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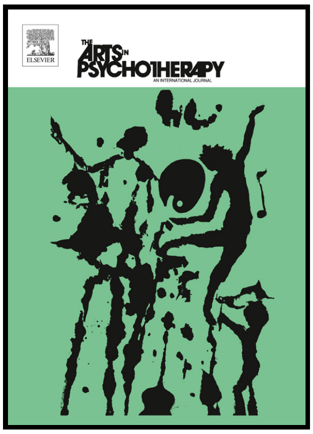

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Increased Functional Connectivity in Military Service Members Presenting a Psychological Closure and Healing Theme in Art Therapy Masks

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Abstract

Military service members (SMs) have an increased risk of developing posttraumatic stress symptoms. Art therapy is a promising intervention that allows SMs with posttraumatic stress to explore their trauma through art-making and reflection in a psychotherapeutic relationship. Thematic analysis of art products may lend itself as a description of visual indicators of an internal state of the brain. We hypothesized that specific neurobiological markers are associated with the theme of psychological closure and/or healing of traumatic memories as represented in the masks created during art therapy. Resting state fMRIs of a convenience sample of 104 SMs who received art therapy as part of the interdisciplinary Intensive Outpatient Program (IOP) at the National Intrepid Center of Excellence were examined. SMs depicting psychological closure and/or healing within their art therapy masks demonstrated greater resting state functional connectivity between regions associated with attention, memory, language, and pain processing. These findings are preliminary in nature therefore causal relationships cannot be assumed between art therapy and neuroimaging metrics, as both art therapy and neuroimaging measures were collected as part of a larger integrative IOP. Future work collecting neuroimaging metrics pre and post an art therapy intervention is warranted to further evaluate these associations.

Keywords: Posttraumatic Stress, Art Therapy, Psychological Closure, military

Although estimates of the prevalence of posttraumatic stress disorder (PTSD) vary across studies, evidence suggests a prevalence of 2% to 17% among U.S. combat-veterans and military personnel (Schein et al., 2021; Spottswood, Davydow, & Huang, 2017; Richardson, Frueh, & Acierno, 2010). Among active duty service members (SMs), posttraumatic stress symptoms (PTSS) can develop from stressors related to combat deployments, and/or non-combat-related traumatic events, such as vehicle accidents or sexual assault (Ramchand et al., 2010; Kilpatrick et al., 2013; Judkins et al., 2020). Characteristic symptoms of PTSD include intrusive memories, flashbacks, avoidance of situations that could bring up memories of the traumatic event, as well as hyperarousal, hypervigilance to threat, low self-esteem, self-critical thinking, and extreme negative beliefs about self and others (World Health Organization, 2015). In addition, SMs with PTSD may also show impairments in cognitive processes such as executive function, attention, learning, memory, and language (Qureshi et al., 2011; Scott et al., 2015, Johnsen & Asbjornsen, 2008, Samuelson, 2011).

Art therapy is “an integrative mental health and human services profession that enriches the lives of individuals, families, and communities through active art-making, creative process, applied psychological theory, and human experience within a psychotherapeutic relationship” (American Art Therapy Association, 2017). Art therapy enables individuals to develop a “visual voice”, using imagery, symbolism, and metaphor to externalize emotions and experiences that they may not be able to express in words (Walker et al., 2017). Anecdotally, in SMs and veterans with combat-related PTSD, art therapy appears to help reduce recurring nightmares, increase positive emotion, improve emotional self-efficacy, and increase self-esteem (Hines-Martin et al., 1993; Spiegel et al., 2006; Walker et al., 2017; Lobban & Murphy, 2019).

Mask making is a widely used art therapy tool that is used with the goal of improving self-identity, communication, and social skills in a range of populations. Specifically in military populations suffering from traumatic brain injury (TBI) and PTSS, there is anecdotal evidence that mask making allows SMs to visually express the impact of traumatic experiences, such as intrusive thoughts and flashbacks, in order to integrate past memories of the trauma and improve communication related to traumatic experiences (Walker et al., 2017; Sargent et al., 2013). Previous research identified common themes that consistently emerged across masks created during art therapy and developed a theoretical framework by grouping common themes into different representations of self (self as individual, self in relationships, self in community, self in society, self over time, and conflicted or split sense of self; Walker et al., 2017). Further research noted associations between mask themes and self-reported symptoms such as post-traumatic stress, anxiety, and depression (Kaimal et al., 2018). For instance, SMs who represented psychological injury within their mask reported increased PTSS compared to those who did not represent psychological injury; however, SMs that represented identification with military unit within their mask reported reduced PTSS and depression compared to those who did not (Kaimal et al., 2018).

