SUPPLEMENTARY MATERIALS

~~Inclusion and Exclusion Criteria~~ Participant Enrollment

~~All participants reported experiencing a DSM-5 criterion-A traumatic event ("index trauma") in the past two years, except within the last one month. Participants were allowed with a concurrent anxiety disorder, dysthymia, Major Depressive Disorder (remitted or on case-by-case basis), or if on a stable dose of an antidepressant (≥8 weeks). Exclusion criteria included: history of chronic childhood abuse or neglect; PTSD diagnosis preceding traumatic event indexed at study interview; neurological disorder or injury; major medical disorders; psychotic, bipolar, autism spectrum or other neurodevelopmental disorders; current drug or alcohol abuse or dependence; history of sleep disorder other than insomnia or nightmare disorder; current use of hypnotic or recently adjusted psychiatric medications; shift work; and any contraindication to MRI scans.~~ One hundred and ninety-five participants were enrolled of whom 132 completed the study. Thirty-seven participants were excluded because exclusion criteria were detected during the clinical interview. Twenty-one participants withdrew consent: Nineteen participants left the study due to scheduling conflicts, 1 participant met exclusion criteria while undergoing the study, and 1 dropped out due to medical issues unrelated to the study. Finally, the participation of 5 subjects was terminated by the investigators, because they could not tolerate the MRI environment (n = 4) and polysomnography (n = 1). Participants were compensated $500 if they completed the study.

Ambulatory PSG

Ambulatory PSG was recorded on 3 nights using the Somte PSG ambulatory sleep monitor (Compumedics USA, Charlotte, NC, USA). Sampling rate was 256 Hz. EEG data were acquired using six EEG channels (F3, F4, C3, C4, O1, O2; positioned according to the 10-20 system). Additional electrodes were placed on bilateral mastoids, above the right and below the left eye (EOG), under the chin (EMG), and below the right clavicle and in the left fifth intercostal space (ECG). Participants returned home to sleep after being instrumented. During the acclimation/screening (first) PSG night, additional channels for pulse oximeter, respiration transducer belts, nasal cannula and tibialis movement sensors were added to screen for obstructive sleep apnea (OSA) and Periodic Limb Movement Disorder (PLMD). No participant met criteria for clinically significant OSA or PLMD. All sleep records were scored by an experienced, registered polysomnographic technologist according to American Academy of Sleep Medicine criteria [113].

Fear conditioning, extinction learning, and extinction recall procedures

A well validated 2-day paradigm [60] was used to probe fear conditioning, extinction learning, and extinction memory during ongoing fMRI recording. This protocol consisted of 4 phases, with Habituation, Fear Conditioning, and Extinction Learning phases taking place on the first day and Extinction Recall 24 hours later. During each phase, images of a colored desk lamp (red, yellow, or blue) appearing in a contextual background (office for conditioning context and conference room for extinction context) served as conditioned stimuli (CS). Context images were presented for nine seconds, with three seconds with the lamp off and six seconds with the lamp on (red, yellow or blue). The unconditioned stimulus (US) was a mild (0.8-4.0 mA), 500 msec electric shock delivered to the index and middle fingers of participants' right hand using a Coulbourn Transcutaneous Aversive Finger Stimulator (Coulbourn Instruments, Allentown, PA). Prior to entering the scanner, participants were administered increasing intensities of shock and they each selected a level that they perceived as "highly annoying but not painful" [64].

During Habituation, all six possible combinations of lamp colors and contexts were presented across six trials. During the following Fear Conditioning phase, two of the three colored lamps (CS+) were each presented 8 times paired with the US at stimulus offset, on a partial reinforcement schedule (5 out of 8 presentations were paired with US). The third lamp color, which was never paired with US (CS-), was interspersed among the CS+s for a total of 16 presentations. Fear Conditioning was followed by Extinction Learning, during which one CS+ (CS+E) was presented in the extinction context 16 times without the US along with 16 interspersed presentations of the CS-. The other CS+ remained conditioned but unextinguished (CS+U). During Extinction Recall, which took place 24 hours later, each CS+ was presented 8 times in the extinction context, with no US, along with 16 interspersed CS-.

