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Research Paper

Trajectories of anhedonia symptoms after traumatic injury

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ABSTRACT

Anhedonia describes the inability or difficulty of experiencing or seeking pleasure. Previous research has demonstrated a relationship between posttraumatic stress disorder (PTSD) or experiencing trauma and anhedonia symptoms; however, little to no work has been done to understand the evolution of anhedonia symptoms after trauma. We aimed to identify anhedonia trajectories following traumatic injury. One hundred ninety-five participants were recruited from the emergency department of a Level-1 Trauma Center after experiencing a traumatic injury. To measure anhedonia symptoms, participants completed the Snaith-Hamilton Pleasure Scale (SHAPS) at 2-weeks, 3-months, and 6-months post-injury. Using latent class mixture modeling, we ran a trajectory analysis with three timepoints of SHAPS scores and compared mental and physical health outcomes across trajectories. Most of the sample fell in the resilient trajectory (85 %), while the remainder were in a remitting trajectory (7 %) where symptoms decreased over time, and a delayed (6 %) trajectory where symptoms did not emerge until 3-months after injury. In the resilient trajectory, there was consistently low levels of PTSD, pain, depression, and anxiety relative to the other trajectories. In the delayed trajectory, depression and PTSD were chronically elevated and pain levels were consistent but mild. In the remitting trajectory, PTSD and depression symptoms decreased over time. Identified anhedonia trajectories mirrored trajectories commonly reported for PTSD symptoms after injury. Evaluating anhedonia trajectories and how they relate to mental health outcomes may inform targeted interventions for traumatic injury patients.

Introduction

Anhedonia is defined as the reduced ability to experience pleasure from activities usually found enjoyable (Ribot, 1897) and plays an important role in several maladaptive behaviors and psychiatric disorders, including posttraumatic stress disorder (PTSD) and major depressive disorder (MDD) after trauma exposure (Vinograd et al., 2022). Anhedonia can have various presentations including blunted response to rewards, apathy, reduced mood reactivity, avolition or amotivation, worthlessness and excessive guilt (Cooper et al., 2018). Though a common trait of PTSD and MDD with significant implications for health-related quality of life, anhedonia is not often prioritized as a target for treatment after trauma exposure (Vinograd et al., 2022; Watson et al., 2020). Yet, untreated symptoms can lead to social withdrawal for long periods of time resulting in higher anxiety, pessimism or self-criticism in social situations, or negative physical effects (Craske et al., 2016).

Though not often evaluated after trauma exposure and traumatic injury, anhedonia may be important to consider along with mental health outcomes as prior work has demonstrated the overlapping symptomology of anhedonia and PTSD (Fani et al., 2020; Frewen et al., 2012; Shankman et al., 2010), both of which negatively impact quality of life (Frewen et al., 2012; Pietrzak et al., 2015). Though anhedonia symptoms emerge in other psychiatric disorders including MDD, factor analytic studies have indicated anhedonia symptoms of PTSD are distinct from those in MDD and reflect a unique dimension of PTSD (Kashdan et al., 2006; Liu et al., 2016; Yang et al., 2017). In MDD, anhedonia symptoms can be categorized as anticipatory (i.e. lack of wanting for future pleasure), or consummatory (i.e. lack of in moment pleasure; Gard et al., 2006). After trauma exposure, posttraumatic anhedonia (PTA) symptoms reflect abnormalities in appetitive response rather than fear or negative affect (Bryant et al., 2017). Although PTA

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symptoms overlap with anhedonia features of depression, a primary difference in PTA is the presence of numbness and social detachment (Fani et al., 2020). In addition, individuals who sustained a traumatic injury in their lifetime (e.g., motor vehicle crash, assault, fall, or motorcycle crash) may experience elevated negative emotions which interfere with the ability to exhibit joy during typically pleasant experiences (Frewen et al., 2012). Those who experience anhedonia following trauma may have additional consequences, including more chronic re-experiencing symptoms (Acheson et al., 2022) and increased negative health behaviors such as excessive alcohol use (Fani et al., 2020; Pietrzak et al., 2015).

