

Methods

Sample and Psychometric Assessment

Participants were recruited via online advertisement (<https://www.stellenwerk.de>). In order to oversample individuals with a history of ACEs, the study was also advertised in psychiatric institutions, counseling centers and self-help programs. Inclusion criteria were age between 18 and 65 years, fluency in German and able to provide written informed consent. Exclusion criteria were contradictions to magnetic resonance imaging, head or brain surgery, history of any neurological disorder, left handedness, chronic pain disorders, colour blindness, hearing impairment, current substance-related disorders, current participation in drug-associated studies, use of benzodiazepines during the last week and/or neuroleptic medication during the last three months. Individuals interested in the study, filled out an online screening questionnaire including demographic data and the Childhood Trauma Questionnaire - Short form (CTQ-SF; (1)). Eligible individuals were assigned to the ACE group when their CTQ scores exceeded the “moderate to severe” cut-off for at least one subscale (1). As pre-registered, group assignment based on the CTQ was preliminary and final group assignment for analyses was based on the German version of the Maltreatment and Abuse Chronology of Exposure questionnaire, named KERF (Belastende Kindheitserfahrungen) (2). The KERF represents a more in-depth assessment instrument but was considered too time-consuming for online pre-screening purposes (3). It covers 75 items across ten subscales (i.e., parental verbal abuse, parental nonverbal emotional abuse, parental physical abuse, emotional neglect, physical neglect, witnessed violence parents, witnessed violence siblings, emotional abuse peers, physical abuse peers, sexual abuse). In addition to a binary yes–no response, individuals can indicate the age of occurrence, as well as

respective perceived helplessness and fear. If the cutoff (2) of any subscale was met, the individual was assigned to the ACE group.

Matching of the participants with and without a history of ACEs was attempted as closely as possible regarding gender, age, and years of education given the available screening sample (Total $n = 2048$) from which participants were recruited. We aimed to recruit 180 participants ($n = 90$ per group), while expecting a drop-out rate of 10 %. For power-calculations, see preregistration (<https://doi.org/10.17605/OSF.IO/W3ARJ>). After study completion, participants were reimbursed with course credit or 60 €. The study procedure was approved by the ethics committee of the University of Hamburg and data were collected at the Department of Systems Neuroscience at the University Medical Center Hamburg-Eppendorf. Next to the ACE assessment instrument, participants were asked to complete an online battery of questionnaires for purposes other than the present study (i.e., in the context of a larger collaborative research initiative), including the Trier inventory for chronic stress (Trier Inventar zum chronischen Stress, TICS-9; (4)), the State-Trait-Anxiety Inventory (STAI-T and STAI-S, (5)), the MacArthur Scale of Subjective Social Status (6), the Life Stressor Checklist – Revised (LSC-R; (7)), the short form of the Intolerance of Uncertainty Scale (IUS; (8)), the Inventory of Depression and Anxiety Symptoms (IDAS-II; (9)), the Childhood Trauma Questionnaire - short form (CTQ-SF; (1)), the Arousal Predisposition Scale (APS; (10)) and the positive dimension of the Community Assessment of Psychic Experiences (CAPE; (11)).

Paradigm

Participants underwent a fear conditioning task in an MR scanner. The fear conditioning paradigm consisted of five phases (habituation, fear acquisition training, fear generalization, fear extinction training, and a ROF test phase following a fear reinstatement manipulation). All phases