Based on clinical experience, one theme of particular interest to the art therapists on our team is the representation of psychological closure and/or healing in the masks created during art therapy. Using Hamber and Wilson's (2002) definition, psychological closure is "a situation where the trauma is no longer seen as unfinished business requiring, for instance, a compulsion to take revenge. Grief and loss no longer plague the individual consciously or unconsciously, and the victim lives not in a state somewhere between denial and obsession, where the loss is to a large degree accepted and incorporated into the functioning of everyday life" (Hamber & Wilson 2002). This closure can be represented within the masks as a transition from trauma-based imagery to peaceful, hopeful elements such as nature scenes, family, or some representation of a "repair". Verbally, this theme can manifest as SMs sharing their trauma narrative with less distress and referring to it as something that is "in the past," or "put to rest" rather than ongoing. Furthermore, SMs may also describe a sense of catharsis from externalizing and communicating their traumatic experience and pain through the physical art product.

While SMs that achieve psychological closure through the mask making directive add to the abundance of anecdotal evidence of the benefits of art therapy, the neural mechanisms that underpin responsivity to art therapy are unknown and represent a potential biomarker that could be leveraged to optimize therapeutic efficacy. Neuroimaging research has focused on brain circuitry associated with PTSD (Hughes & Shin, 2011; DiGangi et al., 2016; Russman Block et al., 2017; Tu, 2021). A common modality used to probe functional communication between brain circuits is resting state functional MRI (fMRI). Resting State functional connectivity (rs-FC) can be measured from resting state fMRI that represent the degree of synchronous activity across various brain regions and/or brain networks during resting conditions (Damoiseaux et al., 2006). PTSD is associated with disruptions in rs-FC within and between multiple networks including the Default Mode Network (DMN) and Dorsal Attention Network (DAN). The DMN has been associated with thoughts of self, attention to self, autobiographical memory, and discretizing emotional experiences (Satpute & Lindquist, 2019; Miller et al., 2017; Greicius et al., 2003; DiGangi et al., 2016). The Dorsal Attention Network (DAN) has been associated with the orientation of attention (Corbetta & Shulman, 2002). For example, increased rs-FC occurs between the DMN and DAN in combat exposed veterans with PTSD compared to combat exposed veterans without PTSD; and the authors hypothesize that increased between-network rs-FC could be the cause of the hypervigilance to external stimuli often witnessed in PTSD (Sheynin et al., 2020). Other brain regions shown to be dysregulated in PTSD include the amygdala and hippocampus. The hippocampus is involved in memory processing including episodic memory (Hayes et al., 2011), and previous work has shown lower activity during memory encoding of trauma related stimuli (Hayes et al., 2011) and reduced rs-FC between the hippocampus and the posterior cingulate cortex (Miller et al., 2017) in combat veterans with

PTSD. The amygdala is critical in processing and regulating emotions (Forster et al., 2017; Hayes et al., 2011). In veterans with PTSD, higher activity in the amygdala correlates negatively with activity in the medial prefrontal cortex during fear response tasks (Shin et al., 2005). Similarly, SMs with PTSD have higher rs-FC between the amygdala and medial prefrontal cortex during fear response tasks (Bryant et al., 2008). Additionally, veterans with PTSD show higher positive rs-FC between the amygdala and the insula, a brain region associated with emotional processing and interoception (Sripada et al., 2012). This reduced rs-FC between the amygdala and hippocampus further supports the involvement of the amygdala and hippocampus in the development and maintenance of PTSS (Sripada et al., 2012).

The aim of this analysis was to investigate associations between resting state brain networks and identifiable themes represented in masks created during the art therapy process. Specifically, this analysis probes differences in rs-FC between SMs representing closure and/or healing within their masks created during art therapy compared to SMs who did not. We hypothesized that specific neurobiological markers are associated with psychological closure and/or healing of traumatic memories. Based on review of PTSD literature, we predicted that SMs who represented closure and/or healing within their masks would have altered communication within and between networks associated with memory processing, emotion regulation, and selective attention of environmental stimuli, and therefore focused our analysis on the DAN, DMN, hippocampus, and amygdala. Unlike previous studies, which typically compare SMs with or without PTSD, this study examines the relative response to art therapy within SMs with varying levels of PTSS.