Development of PTSD after injury has been widely studied through symptom trajectories. Replicated across many samples, trajectories of PTSD typically consist of resilient, chronic, delayed, and remitting symptoms (Bonanno et al., 2024; deRoon-Cassini et al., 2010; Tomas et al., 2022). The resilient trajectory is the most prevalent (60–70 % of individuals post-trauma or injury) and comprises individuals with minimal or transient symptoms over time. The chronic or non-remitting symptom trajectory (10 %) consist of clinically elevated symptoms over time starting acutely after trauma exposure. Delayed symptoms (9 %) in the acute period after trauma are minimal but rise to clinically elevated levels over time and remitting symptoms (20 %) start clinically elevated but diminish to minimal levels over time (Galatzer-Levy et al., 2018). These trajectories are based on overall PTSD symptom severity, but little work has been done to examine specific features of PTSD symptomology over time. In particular, development of anhedonia symptoms over time via trajectories has not been previously reported. However, given anhedonia may exacerbate re-experiencing symptoms of PTSD and other negative health behaviors as previously reported, understanding the changes of anhedonia after trauma may facilitate prediction of changes in PTSD or MDD and provide a specific target for therapeutic intervention (Acheson et al., 2022; Vinograd et al., 2022).

The current study aimed to identify anhedonia trajectories in a racially diverse sample of traumatically injured adults. Building on previous literature, we hypothesized anhedonia trajectories would be similar to those reported for PTSD symptoms after trauma exposure. We further examined how anhedonia trajectories were related to symptoms of PTSD and depression, as well as anxiety, stress, and pain. We hypothesized anhedonia would be related to mental and physical health comorbidities, including higher levels of depression, anxiety, stress, and pain.

Methods

Participants

Participants were recruited after discharge from the emergency department (ED) of a Level 1 trauma center in southeast Wisconsin, for a single-incident traumatic injury as part of a larger longitudinal study, iSTAR (Webb et al., 2021; Weis et al., 2021a; Weis et al., 2021b), that aimed to characterize the neural and behavioral processes that underlie emotion dysregulation and risk for posttraumatic stress disorder. Participants were recruited within 1-month of their injury and followed for 2 years. Participants were eligible for study participation if they were English-speaking, between the ages of 18–60 years of age, and scored a minimum of 3 on the Predicting PTSD Questionnaire or endorsed that the trauma was life-threatening (Rothbaum et al., 2014) aligning with Criterion A PTSD according to Diagnostic and Statistical Manual of Mental Disorders (5th ed.; DSM-5; American Psychiatric Association, 2013). This includes both assaultive and non-assaultive traumatic injuries such as motor vehicle accident, assault/domestic violence, motorcycle crash and pedestrian struck. Participants were excluded if they were over the age of 60, had a spinal cord injury with neurological deficit, evidence of moderate to severe cognitive impairment or had a traumatic brain injury, if taking antipsychotic medication, or if they had any contraindications to magnetic resonance imaging (MRI) given the parent study involved MRI scans.

Procedures

The study protocol was approved by the Medical College of Wisconsin Institutional Review Board. Participants provided written informed consent prior to participation and relevant to the current analysis completed study visits at 2 weeks (i.e., baseline; Time 1 [T1]), 3 months (Time 2 [T2]), and 6 months (Time 3 [T3]) post injury. A total of 245 participants were eligible and enrolled in the parent study of which 195 completed relevant study measures at all timepoints. Participants were financially compensated for their time.

Measures

Participants self-reported demographics including age, gender, and race. Mechanisms of injury were categorized into assaultive (e.g. gunshot wound, stabbing, assault) and non-assaultive (e.g. motor vehicle crash, fall). Injury severity scores (ISS) were extracted from participant's medical charts (Baker et al., 1974). ISS scores range 0–75 with higher scores indicating more severe injury.

Anhedonia symptoms

The Snaith-Hamilton Pleasure Scale SHAPS is a self-report tool to assess symptoms of anhedonia (Ameli et al., 2014). This scale measures the participants' state during the last 2 weeks and uses a four-point Likert scale, ranging from "strongly agree" to "strongly disagree". The SHAPS was administered at each timepoint. SHAPS was scored as the sum of the 14 items so that total scores ranged from 0 to 14 where higher total SHAPS score indicates higher levels of anhedonia. T1 responses were highly reliable in the current sample (Cronbach's $\alpha = 0.94$).