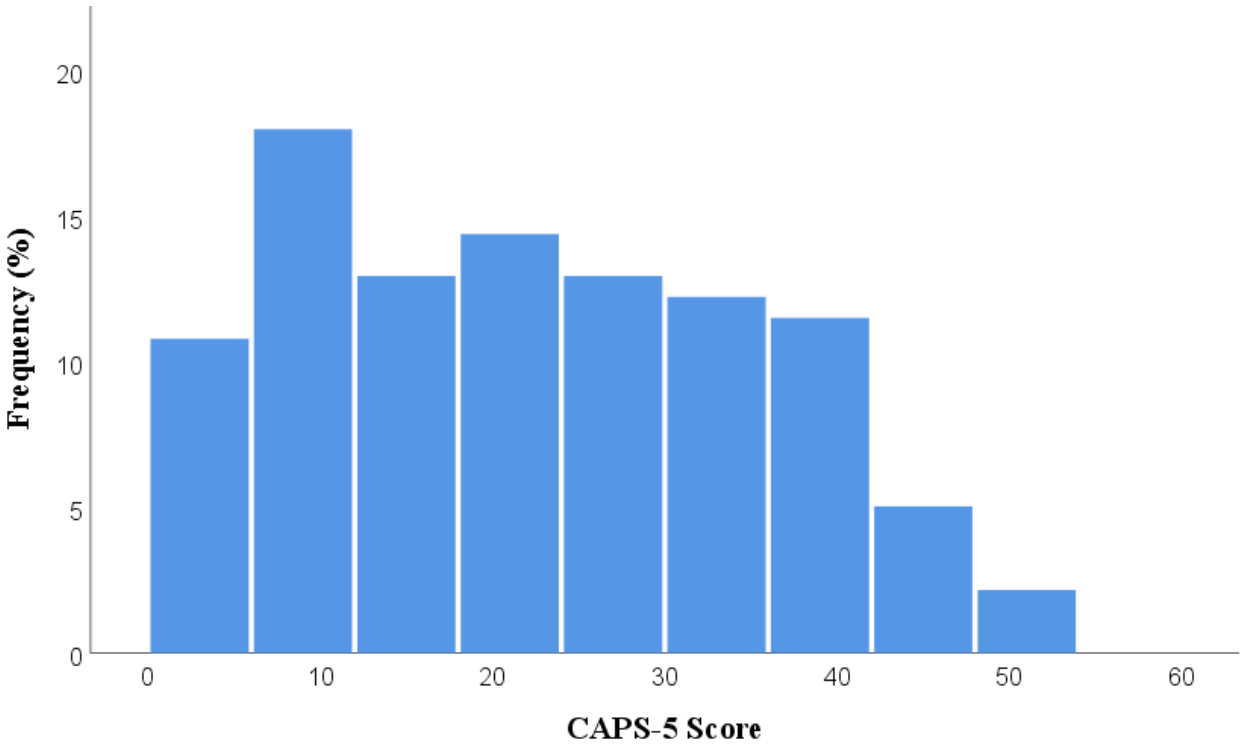

Figure S1. Distribution of CAPS-5 score in the sample.