were completed on the same day. The task was displayed using Presentation Software (Neurobehavioral Systems, Inc., Albany, California). Five colored circles with a resolution of 172 * 172 pixels served as conditioning stimuli (CS) and participants viewed the stimuli through a mirror in the MR scanner. The color of the circles varied along a blue–green dimension. The most blue (HEX #2914cc) and most green (HEX #14cc29) stimuli served as CS+ and CS-, counterbalanced across participants. The stimuli in between served as generalization stimuli (GS). This set of stimuli was designed for a prior study (see preregistration: <https://osf.io/cfqm9/>) using an open source color gradient software to ensure the same degree of difference in color between the stimuli (<https://colordesigner.io/gradient-generator>). The habituation phase started with the presentation of five startle probes (burst of white noise, 95dB, see below for details) and three presentations of CS+ and CS-. At the end of the habituation phase, participants were informed that from now on the occurrence of electrical stimulation was possible at all times without providing specific information about the CS-US contingencies or the learning element. During the fear acquisition training phase, the CS were presented 20 times each, and during the subsequent fear generalization phase all CS and GS were presented 12 times each, resulting in 60 trials. The CS-US reinforcement rate was 80% during both the fear acquisition training and generalization phase and the US was always presented 500 ms before CS+ offset. A partial reinforcement rate was chosen to ensure robust conditioning while preserving sensitivity to individual differences and reducing collinearity between the CS+ and US regressors. The extinction training phase consisted of 20 unreinforced CS+ and CS- presentations each. One second after the end of the extinction training phase, two unannounced US were presented 5000 ms apart (reinstatement manipulation), while participants viewed a black screen. During the following return of fear (ROF) test phase, both CS were presented five times each without reinforcement. Stimuli were presented between 6000 - 8000 ms with an inter-trial interval (ITI)

of 10000 - 16000 ms. During the ITI, a white fixation cross was presented on a black screen. For the assessment of the fear potentiated startle (FPS), a startle probe consisting of 95 dB bursts of white noise was delivered binaurally through headphones in 30% of the CS as well as ITIs presentations at fixed positions across all experimental phases, delivered between 3000 and 5500 ms after stimulus or ITI onset. At the end of each experimental phase, participants were asked to provide US-expectancy, valence, arousal and fear ratings for the CS presented in the preceding phase, as well as US-aversiveness, and startle-aversiveness ratings on a visual analog scale (VAS; anchors “0” = not at all; “100” = extremely).

Electrotactile Stimulus

An electrotactile stimulation served as unconditioned stimulus (US). It was delivered to the back of the participant's right hand between the metacarpal bones of the index and middle finger, using a 1 cm diameter platinum pin surface electrode (Specialty Developments, Bexley, UK). The stimulation consisted of three 2ms rectangular pulses with an interpulse interval of 50 ms. The pulse was delivered via a Digitimer DS7A constant current stimulator (Welwyn Garden City, Hertfordshire, UK). Before the start of the actual experiment, the electrotactile stimulation was calibrated to the maximum tolerable intensity for the participant, reflected as a 7-8 on a scale from 1 (not unpleasant at all) to 10 (extremely unpleasant).

Emotion Ratings and Contingency Awareness

Following the final phase of the experimental task, participants rated the intensity of 22 discrete emotions (e.g., anxious, calm, tense, guilty, amused) they experienced during the task. Each emotion was rated on a visual analog scale (VAS) ranging from 0 (“not at all”) to 100 (“extremely”). Lastly, to assess CS-US contingency awareness at the end of the experiment, participants were shown all five CS and GS and asked which stimulus they thought was paired with the electrical stimulation.

Salivary Cortisol

To assess the physiological stress response, salivary cortisol was measured before and after the experimental task. Two saliva samples were collected using Salivette collection devices (Sarstedt, Germany): one 20 minutes prior to the start of the experimental paradigm and a second one 20 minutes after task completion (i.e., approx. 120 min after the first sample). Samples were stored at -18°C until analysed in a single batch and analyzed using a luminescence assay (IBL, International, Hamburg, Germany). For this study, only the baseline cortisol level was analyzed.

Skin Conductance Recording and Preprocessing

SCRs were measured with two self-adhesive Ag/AgCl electrodes attached to the distal and proximal palmar surface of the left hand (12). Data was recorded continuously at 1000 Hz with a CED2502-SA skin conductance unit together with a Biopac MP100-amplifier system (BIOPAC Systems Inc, Goleta, California, USA) with Spike 2 software (Cambridge Electronic Design, Cambridge, UK). During preprocessing, SCRs were filtered with a 10 ms median filter and a band-pass filter with a low-pass of 5 Hz and a high-pass of 0.03 Hz and then down-sampled to 10 Hz. SCR amplitudes (in μS) were then scored semi-manually by employing a trough-to-peak

approach (12) as reported previously (13) as the first response starting 900 to 4000 ms after stimulus onset with a rise time of 500 – 5000 ms. Non-responses (SCRs smaller than $0.01\mu\text{S}$) were scored as zero and trials showing recording artifacts were scored as missing data points. To normalize the distribution, data was log10-transformed and then range-corrected (dividing each SCR value by the max. SCR for each participant) to account for interindividual differences (14).