PTSD symptoms

PTSD symptoms were assessed based on the diagnostic criteria in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) using the PTSD Checklist for DSM-5 (PCL-5; Weathers et al., 2013) at T1, T2, and T3 in each sample. Each of 20-items was rated on a scale of 0 (*not at all*) to 4 (*extremely*), where higher total sum scores indicate more severe symptom levels (range = 0–80). PTSD symptom clusters including reexperiencing, avoidance, negative cognition and mood, and hyperarousal symptoms were scored in subscales. Proposed clinical thresholds of the PCL-5 suggest a score of 30 indicates probable PTSD diagnosis at 6-months for traumatically injured patients (Geier et al., 2019). T1 responses were highly reliable in the current sample (Cronbach's $\alpha = 0.94$).

Depression and anxiety symptoms

The Depression, Anxiety and Stress Scale—21 (DASS-21) is a 21-item set of three self-report questionnaires designed to measure the emotional states of depression, anxiety, and stress (Lovibond & Lovibond, 1995). This scale measures the participants' emotional state over the past week. Participants can respond on a 0 (*did not apply to me at all* to 3 *Applied to me very much or most of the time*). Scores from the relevant items are summed to generate depression, anxiety, and stress subscales. T1 responses were highly reliable in the current sample (Cronbach's α by subscale; stress = 0.89, anxiety = 0.83, depression = 0.90).

Pain

To assess physical pain, the Visual Analogue Scale for Pain (VAS; Holdgate et al., 2003) was used. Participants rated their current pain using a numbered line with labels 0 (no pain) to 10 (worst possible pain).

Data analysis

Anhedonia trajectories were fit using latent growth mixture modeling (LGMM) of the SHAPS scores from T1–T3 using MPlus 8.9

(Muthén & Muthén, 1998). To ensure optimization and replication of the best log likelihood value for each trajectory solution, 500 initial stage random sets of starting values and 100 final stage optimizations were employed with 50 initial stage iterations. Model selection was evaluated using Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), entropy, Vuong-Lo-Mendell-Rubin likelihood test (VLMR), and class size. Ten models were run to evaluate 1 to 5 class solutions with and without a quadratic term. Participants were assigned to a trajectory based on the highest posterior probability of class membership. Only participants with SHAPS data for at least two of the three assessment points were retained ($N = 195$).

All other analyses were conducted in R version 4.3.1 (R Core Team, 2022). Participant characteristics (i.e. age, race, gender, ISS), and mental health symptoms (i.e. total PTSD, PTSD symptom clusters, depression, anxiety, stress) and pain severity were described for the whole sample with descriptive statistics. Changes in anhedonia and mental health symptoms and pain from T1 to T3 were evaluated using *t*-tests. Pairwise linear correlations were evaluated between all study variables of interest. Anhedonia and mental health symptoms and pain were correlated at each timepoint cross-sectionally and prospectively (e.g. T1 anhedonia and T1 depression, T1 anhedonia and T2 depression). Demographic characteristics, mental health symptoms, and pain were statistically compared between identified anhedonia trajectories. Continuous variables were compared using analyses of variance (ANOVAs), and categorical variables were compared using Fisher's exact test. A Tukey adjustment was implemented for all post hoc comparisons.

Results

The current sample comprised racially diverse (58.9 % Black or African American; 6.6 % multiracial; 26.1 % White) younger adults ($M_{age} = 33.6$; $SD_{age} = 10.74$) who sustained primarily low severity ($M_{ISS} = 0.98$; $SD_{ISS} = 2.40$) non-assaultive injuries (85.1 %; Table 1). From T1 to T3, PTSD symptoms ($t = 3.00$, $p = 0.002$) and pain levels ($t = 4.55$, $p < 0.001$) decreased over time; however, there was no change in average anhedonia ($t = 1.29$, $p = 0.195$), depression ($t = 1.26$, $p = 0.208$), anxiety ($t = 1.36$, $p = 0.171$), or stress ($t = 1.79$, $p = 0.073$) symptoms (Table 1). Anhedonia symptoms at T1 were positively related to anhedonia symptoms at T2 ($r = 0.25$) and symptoms at T2 were positively related to symptoms at T3 ($r = 0.29$). Anhedonia symptoms were not related to age, gender, or mechanism of injury (MOI) at any time point (all $r < 0.1$). Anhedonia symptoms at each timepoint were significantly related to PTSD, anxiety, depression, and stress symptoms at respective timepoints (all $r > 0.14$). Anhedonia symptoms at T1 were related to T2 and T3 PTSD, anxiety, depression, and stress symptoms (all $r > 0.15$). Anhedonia symptoms at T1 were related to T1 pain levels ($r = 0.14$), but this relationship did not hold at T2 or T3, nor did anhedonia symptoms relate to future pain levels (all $r < 0.1$). See Fig. 1 for all pairwise correlations of study variables.