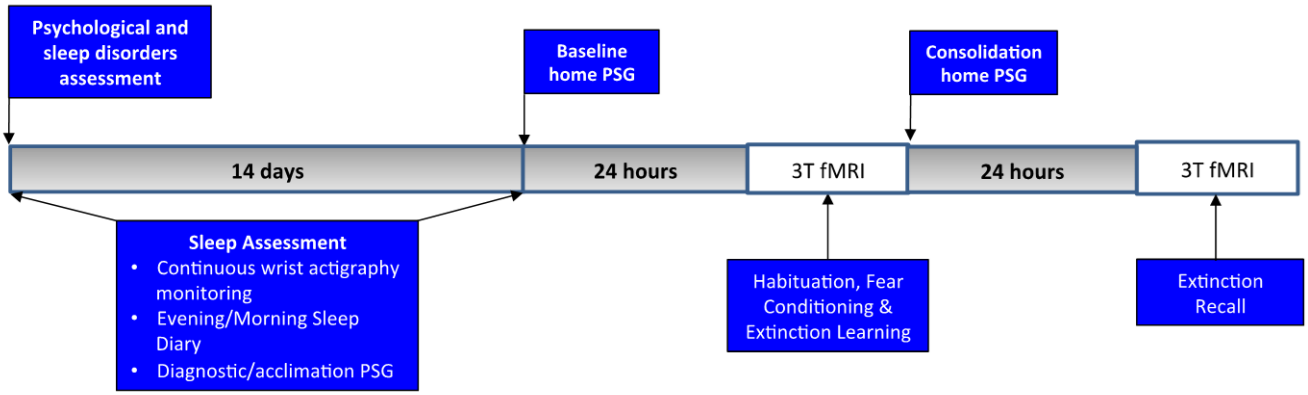

Figure ~~S1~~S2. ~~Distribution of CAPS-5 score in the~~Timeline of the study procedures. The sleep data analyzed in this study was obtained during the consolidation night. ~~sample.~~

Age	24.0±4.8 (18-39)
Sex (%female)	69.9%
Race (%)	
American Indian or Alaskan Native	2.7%
Asian	9.8%
Black or African-American	16.8%
More than one race	6.2%
Unknown/unreported	1.8%
White	62.9%
Ethnicity	
Hispanic or Latino	9.7%
Not Hispanic or Latino	85%
Unknow/unreported	3.5%
Type of trauma	
Transportation accident	26.5%
Violent assault	19.5%
Rape or sexual assault	17.7%
Mass shooting	2.7%
Sudden loss of family or friend	4.5%
Combat incident	2.7%
Multiple or other	26.4%
Trauma Severity	
CAPS-5	21.8±13.0 (0-53)
Depression Severity	
QIDS	7.4±4.4 (0-18)
Months since trauma	13.0±6.8 (1-28)
Medications	
Antidepressants	18.6%
Benzodiazepines	3.5%
Beta-blockers	0%
Mood stabilizers	0%
Antipsychotics	0%

Table S1. Demographic and clinical characteristics of the participants. Some of the data is displayed as mean ± standard deviation (minimum - maximum).

