therapy on PTSD symptoms: A systematic review and meta-analysis. *International Journal of Environmental Research and Public Health, 19*(23), Article 15911. https://doi.org/10.3390/ijerph192315911
7. Seiz, A., Kweon, B. S., Ellis, C. D., et al. (2023). Exploring the psychophysiological effects of viewing urban nature through virtual reality using electroencephalography and perceived restorativeness scale measures. *Sustainability, 15*(17), Article 13090. https://doi.org/10.3390/su151713090
8. Anderson, A. P., Mayer, M. D., Fellows, A. M., et al. (2017). Relaxation with immersive natural scenes presented using virtual reality. *Aerospace Medicine and Human Performance, 88*(6), 520–526. https://doi.org/10.3357/AMHP.4747.2017
9. Blum, J., Rockstroh, C., & Göritz, A. S. (2019). Heart rate variability biofeedback based on slow-paced breathing with immersive virtual reality nature scenery. *Frontiers in Psychology, 10*, Article 2172. https://doi.org/10.3389/fpsyg.2019.02172
10. Grassini, S., Segurini, G. V., & Koivisto, M. (2022). Watching nature videos promotes physiological restoration: Evidence from the modulation of alpha waves in electroencephalography. *Frontiers in Psychology, 13*, Article 871143. https://doi.org/10.3389/fpsyg.2022.871143
11. Kukharuk, O., Tkalich, K., Kamash, N., et al. (2025). Effectiveness of immersive VR therapy in reducing stress-associated symptoms in Ukraine. *European Journal of Psychotraumatology, 16*(1), Article 2488097. https://doi.org/10.1080/20008066.2025.2488097
12. Jensen, B. S., Andersen, N., Petersen, J., et al. (2021). Enhanced mental health with virtual reality mental hygiene by a veteran suffering from PTSD. *Case Reports in Psychiatry, 2021*, Article 5576233. https://doi.org/10.1155/2021/5576233
13. Riva, G., Bernardelli, L., Castelnuovo, G., et al. (2021). A virtual reality-based self-help intervention for dealing with the psychological distress associated with the COVID-19 lockdown: An effectiveness study with a two-week follow-up. *International Journal of Environmental Research and Public Health, 18*(15), Article 8188. https://doi.org/10.3390/ijerph18158188
14. Weibel, R. P., Kerr, J. I., Naegelin, M., et al. (2023). Virtual reality-supported biofeedback for stress management: Beneficial effects on heart rate variability and user experience. *Computers in Human Behavior, 143*, Article 107584. https://doi.org/10.1016/j.chb.2023.107584
15. Kenemore, J., Benham, G., Charak, R., et al. (2024). Heart rate variability biofeedback as a treatment for military PTSD: A meta-analysis. *Military Medicine, 189*(9–10), e1903–e1909. https://doi.org/10.1093/milmed/usae003
16. Eshuis, L. V., van Gelderen, M. J., van Zuiden, M., et al. (2021). Efficacy of immersive PTSD treatments: A systematic review of virtual and augmented reality exposure therapy and a meta-analysis of virtual reality exposure therapy. *Journal of Psychiatric Research, 143*, 516–527. https://doi.org/10.1016/j.jpsychires.2020.11.030
17. Vianez, A., Marques, A., & Simões de Almeida, R. (2022). Virtual reality exposure therapy for armed forces veterans with post-traumatic stress disorder: A systematic review and focus group. *International Journal of Environmental Research and Public Health, 19*(1), Article 464. https://doi.org/10.3390/ijerph19010464
18. Kida, S. (2019). Reconsolidation/destabilization, extinction and forgetting of fear memory as therapeutic targets for PTSD. *Psychopharmacology, 236*(1), 49–57. https://doi.org/10.1007/s00213-018-5086-2
19. Foa, E. B., & Kozak, M. J. (1986). Emotional processing of fear: Exposure to corrective information. *Psychological Bulletin, 99*(1), 20–35.