Anhedonia symptom trajectories

After evaluation of the LGMM fit metrics, a linear 3-class solution was chosen as optimal due to high entropy, low AIC, low BIC, low SABIC, and a significant VLMR *p*-value relative to other class solutions (Tein et al., 2013); Fig. 2; Table 2). Trajectories were characterized as resilient (86.1 %, $n = 168$), delayed (6.6 %, $n = 13$), and remitting (7.1 %, $n = 14$; Table 3). The resilient trajectory described participants who had low levels of anhedonia symptoms across time. The delayed trajectory describes participants who had low levels of anhedonia at T1, but symptoms increased by T2 or T3. The remitting trajectory describes participants who had high levels of anhedonia at T1, but symptoms resolved by T2 or T3.

At T1, the resilient anhedonia trajectory had significantly lower total PTSD, avoidance, negative cognition and mood, and depression symptoms than the remitting trajectory, and lower depression than the delayed trajectory (all $p < 0.050$). At T2, the resilient trajectory had significantly lower total PTSD, negative cognition and mood, hyperarousal, depression, and anxiety than the remitting trajectory (all $p < 0.050$). At T3, the resilient trajectory had significantly lower total PTSD, negative cognition and mood, depression, and anxiety than the delayed trajectory (all $p < 0.050$). There were no significant differences in age, gender, race, MOI, ISS, reexperiencing symptoms, stress, or pain between trajectories (all $p > 0.050$).

In the delayed trajectory, total PTSD ($t = 0.85$, $p = 0.398$), all PTSD symptom clusters (all $p > 0.248$), depression ($t = 0.92$, $p = 0.359$), and pain levels ($t = 0.01$, $p = 0.989$) did not change over time. In the resilient

Table 1
Sample characteristics.

Variable		Total (n = 195) %	Delayed (n = 13, 6.6 %) %	Resilient (n = 168, 85.6 %) %	Remitting (n = 14, 7.6 %) %
Gender (% female)		53	46.15	54.76	42.86
Race	Asian	<5	0	<5	0
	Black or African American	58.97	76.92	60.12	30.77
	White	26.15	15.38	26.19	38.46
	Multiracial	6.66	0	6.54	15.38
	Other or Unknown	6.15	7.69	5.35	15.38
MOI	Assaultive	14.87	.51	11.7	2.56
	Non-assaultive	85.12	6.15	74.36	4.62
		M (SD)	M (SD)	M (SD)	M (SD)
Age		33.64 (10.74)	32.20 (10.41)	33.73 (10.77)	33.83 (11.29)
ISS		0.98 (2.40)	0.53 (1.13)	0.93 (2.23)	2.00 (4.47)
Anhedonia	T1	2.13 (2.95)	1.50 (1.84)[a]	1.55 (2.01)[b]	9.77 (2.77)[a,b]
	T2	2.45 (3.37)	5.30 (5.20)[a]	2.02 (2.89)[a,b]	4.28 (4.39)[b]
	T3	1.74 (2.87)	10.60 (2.57)[a,b]	1.20 (1.66)[a]	0.38 (0.87)[b]
PTSD	T1	28.08 (18.82)	27.23 (21.84)	27.03 (18.41)[a]	41.35 (16.81)[a]
	T2	25.63 (18.10)	24.84 (23.21)	24.64 (17.63)[a]	36.92 (14.92)[a]
	T3	22.22 (19.33)	36.16 (31.52)[a]	20.75 (18.19)[a]	27.78 (14.39)
Depression	T1	9.52 (10.03)	9.53 (10.10)[a]	8.72 (9.48)[b]	19.69 (11.91)[a,b]
	T2	10.38 (10.85)	14.61 (16.17)	9.36 (9.88)[a]	17.28 (12.31)[a]
	T3	8.20 (10.36)	14.83 (16.72)[a]	7.56 (9.57)[a]	10.14 (11.40)
Anxiety	T1	9.73 (8.93)	7.23 (10.05)	9.57 (8.65)	14.30 (10.57)
	T2	9.55 (9.59)	14.61 (13.72)	8.61 (8.63)[a]	14.85 (12.34)[a]
	T3	8.42 (9.82)	16.66 (16.69)[a]	7.75 (9.15)[a]	9.28 (7.17)
Stress	T1	13.11 (10.31)	11.53 (10.42)	12.74 (10.19)	19.38 (10.43)
	T2	13.57 (10.31)	16.61 (14.86)	12.89 (9.66)	18.00 (11.31)
	T3	11.22 (10.25)	16.33 (13.69)	10.68 (10.08)	13.28 (7.94)
Pain	T1	4.36 (2.87)	3.46 (3.17)	4.39 (2.88)	4.78 (2.54)
	T2	3.25 (2.84)	2.69 (2.75)	3.22 (2.84)	4.07 (2.99)
	T3	2.98 (3.05)	3.50 (3.72)	2.96 (2.97)	2.78 (3.57)