Startle Response Recording and Preprocessing

Startle data were acquired through EMG recordings within the MR-scanner using a FaceEMG Cap-MR (EasyCap GmbH, Herrsching, Germany). Five Ag/AgCl electrodes, including 5 kOhm resistors, were attached to the cap to facilitate the wire management in the magnetic field. The skin was prepared with an abrasive electrode gel. Two EMG electrodes were placed below the participant's left eye on the orbicularis oculi muscle, one EMG electrode was placed on the participant's forehead as a reference, and two electrocardiogram (ECG) electrodes were placed at the participant's back. The maximum transmission resistance threshold was set to 20 kOhm. EMG data were recorded using the BrainVision Recorder software and the BrainAmp ExG MR amplifier (Brain Products GmbH, Gilching, Germany) as well as the SyncBox device for synchronization of recorded data and MR gradient switching. As described in (13), the startle data was pre-processed using the built-in Brain Vision Analyzer MR gradient correction by subtraction of an artifact template averaged over seven EPI volumes from the raw signal. The signal then was downsampled to 1000 Hz. Eye-movement related artifacts were reduced by applying a low cutoff filter of 60 Hz with a time constant of 0.0027 and 48 db/oct. Lastly, the signal was rectified and segmented relative to the respective marker. Startle probe responses were then scored semi-manually using a custom-made program by employing a trough-to-peak approach (13,15). Only blinks starting 20–120 ms after probe onset were scored (15,16). Not

detectable blinks were scored as zero responses. Trials with excessive electrode or baseline artifacts, as well as blinks in the time window -50 ms to 20 ms relative to a startle probe were scored as missings. For statistical analyses, eye-blink amplitudes were T-transformed.

MRI/fMRI

For functional scans, we used an echo planar image sequence (repetition time (TR) = 1490 ms, echo time (TE) = 30 ms). For each volume, 42 slices with a voxel size of $1.7 \times 1.7 \times 1.7$ mm (1 mm gap) were acquired. A T1-weighted structural image (TR = 2300 ms, TE = 2.98 ms, flip angle = 9° , 240 slices, FOV = 256 mm, voxel size $1 \times 1 \times 1$ mm³) was obtained by using a 3D magnetization prepared rapid gradient echo (MPRAGE) sequence. Data processing was carried out using SPM12 in MATLAB 2023a (The MathWorks, Natick, MA, USA). To account for T1 equilibrium effects, the initial five volumes of each time series were discarded. A preprocessing pipeline including slice timing, realignment, skull stripping, co-registration to the individual mean functional image, normalization and smoothing with a full-width half maximum Gaussian kernel of 6 mm was applied.

Statistical Analyses

Main effect of task.

For the full sample (main effect of task), paired t-tests were calculated, comparing CS+ and CS- responses averaged across trials for all subjective ratings, SCR and FPS for each experimental phase. Additionally, for the fear generalization phase, a one-way ANOVA with stimulus type as within-subject factor was calculated. Post hoc two-tailed paired t-tests were used to compare the responses to the different CS and GS. For the fear extinction phase, a 2×2 repeated-measures ANOVA with phase (early extinction, late extinction) and stimulus type (CS+, CS-) as within-subjects factors was conducted. Post hoc two-tailed paired t-tests were used to compare the responses to the CS for early and late

extinction phase. Of note, for SCR and fMRI analyses the first trial of each CS type during acquisition as well as extinction training was excluded, as no learning of CS-US contingencies or changes thereof during extinction could have possibly taken place at this point. For the BOLD fMRI data, for the whole sample, t-tests were conducted at the second level, for the contrasts CS+ > CS- and CS- > CS+ for each experimental phase. For the fear generalization phase, additionally, a GLM with 5 levels (CS+, GS+, GSA, GS-, CS-) was calculated. For the fear extinction phase, the CS+ > CS- and CS- > CS+ contrasts were calculated separately for early and late extinction.