20. Kindt, M. (2018). The surprising subtleties of changing fear memory: A challenge for translational science. *Philosophical Transactions of the Royal Society B: Biological Sciences, 373*(1742), Article 20170033. https://doi.org/10.1098/rstb.2017.0033

21. Reger, G. M., Smolenski, D., Norr, A., et al. (2019). Does virtual reality increase emotional engagement during exposure for PTSD? Subjective distress during prolonged and virtual reality exposure therapy. *Journal of Anxiety Disorders, 61*, 75–81. https://doi.org/10.1016/j.janxdis.2018.06.001
22. Knaust, T., Felnhofer, A., Kothgassner, O. D., et al. (2020). Virtual trauma interventions for the treatment of post-traumatic stress disorders: A scoping review. *Frontiers in Psychology, 11*, Article 562506. https://doi.org/10.3389/fpsyg.2020.562506
23. Difede, J., Rothbaum, B. O., Rizzo, A. A., et al. (2022). Enhancing exposure therapy for posttraumatic stress disorder (PTSD): A randomized clinical trial of virtual reality and imaginal exposure with a cognitive enhancer. *Translational Psychiatry, 12*(1), Article 299. https://doi.org/10.1038/s41398-022-02066-x
24. van Loenen, I., Scholten, W., Muntingh, A., et al. (2022). The effectiveness of virtual reality exposure-based cognitive behavioral therapy for severe anxiety disorders, obsessive-compulsive disorder, and posttraumatic stress disorder: Meta-analysis. *Journal of Medical Internet Research, 24*(2), Article e26736. https://doi.org/10.2196/26736
25. van 't Wout-Frank, M., Arulpragasam, A. R., Faucher, C., et al. (2024). Virtual reality and transcranial direct current stimulation for posttraumatic stress disorder: A randomized clinical trial. *JAMA Psychiatry, 81*(5), 437–446. https://doi.org/10.1001/jamapsychiatry.2023.5661
26. Jones, C., Smith-MacDonald, L., Brown, M. R. G., et al. (2022). The redesign and validation of multimodal motion-assisted memory desensitization and reconsolidation hardware and software: Mixed methods, modified Delphi-based validation study. *JMIR Human Factors, 9*(3), Article e33682. https://doi.org/10.2196/33682
27. van Gelderen, M. J., Nijdam, M. J., Dubbink, G. E., et al. (2020). Perceived treatment processes and effects of interactive motion-assisted exposure therapy for veterans with treatment-resistant posttraumatic stress disorder: A mixed methods study. *European Journal of Psychotraumatology, 11*(1), Article 1829400. https://doi.org/10.1080/20008198.2020.1829400
28. Hamilton, T., Burback, L., Smith-MacDonald, L., et al. (2021). Moving toward and through trauma: Participant experiences of multi-modal motion-assisted memory desensitization and reconsolidation (3MDR). *Frontiers in Psychiatry, 12*, Article 779829. https://doi.org/10.3389/fpsyt.2021.779829
29. Nijdam, M. J., & Vermetten, E. (2018). Moving forward in treatment of posttraumatic stress disorder: Innovations to exposure-based therapy. *European Journal of Psychotraumatology, 9*(1), Article 1458568. https://doi.org/10.1080/20008198.2018.1458568
30. Gausemel, Å., & Filkuková, P. (2024). Virtual realities, real recoveries: Exploring the efficacy of 3MDR therapy for treatment-resistant PTSD. *Frontiers in Psychology, 15*, Article 1291961. https://doi.org/10.3389/fpsyg.2024.1291961
31. Tang, E., Jones, C., Smith-MacDonald, L., et al. (2021). Decreased emotional dysregulation following multi-modal motion-assisted memory desensitization and reconsolidation therapy (3MDR): Identifying possible driving factors in remediation of treatment-resistant PTSD. *International Journal of Environmental Research and Public Health, 18*(22), Article 12243. https://doi.org/10.3390/ijerph182212243
32. Bisson, J. I., van Deursen, R., Hannigan, B., et al. (2020). Randomized controlled trial of multi-modular motion-assisted memory desensitization and reconsolidation (3MDR) for male military veterans with treatment-resistant post-traumatic stress disorder. *Acta Psychiatrica Scandinavica, 142*(2), 141–151. https://doi.org/10.1111/acps.13200
33. Jones, C., Smith-MacDonald, L., Brown, M. R. G., et al. (2022). Quantitative changes in mental health measures with 3MDR treatment for Canadian military members and veterans. *Brain and Behavior, 12*(8), Article e2694. https://doi.org/10.1002/brb3.2694