Note. M, mean; SD, standard deviation; MOI, mechanism of injury; ISS, injury severity score. Depression, anxiety, and stress measured with the DASS21. Posttraumatic stress disorder symptom (PTSD) severity measured with the PTSD Checklist for DSM-5. Anhedonia measured with the Snaith-Hamilton Pleasure Scale. Superscript letters indicate significant post hoc pairwise comparisons conducted across anhedonia trajectories; there was a significant difference after Tukey adjustment between trajectories with corresponding superscripts.

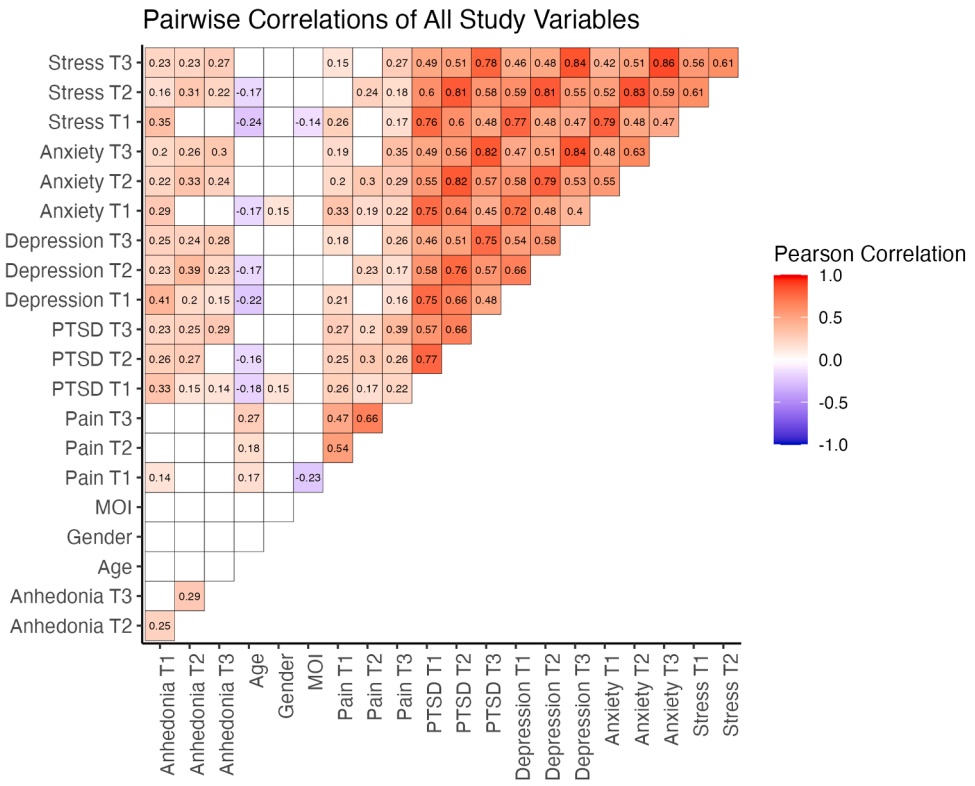

Fig. 1. Pairwise correlations of all study variables. Values represent Pearson correlation coefficients. Blank cells indicate significant correlations where $p > 0.05$ uncorrected. T1, 2-weeks post injury; T2, 3-months post injury; T3, 6-months post injury; MOI, mechanism of injury. Depression, anxiety, and stress measured with the DASS21. Posttraumatic stress disorder symptom (PTSD) severity measured with the PTSD Checklist for DSM-5. Anhedonia measured with the Snaith-Hamilton Pleasure Scale.