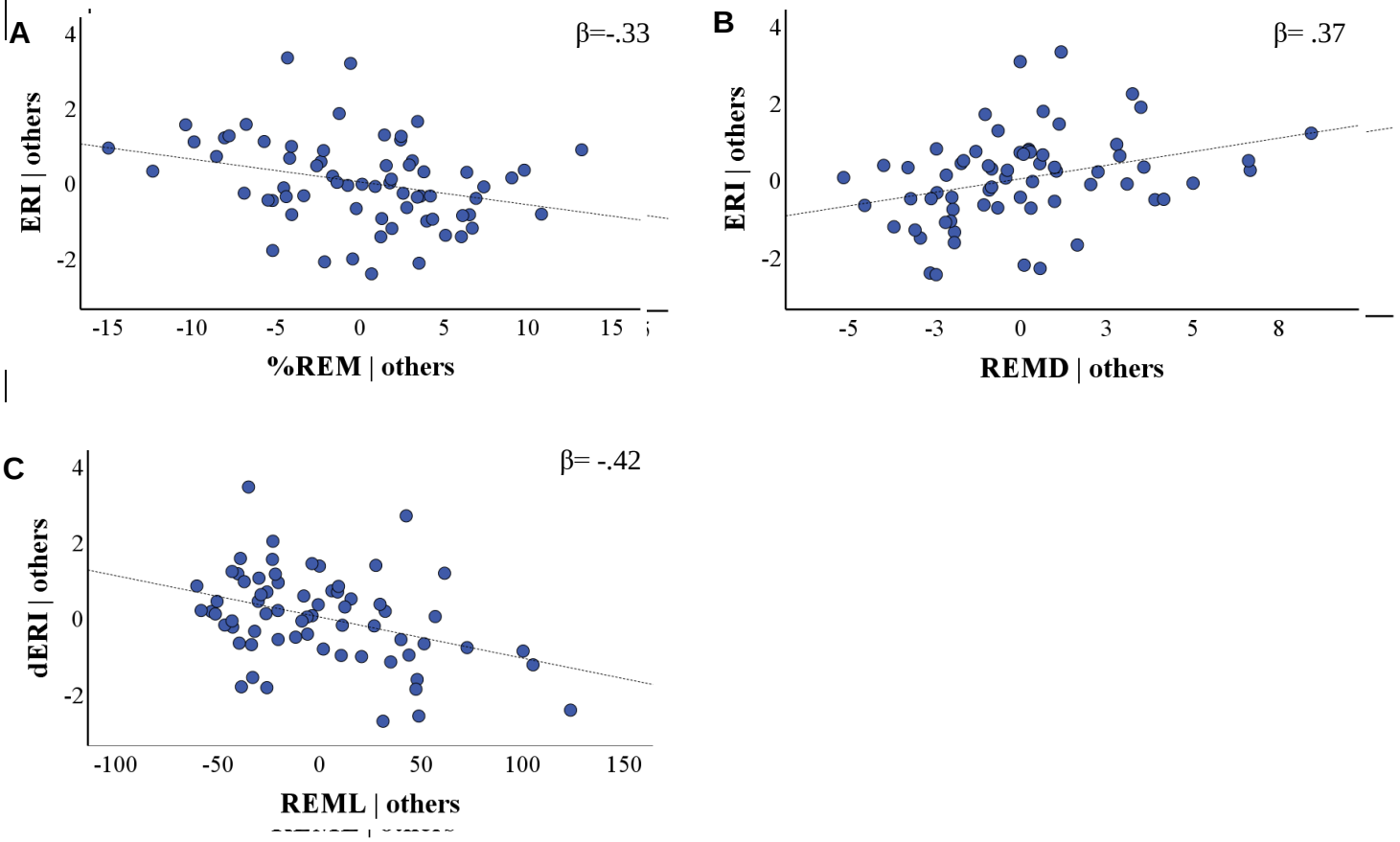

Figure ~~S2~~S3. Partial regression (added variable) plots of the significant REM variables in the regression analyses that tested the hypothesis 1 for physiological extinction recall (~~d~~ERI). The Y axis represents the residuals derived from regressing ~~d~~ERI on all the predictor variables in the corresponding model, except the variable noted on the X axis. The X axis represents the residuals derived from regressing the predictor variable noted on the X axis on all the other predictor variables in the corresponding models. The slope reflects the standardized partial regression coefficient (β). Note that smaller ~~d~~ERI denotes better physiological extinction recall. HF[ms^2]: Absolute power of high frequency heart rate variability; %REM: Proportion of REM sleep to total sleep time; REMD: REM density; REML: REM latency.