Methods

Participants

This study includes retrospective data from 113 SMs who attended the National Intrepid Center of Excellence's (NICoE) four-week Intensive Outpatient Program (IOP). See DeGraba et al (2021) for complete description of the NICoE IOP. All SMs in this dataset participated in group and individual art therapy sessions, self-report assessments, a traumatic brain injury history assessment, and an advanced magnetic resonance imaging (MRI) scan.

Self-report Assessments

SMs completed the following self-report assessments during admission to and discharge from the NICoE IOP. In addition to collecting scores at admission and discharge, a change score was also calculated by subtracting the admission scores from discharge scores for each self-report assessment.

Neurobehavioral Symptom Inventory (NSI): The NSI is a measure of post-concussive symptoms tracked after traumatic brain injury (Cicerone & Karlmar, 1995). Higher scores indicate greater severity of postconcussive symptoms.

PTSD Checklist: Military Version (PCL-M): The PCL-M is a measure of PTSS based on the DSM IV diagnostic criteria (Weathers, Huska, & Keane, 1991). Higher scores indicate greater severity of PTSS.

Generalized Anxiety Disorder (GAD-7): The GAD-7 is a self-reported measure that screens for generalized anxiety symptoms (Spitzer et al., 2006). Higher scores indicate greater severity of anxiety symptoms.

Patient Health Questionnaire-9 (PHQ-9): The PHQ-9 is a self-reported measure of depression severity (Kroenke et al., 2001). Higher scores indicate greater severity of depressive symptoms.

Art Therapy

The goals of the art therapy program at NICoE are to help SM's achieve awareness of self and others, reduce stress, manage anxiety, and regulate their emotions. During the first week of care, SMs are part of a group art therapy session where an art therapist offers SMs a range of art supplies including paint, print materials, and clay for use to create personal symbols and metaphors within a premade paper mâché mask template to represent any aspects of their experiences and/or identities. Although the majority of SMs complete their masks within the two-hour session, others continue to work on their masks during individual art therapy sessions throughout their 4-week IOP. During each session, SMs are encouraged to describe their masks, what creating the mask meant to them, and to process and explain the meaning of any of the components of the mask with the art therapist.

Thematic Analysis

Three independent coders participated in the thematic analysis of the masks. All masks were coded for 23 individual themes based on themes identified in Walker et al 2017 as well as additional themes selected from clinical experience of the art therapists involved in the study. For each mask, themes were coded by two of the independent reviewers based on review of the mask image as well as clinical notes describing the art therapy sessions and the SM's description of the mask (Walker et al., 2017). Each mask was coded for the presence or absence of each theme. Any discrepancies were resolved through consensus meeting with all three coders. Although all masks were coded for 23 themes (data not shown), the following analysis includes only the results for the theme of psychological closure and/or healing.

MRI data acquisition

During the 2nd week of the IOP, anatomical and resting state images were obtained using a 3T whole-body MRI scanner (Discovery MR750; General Electric Medical Systems, Milwaukee, WI) equipped with a 32-channel phased-array head coil (Nova Medical, Wilmington, MA). A high-resolution 3D T1-weighted structural scan was acquired with the following parameters: sagittal plane, three-dimensional BRAVO sequence, 9.576ms repetition time (TR), 4.124ms echo time (TE), 450ms inversion time, 1.2mm slice thickness, 256mm field of view (FOV), 12°flip angle, 0.47x0.47x0.60mm voxel size, duration 5 minutes. In addition, an 11-minute eyes closed resting state scan consisting of a two-dimensional echo planar pulse sequence consisting of 2000ms TR, 25ms TE, 40 sections with 4mm slice thickness, 240x240 FOV, 60°flip angle, 3.75×3.75×4.00mm voxel size.

fMRI Analysis

All neuroimaging data were de-identified prior to analysis. Preprocessing was conducted using SPM12 (Penny et al., 2011). Standard preprocessing included: slice timing correction, motion correction, co-registration of the structural image to the mean functional image, segmentation of the structural image into grey matter, white matter, and cerebrospinal fluid (CSF), normalization of the structural image, and realignment of functional images to the standard Montreal Neurological Institute (MNI) brain template, and spatial smoothing with a 6-mm Gaussian kernel.