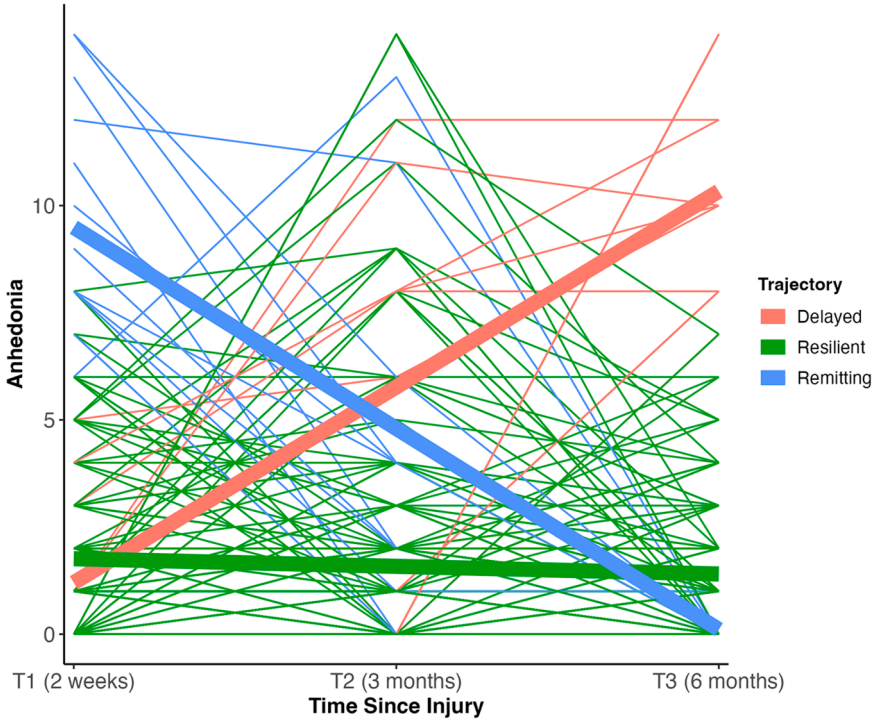

Fig. 2. Anhedonia trajectories identified using latent growth mixture models. Bold lines depict optimal 3 class solution, while thin lines depict individual mean anhedonia symptoms as measured by the Snaith-Hamilton Pleasure Scale at each timepoint colored according to trajectory assignment per the highest posterior probability of class membership. Classes are characterized as delayed (n = 13, 6.6 %), resilient (n = 168, 85.6 %), and remitting (n = 14, 7.6 %).

Table 2
Latent class mixture modeling fit metrics for anhedonia trajectories.

								% of sample in class			
Sample	Classes	AIC	BIC	SABIC	Entropy	VLMR	LRT	1	2	3	4	5
Linear slope	1	2752.67	2778.85	2753.51	–	–	–	100				
	2	2636.04	2672.05	2637.20	0.97	0.001	0.001	92	7			
	3	**2563.52**	**2609.35**	**2565.00**	**0.96**	**0.02**	**0.03**	**6**	**85**	**7**		
	4	2502.28	2557.92	2504.07	0.94	0.07	0.07	6	4	71	18	
	5	2462.13	2527.59	2464.24	0.94	0.16	0.17	71	11	10	2	3
Quadratic slope	1	2757.21	2796.48	2758.21	–	–	–	100				
	2	2641.82	2694.19	2643.51	0.97	0.01	0.01	7	92			
	3	2562.34	2627.80	2564.45	0.96	0.01	0.01	6	6	87		
	4	2500.79	2579.35	2503.32	0.94	0.04	0.05	3	71	18	6	
	5	2461.95	2553.59	2464.89	0.95	0.32	0.33	3	11	10	71	2

Note. AIC, Akaike Information Criteria; BIC, Bayesian Information Criteria; SABIC, sample-size-adjusted BIC.; VLMR, Vuong-Lo-Mendell-Rubin Likelihood Ratio test; LRT, Lo-Mendell-Rubin Adjusted Likelihood Ratio Test.