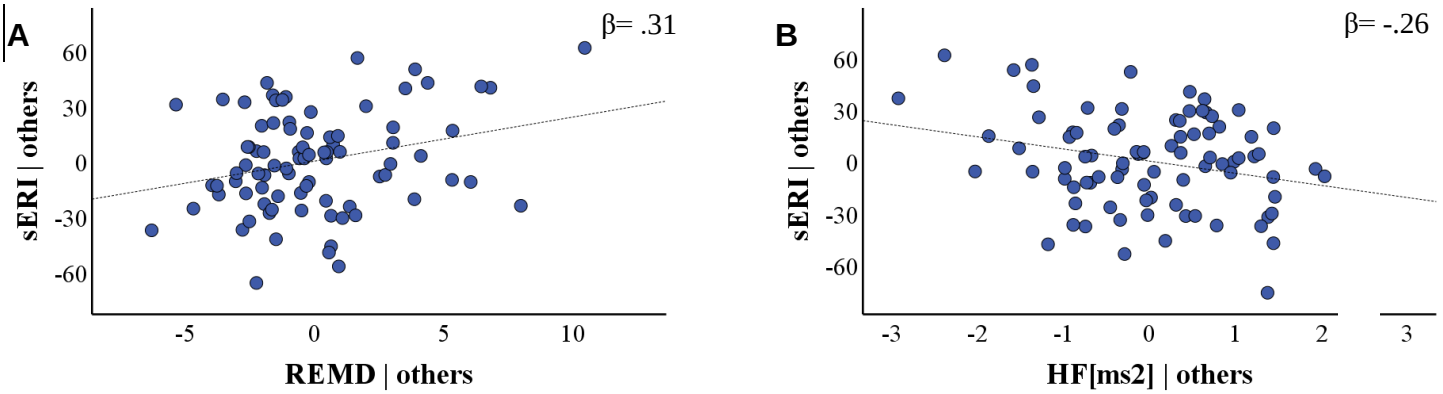

Figure ~~S3~~S4. Partial regression (added variable) plots of the significant REM variables in the regression analyses that tested the hypothesis 1 (A), and the hypothesis 2 (B), for subjective extinction recall (sERI). The Y axis represents the residuals derived from regressing sERI on all the predictor variables in the corresponding model, except the variable noted on the X axis. The X axis represents the residuals derived from regressing the predictor variable noted on the X axis on all the other predictor variables in the corresponding models. The slope reflects the standardized partial regression coefficient (β). Note that smaller sERI denotes better subjective extinction recall. HF[ms^2]: Absolute power of high frequency heart rate variability; REMD: REM density.

Model	Predictors	B	SE	β	t	p	95% CI						
1	**Sex**	-.603	.351	-.242	-1.714	.092	-1.307	.102					
	Medication	-.075	.396	-.025	-.189	.850	-.869	.719					
	%REM	-.052	.026	-.281	-2.004	.050	-.104	.000					
	REMD	.147	.053	.391	2.793	.007	.041	.253					
	REML	-.010	.004	-.383	-2.688	.010	-.017	-.003					
	REMF	.034	.032	.148	1.035	.305	-.032	.099					
									Change			**ANOVA**	
									ΔF	**p**	**Adj. R^2**	**F**	**p**
2	**Sex**	-.651	.345	-.261	-1.886	.065	-1.344	.042	2.553	.088	.162	2.450	**.025**
	Medication	.064	.396	.022	.162	.872	-.730	.859					
	%REM	-.058	.026	-.313	-2.280	**.027**	-.109	-.007					
	REMD	.159	.053	.423	3.030	**.004**	.054	.265					
	REML	-.012	.004	-.446	-3.122	**.003**	-.019	-.004					
	REMF	.028	.032	.124	.885	.380	-.036	.092					
	HF[ms^2]	-.401	.201	-.345	-1.999	.051	-.803	.002					
	HF[ms^2]×Sex	.635	.294	.391	2.160	**.035**	.045	1.224					

Table ~~S2~~S1. Hierarchical regression analysis for physiological extinction recall (~~d~~ERI) with all REM variables included in the model. Note that smaller ~~d~~ERI denotes better extinction recall. HF[ms^2]: Absolute power of high frequency heart rate variability; %REM: Proportion of REM sleep to total sleep time; REMD: REM density; REMF: REM fragmentation; REML: REM latency.

Model	Predictors	B	SE	β	t	p	95% CI						
1	**Age**	-.265	.655	-.045	-.404	.687	-1.569	1.039					
	Sex	.029	7.341	.000	.004	.997	-14.589	14.646					
	Medication	-17.151	8.405	-.232	-2.041	.045	-33.886	-.415					
	%REM	.246	.543	.055	.453	.652	-.836	1.328					
	REMD	2.663	.993	.317	2.681	.009	.685	4.640					
	REML	.066	.078	.103	.847	.400	-.090	.222					
	REMF	.823	.671	.145	1.227	.224	-.513	2.159					
									Change			**ANOVA**	
									ΔF	**p**	**Adj. R^2**	**F**	**p**
2	**Age**	-.433	.640	-.073	-.676	.501	-1.707	.842					
	Sex	1.142	7.143	.018	.160	.873	-13.083	15.368	5.681	**.020**	.137	2.671	**.012**
	Medication	-20.916	8.312	-.283	-2.516	**.014**	-37.471	-4.362					
	%REM	.217	.528	.048	.411	.682	-.834	1.268					
	REMD	2.399	.971	.286	2.472	**.016**	.466	4.332					
	REML	.067	.076	.103	.877	.383	-.085	.218					
	REMF	.800	.651	.141	1.228	.223	-.498	2.097					
	HF[ms^2]	-6.940	2.912	-.251	-2.384	**.020**	-12.740	-1.141					

Table ~~S3~~S2. Hierarchical regression analysis for subjective extinction recall (sERI) with all REM variables included in the model. Note that smaller sERI denotes better extinction recall. HF[ms^2]: Absolute power of high frequency heart rate variability; %REM: Proportion of REM sleep to total sleep time; REMD: REM density; REMF: REM fragmentation; REML: REM latency.