Preprocessed functional data was analyzed using the CONN Functional Connectivity Toolbox (version v.17.f; Whitfield-Gabrieli & Nieto-Castanon, 2012). The BOLD signal was linearly de-trended to remove linear drifts, band pass filtered at a frequency window of 0.008–0.09 Hz to remove high frequency noise from the data. To remove the variance related to non-neuronal contributions and motion within the model we included the following as regressors: six motion parameters, the impact of rest, the first five principal components of mean white matter, and the first five principal components of mean CSF blood-oxygen-level-dependent (BOLD) signal. BOLD signal despiking was applied after regression of covariates to remove the influence of potential outlier scans from the data.

Regions of interest (ROI) for selected networks (DMN, DAN, amygdala, and the hippocampus) were selected from the CONN toolbox are shown in Figure 1. The mean BOLD signal time course of each ROI was extracted and correlated with the time course for other ROIs (ROI to ROI analysis) using bivariate correlation.

The averaged time course of all ROIs within each network was calculated to represent the average network activity and was subsequently correlated with the time series from all other voxels across the whole brain using bivariate correlations. Group level analysis of the functional connectivity maps were generated using a whole-brain general linear model, random effects approach, to compare cluster level connectivity differences between the presence and the absence of the closure and/or healing theme. All correlations were converted to normalized z-scores using the Fisher transformation for group comparisons. A cluster-forming threshold was set to an uncorrected voxel threshold of $p < 0.001$, and an FDR corrected cluster threshold of $p < 0.05$ (Eklund et al., 2016). Pairwise correlations between mean BOLD time series for ROIs were extracted individually for each group (Closure group and Closure Absent group).

Statistics

Group differences in demographics were assessed using independent samples *t-tests* or *chi-square tests* as appropriate using IBM SPSS statistics version 24. In addition, self-report measures at admission, at discharge, and change score (calculated as the difference in scores between admission and discharge) were assessed using independent samples *t-tests* to compare Closure vs Closure absent group differences.

Results

Demographics

Data from nine SMs were excluded due to missing or incomplete fMRI data, resulting in a final dataset of n=104. Demographics are shown in Table 1. The psychological closure and/or healing theme was present in the masks of 36 SMs (Closure group) and absent in the masks of 68 SMs (Closure Absent group). Out of all the demographic measures, the only statistically significant differences between groups was ethnicity ($X^2(2) = .247, p= 0.042$), and Special Operations Status ($X^2\ (2) = 7.755, p = 0.005$).

Self-reported Symptoms

No group differences in total scores on the NSI, PCL-M, GAD-7, or PHQ-9 were noted between the Closure and Closure Absent groups at admission or discharge ($p > 0.05$) (Table 2). In addition, no group differences were found in change scores on the NSI, PCL-M, GAD-7, or PHQ-9. PCL-M scores were missing for a small number of SMs resulting in smaller group sizes for this measure.

ROI to ROI rs-FC

Figure 2 displays the pairwise rs-FC between the 12 ROI pairs in 12 by 12 rs-FC matrices for the Closure Absent (Figure 2A) and Closure (Figure 2B) groups. No differences were noted between groups in any pairwise rs-FC comparisons (all *p-values* > *0.05*).

Whole Brain rs-FC

Hippocampus: Whole brain rs-FC results demonstrate significantly greater rs-FC between the hippocampus and the left inferior frontal gyrus, right insular cortex, left postcentral gyrus, and right orbitofrontal cortex in the Closure group compared to the Closure Absent group after $p < 0.05$ FDR correction (Figure 3A; Table 3).

DAN: Whole brain rs-FC results demonstrate significantly increased rs-FC between the DAN and regions in the right thalamus and left hippocampus in the Closure group compared to the Closure Absent group after $p < 0.05$ FDR correction (Figure 3B; Table 3).

DMN: No group differences were noted in whole brain rs-FC analysis with the DMN.

Amygdala: No group differences were noted in whole brain rs-FC analysis with the amygdala.