Regions of Interest

Small volume corrections were conducted for the following regions of interest (ROI) with anatomical masks extracted from the Harvard-Oxford atlas (17) using a maximum probability threshold of 0.5 for the bilateral amygdala, hippocampus, caudate nucleus, putamen, pallidum, nucleus accumbens and thalamus. The ROI for the anterior insula was defined as the intersection between the thresholded Harvard-Oxford anatomical mask (probability threshold: 0.5) and a 60 × 30 × 60 mm box centered at MNI coordinates (0, 30, 0), based on anatomical subdivisions described in (18). The cortical dlPFC and dACC ROIs were constructed as 20 × 16 × 16 mm boxes centered on peak voxels identified in a meta-analysis (19). For the dACC, the x-coordinate was set to 0 to ensure symmetry around the midline (left dlPFC: MNI -36, 44, 22; right dlPFC: 34, 44, 32; dACC: 0, 18, 42). Following previous work (20), the vmPFC ROI was created as a 20 × 16 × 16 mm box centered on coordinates based on previous work (vmPFC: MNI 0, 40, -12; e.g., 21, 22), again the x-coordinate was set to 0 to obtain the mask symmetrical around the midline.

Results

Missing Data

Data were originally collected from 183 participants but procedural and technical problems resulted in a final sample of 171 participants. Four participants were excluded for procedural and technical reasons (discontinued the experiment after completing the habituation phase ($n=1$), technical problems with the electro-tactile stimulation ($n=1$), participation in a study using the same experimental paradigm ($n=2$). Eight participants were excluded because they did not complete the online survey, which included the KERF among other questionnaires, leaving a sample of 171 participants. Due to missing data for individual outcome measures and experimental phases, sample sizes vary: Nine participants discontinued the experiment early: Five participants discontinued the experiments after the acquisition phase, and five participants after the generalization phase. For one participant, the US electrode got loose after acquisition training, hence only data from the acquisition phase was analyzed for them and four more participants reported not receiving reinstatement shocks, which led to their exclusion from the analyses for the ROF phase. Due to a technical error, the habituation data from one participant is missing.

For ratings, data from three subjects are missing (all phases: $n=1$, acquisition phase: $n=1$, generalization phase: $n=1$). For SCR analyses, technical problems led to the exclusion of three participants (after acquisition phase: $n=1$, after generalization phase: $n=2$). For FPS analyses, technical problems led to the exclusion of 19 participants. For fMRI analyses, four participants had to be excluded because of missing anatomical scans ($n=2$) or severe artifacts ($n=2$). For two participants, markers were incomplete for the acquisition phase ($n=1$), for the extinction phase ($n=1$) and the ROF phase ($n=1$). Forty-four participants were classified as physiological SCR

non-responders and excluded from data analysis, as they showed responses to the US in less than 67% of trials across fear acquisition training and generalization phase (23). For startle, thirty-four participants were classified as physiological non-responders and excluded from further data analyses as they showed null-responses responses to the startle probes (across stimuli) in more than 67% of potentially valid trials across startle habituation and fear acquisition training (13).

Sample Description

Groups did not differ in average age, education level, baseline cortisol levels, US-aversiveness ratings, US-intensity or startle sound aversiveness. As expected, more individuals with ACEs met the criteria for current and lifetime psychiatric diagnosis and consequently reported significantly higher STAI-T levels, lower GAF as well as lower childhood but also currently perceived social status. Despite attempts to match both groups as closely as possible, females were overrepresented in the group with ACEs.