Model	Predictors	B	SE	β	t	p	95% CI						
1	**Sex**	-.531	.345	-.213	-1.539	.130	-1.221	.160					
	Medication	.017	.386	.006	.045	.964	-.757	.791					
	%REM	-.043	.025	-.234	-1.763	.083	-.093	.006					
	REMD	.143	.053	.379	2.718	.009	.037	.248					
	REML	-.008	.003	-.323	-2.481	.016	-.015	-.002					
									Change			**ANOVA**	
									ΔF	**p**	**Adj. R^2**	**F**	**p**
2	**Sex**	-.581	.337	-.233	-1.726	.090	-1.256	.094	2.700	0.076	0.164	2.686	**0.019**
	Medication	.088	.382	.030	.231	.818	-.679	.855					
	%REM	-.049	.024	-.266	-2.051	**.045**	-.098	-.001					
	REMD	.151	.052	.402	2.914	**.005**	.047	.256					
	REML	-.010	.003	-.390	-2.981	**.004**	-.017	-.003					
	RMSSD	-.872	.396	-.375	-2.200	**.032**	-1.667	-.077					
	RMSSD×Sex	1.209	.580	.369	2.085	**.042**	.046	2.371					

Table ~~S4~~S3. Hierarchical regression analysis for physiological extinction recall (~~d~~ERI). RMSSD and RMSSD × Sex interaction were significant predictors. Note that smaller ~~d~~ERI denotes better extinction recall. %REM: Proportion of REM sleep to total sleep time; REMD: REM density; REML: REM latency; RMSSD: Root mean square of successive differences.

Model	Predictors	B	SE	β	t	p	95% CI						
1	**Age**	-.506	.630	-.085	-.803	.424	-1.761	.748					
	Sex	-.224	7.153	-.004	-.031	.975	-14.458	14.010					
	Medication	-14.982	8.278	-.203	-1.810	.074	-31.456	1.492					
	REMD	2.917	.970	.348	3.006	.004	.986	4.849					
									Change		**ANOVA**		
									ΔF	**p**	**Adj. R^2**	**F**	**p**
2	**Age**	-.628	.620	-.106	-1.013	.314	-1.861	.605	4.515	**0.037**	0.133	3.265	**0.010**
	Sex	.062	7.002	.001	.009	.993	-13.875	13.999					
	Medication	-18.339	8.255	-.248	-2.222	**.029**	-34.770	-1.909					
	REMD	2.758	.953	.329	2.895	**.005**	.862	4.655					
	RMSSD	-12.436	5.853	-.225	-2.125	**.037**	-24.085	-.787					

Table ~~S5~~S4. Hierarchical regression analysis for subjective extinction recall (sERI). Addition of RMSSD significantly increased the proportion of variance explained by the model. Note that smaller sERI denotes better extinction recall. REMD: REM density; RMSSD: Root mean square of successive differences.

								ANOVA		
Predictors	**B**	**SE**	**β**	**t**	**p**	**95% CI**		**Adj. R^2**	**F**	**p**
Sex	-.604	.325	-.236	-1.856	.068	-1.255	.046	.141	3.702	**.009**
%REM	-.050	.023	-.271	-2.190	**.032**	-.096	-.004			
REMD	.139	.051	.362	2.755	**.008**	.038	.241			
REML	-.009	.003	-.359	-2.933	**.005**	-.016	-.003			

Table ~~S2~~S5. Linear regression analysis for physiological extinction recall (ERI). Non-contributory predictors included in the original model (see the manuscript) are removed. Note that smaller ERI denotes better extinction recall. %REM: Proportion of REM sleep to the total sleep time; REMD: REM density; REML: REM latency.