Discussion

In this study, we investigated associations between resting state brain networks and the closure and/or healing theme represented in masks created during the art therapy process. Our ROI to whole brain findings suggest that SMs who depicted the theme of closure and/or healing within their art therapy masks presented alterations in resting brain states compared to those who did not depict these themes within their masks. Our prediction that communication between networks and brain regions associated with memory processing, emotional processing, and selective attention of environmental stimuli would be altered in the closure group was supported (Figure 3). More specifically, SMs in the closure group demonstrated increased rs-FC between regions associated with attention (DAN), memory (hippocampus), and processing of painful stimuli (insula, thalamus, postcentral gyrus). Many of these regions overlap with brain regions frequently associated with the experience of physical pain including the anterior cingulate cortex, the insula, the thalamus, and less frequently observed regions including the somatosensory and prefrontal regions of the brain (Wager et al., 2013; Cauda et al., 2014).

Psychological pain is the subjective experience of pain associated with either an internal response to situational, environmental, or social psychological stimuli (such as the death of a loved one) or the psychological pain associated with behavioral health conditions such as PTSD and depression (Mee et al., 2006). For example, psychological pain is often described with metaphors or symbols of physical pain such as “I am hurt” or “I have a broken heart” (Conejero et al., 2018). Several studies have reported that ending the unbearable psychological “pain” is the most common reason that people think about and attempt suicide (Conejero et al., 2018; Ducasse et al., 2018). This observation is especially relevant to military populations because combat exposed veterans that develop both PTSD and depression have a higher risk of committing suicide (Rozanov & Carli, 2012; Flory & Yehuda, 2015). The associations between TBI, pain, and PSTD is an active area of investigation across the field. Previous imaging studies testing different psychological pain states such as sadness, grief, social exclusion, and pain empathy reported an increase neural activity in the insula, anterior cingulate cortex, thalamus, amygdala, and dorsolateral prefrontal cortex which overlap with the neural activity reported during the experience of physical pain (Mee et al., 2006; Eisenberger, 2012). Alternatively, the overlap in brain activity between psychological pain and physical pain may be attributed to attentional processing because pain (whether physical or psychological) is interpreted as a salient stimulus and elicits attentional focus resulting in the activity in these regions (Mee et al., 2006; Ferris et al., 2019; Iannetti and Mouraux, 2011). Therefore, we could postulate that the increased rs-FC between memory and attention networks with pain processing regions may represent a willingness to attend to painful traumatic memories or may represent reduced avoidance of emotionally traumatic or morally injurious memories. Furthermore, this finding may suggest that these SMs who represent the theme of psychological closure and/or healing within their masks are more willing to work through these events through art therapy because they are less behaviorally avoidant. In addition, the consistent physical training and combat deployments experienced the SMs within this population often leads to a high prevalence of chronic pain; however, the potential impact of physical pain on these results cannot be accounted for within this retrospective dataset that did not contain structured pain assessment. However, our interpretation of the psychological conditions of closure as represented in the masks are based on reverse inferences of the patterns of neural activity and additional research investigating the impact of physical versus psychological pain on functional brain networks is needed to objectively assess the above interpretation.

An additional intriguing finding within the context of art therapy is the increased rs-FC between the hippocampus and the left inferior frontal gyrus (IFG) in SMs who portrayed closure within their masks. The left IFG region, Broca's area, is an important part of the left lateralized language network responsible for speech production. Theory suggests that the imagery, symbolism, and metaphor used in art therapy enables individuals to develop a "visual voice" to externalize emotions and experiences that they may not be able to verbally express (Jones et al., 2018; Stone, 2015). This process is especially relevant to SMs with PTSS because they often remember their trauma as an incoherent, fragmented memory that is dominated by sensory experiences (van der Kolk and Fisler, 1995). These memory fragments are thought to result from a disruption in memory encoding resulting in response to the strong emotion associated with the trauma in addition to the potential dissociation that occurs both during and in the time following the trauma (Bedard-Gilligan and Zoellner, 2012). Within psychology-minded professions, this theory suggests that traumatic memories are stored within the right hemisphere as non-verbal, sensory memories, and has been further described as "speechless terror" (van der Kolk, 2000; Harris, 2009; Moss, 2020). Additionally, Broca's area is typically inhibited during the creation of the traumatic memory and during attempted recall of traumatic events, resulting in an inability to develop a verbal narrative of the event crucial for therapeutic recovery (Walker et al., 2016). Therefore, we hypothesize that developing a verbal narrative of the traumatic event may be represented by increased hippocampal to Broca's area rs-FC. To further test this prediction, future work investigating rs-FC between autobiographical memory and language networks during both rest and recollection of trauma narratives is needed.