Table 3
Parameter estimates for 3-class solution from growth mixture modeling.

	Parameter	Coefficient	SE
Class 1; Delayed (6.6 %, $n = 13$)	Intercept mean	1.129	0.707
	Intercept variance	2.359*	0.879
	Slope mean	4.722*	0.596
	Slope variance	0.034	0.086
	Intercept-slope correlation	−0.283	0.405
Class 2; Resilient (85.6 %, $n =$ 168)	Intercept mean	1.618*	0.179
	Intercept variance	2.359*	0.879
	Slope mean	−0.182*	0.075
	Slope variance	0.034	0.086
	Intercept-slope correlation	−0.283	0.405
Class 3; Remitting (7.6 %, $n =$ 14)	Intercept mean	9.526*	1.067
	Intercept variance	2.359*	0.879
	Slope mean	−4.510*	0.625
	Slope variance	0.034	0.086
	Intercept-slope correlation	−0.283	0.405

Note. SE, standard error; * $p < 0.05$.

trajectory, total PTSD symptoms ($t = -3.13$, $p < 0.001$), all PTSD symptom clusters (all $p < 0.021$), and pain levels ($t = -4.49$, $p < 0.001$) decreased over time, while depression symptoms did not change ($t = -1.09$, $p = 0.275$). In the remitting trajectory, total PTSD ($t = -2.35$, $p = 0.023$), reexperiencing ($t = -2.51$, $p = 0.015$), and depression symptoms ($t = -2.11$, $p = 0.040$) decreased over time, while pain levels ($t = -1.74$, $p = 0.088$) did not change. Anxiety and stress symptoms did not change over time for any trajectory (all $p > 0.060$).

Of note in the final 3-class trajectory solution, there was a subset of participants who were classified as resilient but have a sharp increase in anhedonia symptoms at T2 (Fig. 2). There were 17 individuals whose anhedonia scores increased 5 or more points from T1 to T2 and then returned to T1 levels by T3. These individuals were not reliably captured in any trajectory solution because with additional classes the model fit became increasingly unstable. We compared demographic and self-report measures between these 17 and the rest of the resilient individuals. The only significant difference between groups was that these 17 individuals had significantly higher T2 depression symptoms than the other resilient individuals ($t = 3.18$, $p < 0.001$); however, there were no differences in depression symptoms between groups at T1 or T3. There were no group differences in age, gender, MOI, PTSD, anxiety, stress symptoms, or pain levels.

Discussion

In this 6-month prospective study of a sample of traumatically injured adults, we identified trajectories of anhedonia symptoms and assessed the relationship of anhedonia and other mental health outcomes over time. There were three anhedonia symptom trajectories identified; resilient (i.e. low levels of symptoms across time), delayed (i.e. initially low symptoms which increased over time), and remitting (i.e. high levels initially which decrease over time). Most of the sample fell into the resilient category, who experienced consistently low levels of anhedonia, PTSD, pain, depression, and anxiety relative to the other trajectories. Alternatively, those in the delayed trajectory had elevated depression relative to other trajectories that persisted over time in addition to chronically elevated PTSD symptoms and consistent but mild pain levels. Those in the remitting trajectory experienced decreasing anhedonia, PTSD, and depression symptoms over time.

The current findings support previous literature that demonstrates anhedonia, PTSD, and MDD symptoms co-occur, as changes in anhedonia largely aligned with changes in depression and PTSD symptoms over time. As such, anhedonia may be experienced as part of the broader symptom profile of psychological distress after trauma exposure. A recent study found that anhedonia increases PTSD risk and chronicity (Acheson et al., 2022), thus, understanding anhedonia may aid in identifying risk for PTSD. Anhedonia is also closely related to negative affect, which includes feelings of sadness, emptiness, and emotional numbing (Frewen et al., 2012). Current results support this finding through greater negative cognition and mood symptoms for remitting and delayed trajectories as compared to the resilient anhedonia trajectory. These emotions are common in individuals with PTSD and may be intertwined with their anhedonia experiences (Acheson et al., 2022).