								ANOVA		
Predictors	**B**	**SE**	**β**	**t**	**p**	**95% CI**		**Adj. R^2**	**F**	**p**
REMD	2.363	.876	.268	2.698	**.008**	.624	4.103	.062	7.277	**.008**

Table ~~S3~~S6. Linear regression analysis for subjective extinction recall (sERI). Non-contributory predictors included in the original model (see the manuscript) are removed. Note that smaller sERI denotes better extinction recall. REMD: REM density.

								ANOVA		
Predictors	**B**	**SE**	**β**	**t**	**p**	**95% CI**		**Adj. R^2**	**F**	**p**
Sex	-.559	.324	-.224	-1.726	.090	-1.208	.090	.179	3.177	**.010**
%REM	.158	.052	.420	3.063	**.003**	.055	.261			
REMD	-.051	.024	-.273	-2.115	**.039**	-.099	-.003			
REML	-.010	.003	-.392	-3.024	**.004**	-.017	-.003			
HF[ms^2]	-.413	.198	-.356	-2.092	**.041**	-.809	-.017			
HF[ms^2]×Sex	.630	.285	.389	2.211	**.031**	.059	1.202			

Table ~~S4~~S7. Final model in the hierarchical regression analysis for physiological extinction recall (ERI), after non-contributory predictors included in the original model (see the manuscript) are removed. Note that smaller ERI denotes better extinction recall. %REM: Proportion of REM sleep to the total sleep time; HF[ms^2]: Absolute power of high frequency heart rate variability; REMD: REM density; REML: REM latency.

								ANOVA		
Predictors	**B**	**SE**	**β**	**t**	**p**	**95% CI**		**Adj. R^2**	**F**	**p**
Medications	-17.781	8.015	-.241	-2.218	**.029**	-33.727	-1.834	.140	5.568	**.002**
REMD	2.722	.902	.324	3.019	**.003**	.928	4.516			
HF[ms^2]	-6.619	2.877	-.240	-2.301	**.024**	-12.343	-.895			

Table ~~S5~~S8. Final model in the hierarchical regression analysis for subjective extinction recall (sERI), after non-contributory predictors included in the original model (see the manuscript) are removed. Note that smaller sERI denotes better extinction recall. %REM: Proportion of REM sleep to the total sleep time; HF[ms^2]: Absolute power of high frequency heart rate variability; REMD: REM density.

Reliability of Heart Rate Variability Measures Across Baseline and Consolidation Nights

To examine the stability of vagally mediated heart rate variability across baseline and consolidation nights, we calculated the intraclass correlation coefficients (ICC) for both HF[ms^2] and RMSSD. Heart rate variability indexes from the baseline night was reported in a previous study (Daffre et al. 2023), which calculated the HRV metrics differently from the current study. In the previous study, time-weighted averages (in contrast to the simple averages in the current study) were used for all indexes, and frequency domain metrics were calculated using Fourier transformation (in contrast to the autoregressive method used in the current study). Despite these methodological differences, both indexes showed high reliability across the two nights:

	ICC	**95% Confidence Interval**	
HF-HRV	0.92	.864	.948
RMSSD	0.90	.835	.936

*HF-HRV: High-frequency heart rate variability; ICC: Intraclass correlation coefficient.

Association of Heart Rate Variability With Demographic and Clinical Variables

HF[ms^2] was not associated with age ($F(1,89)=1.137$, $p=0.289$), sex ($F(1,89)=0.199$, $p=0.656$), PTSD diagnosis ($F(1,89)=.264$, $p=0.608$), depressive symptom severity as measured by Quick Inventory of Depressive Symptomatology (QIDS; $F(1,89)=0.795$, $p=0.375$) or the severity of posttraumatic stress symptoms as measured by Clinician-Administered PTSD Scale for DSM-5 (CAPS-5; $F(1,89)=0.444$, $p=0.507$). Medication use (benzodiazepines or antidepressants) was associated with lower HF[ms^2] ($F(1,89)=5.123$, $p=0.026$).

Daffre C, Oliver KI, Nazareno JRS, Mader T, Seo J, Dominguez JP, Gannon K, Lasko NB, Orr SP and Pace-Schott EF (2023) Rapid eye movement sleep parasympathetic activity predicts wake hyperarousal symptoms following a traumatic event. *J Sleep Res* **32**(1)**,** e13685. https://doi.org/10.1111/jsr.13685.