Based on prior work from our group showing associations between art mask themes and self-reported measures of anxiety, PTSS, and depression (Walker et al., 2016 & 2017; Kaimal et. al., 2018), we expected to note differences in self-reported symptoms in those depicting the psychological closure and/or healing theme compared to those who did not. However, our results failed to detect group differences in self-reported symptoms at admission, discharge, or the change in symptoms over the course of the four weeks. This lack of difference may be due to the retrospective nature of our convenience sample; given that art therapy was conducted as one component of a larger integrative IOP and therefore symptom changes experienced by SMs were likely influenced by many aspects of the IOP and not directly linked to the art therapy. In addition, our results may be limited by a small sample. Future work investigating the direct impact of art therapy itself and associations of thematic representations within art therapy products and symptom presentation is needed to more accurately investigate the causal impact. An additional limit of this dataset that makes the interpretation of these results challenging is that SMs participated in several art therapy sessions (both group, individual, and open studio time) over the entire four weeks of the IOP while the neuroimaging scan was obtained at a single time point (in the second week of the program). Therefore, we do not know if patients had experienced different degrees of psychological closure or resolution at the time of the neuroimaging scan. However, there were no differences in self-reported scores at admission between the two groups. This observation may be interpreted as preliminary evidence that regardless of symptom presentation at the start of a program, SMs have the potential to experience some aspect of closure or healing throughout the art therapy process and the IOP at large.

An additional limitation of this analysis is that the thematic coding relies entirely on art therapy mask images and the content of the medical record note collected by the art therapist. Therefore, a SM may have experienced a sense of healing or closure during either the art therapy process or as part of another aspect of the NICoE IOP that would not have been noted in this thematic analysis which focused entirely on the art therapy product and the art therapist's interpretation of the SM's experience. In addition, the majority of SMs in this analysis were members of special operations communities (*77%*) who represent a unique subgroup of the larger active duty population. Finally, as is often the case in military samples, our dataset consists of mostly men. Future prospective data collection investigating the efficacy and thematic analysis of art therapy within military populations would benefit from including greater percentages of female SMs as well as SMs who are not members of the special operations communities to determine the generalizability of the findings.

Conclusions

In conclusion, in a convenience sample of SMs receiving art therapy as part of the NICoE IOP, SMs who depicted the theme of psychological closure and/or healing within their art therapy masks demonstrated alterations in resting state rs-FC across regions associated with attention, memory, pain processing, and language. These preliminary findings provide support for additional work using neuroimaging techniques to investigate the neurobiological mechanisms of art therapy. Our group is currently pursuing prospective collection of neuroimaging data before and after an art therapy intervention to further investigate the associations between measures of functional brain states and changes in behavioral health symptoms in active duty SMs and veterans.

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Author Contributions

Janell Payano Sosa: Conceptualization, Software, Validation, Formal Analysis, Data Curation, Writing- Original Draft, Writing- Reviewing and Editing, Visualization. Rujirutana Srikanchana: Methodology, Software, Validation, Investigation, Data Curation, Writing- Reviewing and Editing. Melissa Walker: Conceptualization, Writing- Reviewing and Editing. Adrienne Stamper: Writing- Reviewing and Editing. Juliet King: Writing- Reviewing and Editing. John Ollinger: Methodology, Investigation, Validation, Writing- Reviewing and Editing, Project Administration. Grant Bonavia: Investigation, Resources, Project Administration. Clifford Workman: Writing- Reviewing and Editing. Kohinoor Darda: Writing- Reviewing and Editing. Anjan Chatterjee: Writing- Reviewing and Editing. Chandler Sours Rhodes: Conceptualization, Methodology, Writing- Reviewing and Editing, Supervision, Project Administration, Funding Acquisition.

Declaration of Interest

None.