Though the profiles of anhedonia trajectories align with previously reported PTSD trajectories, there are notable differences in the proportions of trajectories. We identified a much higher rate of those in the resilient anhedonia trajectory (85 %) compared to what is typically reported for a resilient PTSD trajectory (66 %; Galatzer-Levy et al., 2018). We also report lower rates of delayed (6 %) and remitting (7 %) anhedonia trajectories compared to those reported in PTSD (9 % and 20 %, respectively; Galatzer-Levy et al., 2018). These differences suggest that while anhedonia and PTSD may be related, there are discordant features between the two. Continued work should explore the relationship between trajectories and if anhedonia might be related to or predict other mental health outcomes.

Likewise, with regards to physical health, the current study focused solely on pain. While pain is a critical aspect of physical health that is related to other health outcomes, it represents only one facet of the complex interplay between anhedonia and overall well-being. Future studies should encompass a range of physical health outcomes including quality of life (i.e., subjective experiences and satisfaction across various life domains; (Whitton et al., 2023), functional impairment (May et al., 2022), healthcare utilization, social functioning (Barkus, 2021), and physical health markers such as blood pressure, heart rate variability, or immune function. By incorporating these additional outcomes, researchers can gain a more comprehensive understanding of the impact of anhedonia on overall health and well-being to inform the

development of targeted clinical interventions (Pizzagalli, 2022).

To date, there is limited research examining anhedonia symptoms in an acute traumatic injury population. Studies examining individuals with PTSD found that anhedonia influences BMI (Cho et al., 2018), drug use (Fani et al., 2020), long term head injuries (Lewis et al., 2015), and potential for future self-harm following trauma that did not involve injury (Zielinski et al., 2017). This underscores the importance of evaluating other health behavior consequences of anhedonia in an injured population, given their greater risk for disability and lower quality of life. By identifying trajectories of anhedonia, we can better assess for who is at risk for short term or chronic symptomology and negative health outcomes to provide appropriate intervention.

It is essential for providers to consider anhedonia in the context of a comprehensive mental health assessment as it plays a crucial role in understanding the overall clinical picture and tailoring treatment to the individual's needs. The presence and severity of anhedonia has been suggested to be a strong predictor of psychosocial functioning and symptomatic remission in individuals with MDD (Vinckier et al., 2017). Symptoms such as depression, mania, or suicide ideation can be masked as anhedonia, which if identified can guide treatment plans. Anhedonia impacts individuals' trauma recovery by increasing negative health behaviors such as excessive alcohol use (Fani et al., 2020) which can lead to poor recovery.

Strengths of the current study include the large racially diverse sample. The longitudinal design and multiple follow-up assessments extend the extant cross-sectional research on the measurement of anhedonia. However, results of the current study may not extend to other types of injury or trauma as the current sample sustained primarily non-assaultive injury. In addition, the parent study inclusion criteria required participants be safe to scan in a magnetic resonance environment which excluded participants who had retained metal fragments from their injuries. This yielded a sample who was less likely to have sustained firearm-related injuries or those who required metal implants. Additionally, trauma survivors who did not meet the DSM-5 Criteria A for PTSD were also excluded from the study. Finally, the subset of individuals in the resilient trajectory with elevated anhedonia symptoms at T2 indicates uncertainty in fitting the trajectory solutions in the current sample. These results warrant replication in other diverse traumatic injury samples.

Evaluating anhedonia trajectories and their associations with PTSD, depression, and other mental and physical health outcomes may inform targeted interventions for patients at risk for poor recovery. Tracking how anhedonia symptoms change over time will continue to improve our understanding of anhedonia during post-injury recovery. Targeted and personalized treatment plans based on symptom presentation may aid in the prevention of development of psychopathology after traumatic injury.

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CRediT authorship contribution statement

Isela G. Piña: Writing – review & editing, Writing – original draft. **Sydney C. Timmer-Murillo:** Writing – review & editing, Writing – original draft, Supervision. **Christine L. Larson:** Writing – review & editing, Writing – original draft, Supervision, Resources, Funding acquisition. **Terri A. deRoon-Cassini:** Writing – review & editing, Writing – original draft, Supervision, Resources, Funding acquisition. **Carissa W. Tomas:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Methodology, Formal analysis.

Declaration of competing interest

The authors declare that they have no conflict of interest.

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