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Table 1 *SMs Demographics*

Characteristic	Total	Closure	Closure Absent	*p-value*	t or X^2

		group	group		
Participant total (n)	104	36	68		
Mean age (SD)	40 (5.7)	40 (6.8)	41 (5.1)	*.523*	*.642*
Gender (n)					
Male	103	36	67	*.465*	*.535*
Female	1	0	1		
Average TBI count (SD)	1.7 (1.6)	1.8 (1.6)	1.3 (1.3)	*.527*	*.634*
Mean years of education (SD)	15 (1.9)	15.2 (1.9)	15.9 (1.8)	*.859*	*-.179*
Race (n)					
White	86	28	58		
Black or African American	1	1	0		
Asian or Pacific Islander	1	0	1	*.390*	*.246*
American Indian	1	0	1		
Multi-racial	2	1	1		
No answer	11	6	5		
Ethnicity (n)					
Hispanic	3	3	0	*.042*	*.247*
Non-Hispanic	29	11	18		
Service Branch (n)					
Army	27	8	19		
Navy	66	23	43	*.819*	*.927*
Marines	4	2	2		
Air Force	7	3	4		
Special Operations Status (%)	77	61	85	*.005*	*7.755*

Note. Demographics for the entire sample (n= 104), the Closure group (n= 36), and Closure Absent group (n = 68) along with between group comparisons of closure compared to Closure Absent group. ^{SD}standard deviation, ^{t}t-test statistic value, $^{x^2}$Pearson's chi-square value.

Table 2 *Clinical self-report scores*

	Closure N	Closure Mean (SD)	Closure Absent N	Closure Absent Mean (SD)	*t*	*p-value*
Admission						
NSI	36	37.72 (16.1)	68	36.38 (14.0)	-.441	.660
PCL-M	32	44.25 (14.4)	58	45.29 (13.5)	.343	.733

GAD-7	36	12.19 (5.6)	68	11.32 (5.2)	-.795	.429
PHQ-9	36	10.89 (5.9)	68	10.26 (4.8)	-.580	.563
Discharge						
NSI	31	20.77 (13.9)	62	22.27 (12.6)	.523	.602
PCL-M	24	34.75 (14.2)	55	36.15 (13.5)	.416	.679
GAD-7	30	6.07 (5.3)	62	6.24 (4.5)	.164	.870
PHQ-9	29	5.72 (4.8)	60	5.48 (3.7)	-.258	.797
Change Score						
NSI	31	16.81 (12.8)	62	14.27 (11.7)	-1.280	.191
PCL-M	23	9.52 (9.4)	48	8.27 (9.6)	-.520	.606
GAD-7	30	6.17 (4.7)	62	4.63 (3.8)	-1.675	.097
PHQ-9	29	5.01 (4.5)	60	4.47 (4.1)	-.633	.529

Note. Clinical self-report scores at admission and discharge per group (Closure vs Closure Absent) along with between (Closure vs Closure Absent) and within group comparison (admission vs discharge) results. [N] number of SMs, [SD] standard deviation, [p-value] independent sample t-test probability value, [t] test statistic value, *change score = [admission score – discharge score].

Table 3 *Resting State Connectivity Results*

Closure vs. Closure Absent				MNI coordinates (x,y,z)		
Seed	**Region**	**Peak *P (FDR corrected)***	**k**	**x**	**y**	**z**
Hippocampus to						
	Left Inferior Frontal Gyrus	*.0001*	164	-42	12	24
	Left Postcentral Gyrus	*.0031*	95	-40	-30	38
	Right Frontal Orbital Cortex	*.0049*	82	42	24	-04
	Right Insular Cortex	*.0069*	73	46	06	04

Dorsal Attention Network to					
Left Hippocampus	*.0029*	99	-20	-22	-08
Right Thalamus	*.0144*	68	16	-10	00

Note. Statistical results of hippocampus and dorsal attention network resting state functional connectivity (rs-FC) between group comparisons of Closure to Closure Absent group. Only results with significant p-values < 0.05 FDR corrected are reported. [k] cluster size in cubic millimeters, [xyz] brain coordinate axis values, [P] cluster level thresholds, [FDR] False Discovery Rate.

List of Figures

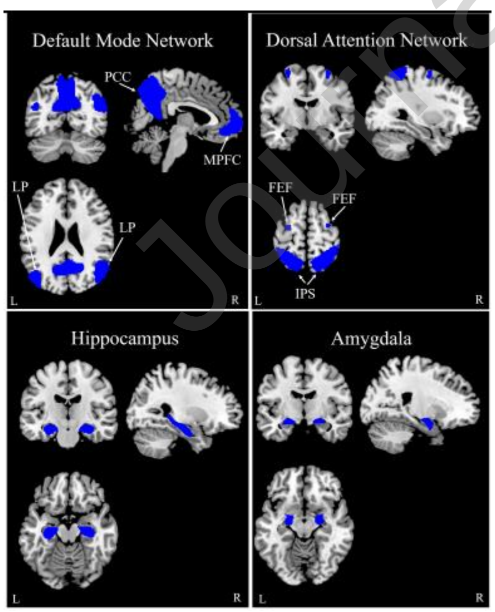

Figure 1: Networks and brain regions of interest (ROIs). FEF: frontal eye fields; IPS: intraparietal sulcus; MPFC: medial prefrontal cortex; PCC: posterior cingulate cortex; LP: lateral parietal cortex; L: left; R: right.

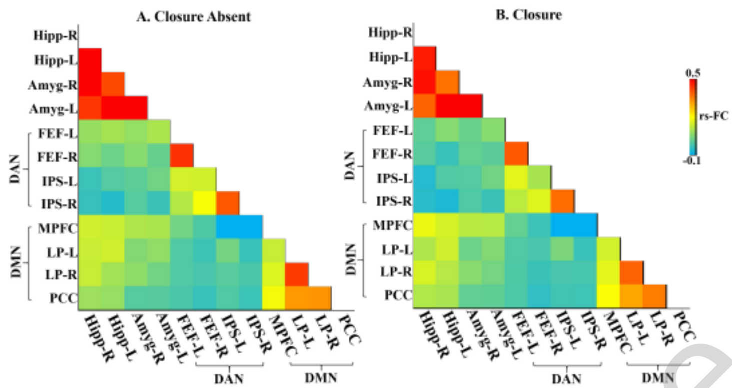

Figure 2: Pairwise resting state functional connectivity (rs-FC) matrices depicting rs-FC between each pair of regions for A. Closure Absent group and B. Closure group. Colors represent the average rs-FC (defined as the Fisher transformed pairwise correlation). DAN: Dorsal Attention Network; DMN: Default Mode Network; Hipp: hippocampus; Amyg: amygdala; FEF: frontal eye fields; IPS: intraparietal sulcus; MPFC: medial prefrontal cortex; LP: lateral parietal cortex; PCC: posterior cingulate cortex; -R: right; -L: left.

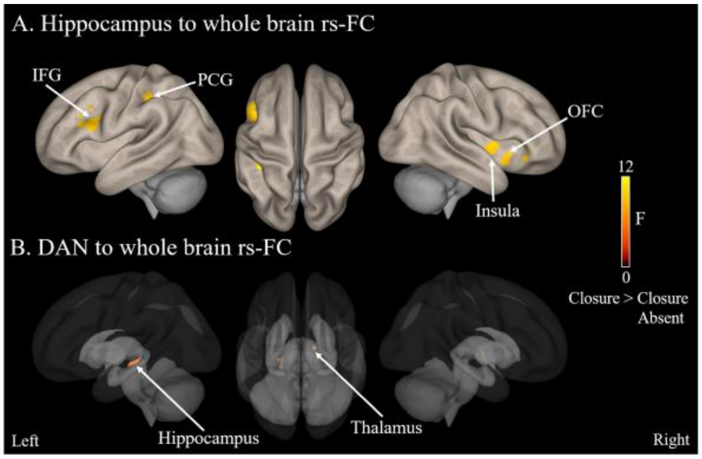

Figure 3: *Whole brain resting state functional connectivity (rs-FC) analysis results of Closure group compared to Closure Absent group*. Note. A. Clusters represent brain regions with significantly higher rs-FC with the Hippocampus at p < 0.05 FDR corrected. B. Clusters represent brain regions with significantly higher rs-FC with the Dorsal Attention Network (DAN) at p < 0.05 FDR corrected. Bar depicts the range of statistical parametric mapping of F-values (F). IFG: inferior frontal gyrus; PCG: postcentral gyrus; OFC: orbitofrontal cortex.

Highlights

- Art therapy is a promising intervention for posttraumatic stress symptoms
- Masks created during art therapy depict multiple themes
- 35% of service members depicted closure and healing within their art therapy mask
- SMs depicting closure had higher functional connectivity between brain regions associated with pain, attention, and memory