Sensitivity analyses

Despite attempts to match both groups as closely as possible, females were overrepresented in the group with a history of ACEs. Sensitivity analyses including sex as covariate showed that, in general, males and females did not differ in their responses towards the CS, with exception for fear ratings after fear acquisition (i.e., females had higher fear ratings for the CS+ compared to males). The interaction between the dichotomous ACE measure and sex was significant for fear ratings after the extinction phase ($p = .038$), as women with ACEs show higher fear responses after fear extinction than men with ACEs. For ROF expectancy ($p = .023$) and valence ($p = .012$) ratings the interaction effect seems to be driven by men, as men with ACEs have strongly reduced US-expectancy and valence ratings compared to men without ACEs, while for women this difference is not as pronounced. As men are underrepresented among the

individuals with ACEs in the present sample, this sex-specific effect, however, does not affect interpretation of results. Also for FPS data, during fear acquisition, this interaction was statistically significant ($p = .001$) as men with ACEs showed higher startle responses than men without ACEs, for women, this difference was not significant.

Fear Acquisition

Fear acquisition training was successful in all behavioral and physiological outcome measures as indicated by stronger responses to the CS+ as compared to the CS- (all p 's < 0.001). Whole brain analyses for the CS+ > CS- contrast during the fear acquisition phase showed widely distributed, typical activation patterns for differential fear conditioning (19), including in the anterior Insula, Caudate, Pallidum, Putamen, Thalamus, dACC and vmPFC as well as the Amygdala and Hippocampus. For the CS- > CS+ contrast, we observed stronger activation in the vmPFC.

Fear Generalization

During fear generalization, one-way ANOVAs and respective post-hoc pairwise comparisons showed significant differences between CS and GS responses (all p 's < 0.05 , except for the pairwise comparison of CS- vs. GS- for valence ratings which was non-significant), with a gradual increase in all ratings with increasing similarity to the CS+. The SCR data for the generalization phase showed a similar pattern, but with numerically smaller discrimination between the generalization stimuli: Post-hoc t-tests revealed significant discrimination between CS+ and GS+ ($p < .001$) as well as GSA and GS- ($p = .003$) but the pairwise comparisons of GS+ vs. GSA and GS- vs. CS- were non-significant ($p > .05$). For FPS data, the one-way ANOVA showed a main effect for stimulus and respective post-hoc pairwise comparisons showed significant differences between stimuli. The increase in responses, however, was not gradual, as

the most ambiguous stimulus (GSA) elicited significantly lower responses compared to both the GS+ and GS-. At a neural level, a very similar activation pattern was observed for both contrasts (i.e., CS+>CS- and CS->CS+) as during the fear acquisition training phase. For the CS- > CS+ contrast, however, we observed additional activation of the left hippocampus.

Fear Extinction

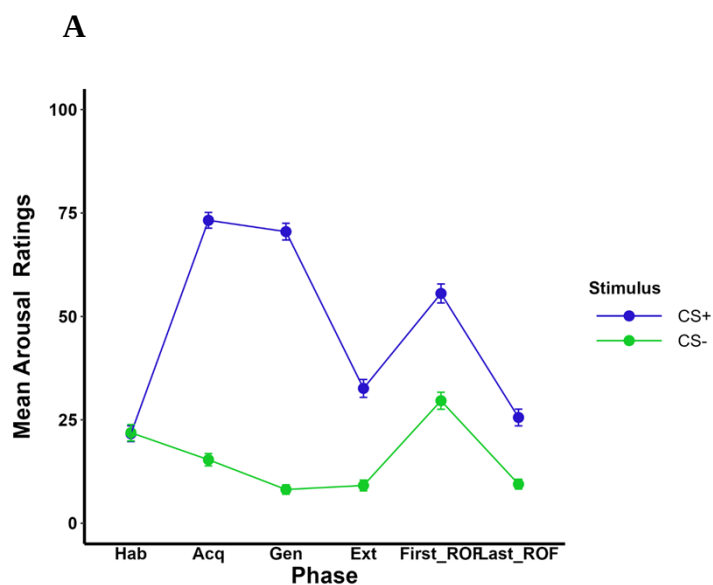
During fear extinction training, the mean difference in responses towards the CS+ and CS- still reached significance for subjective ratings, SCRs and FPS (all p 's < .05). When dividing the 20 trials into "early" and "late" extinction phase, the respective 2 x 2 ANOVA for SCRs revealed a significant interaction between stimulus type (CS+, CS-) and phase (early extinction, late extinction), $F(1, 115) = 9.14$, $p = .003$, $\eta^2 = .06$. Follow-up pairwise comparisons confirmed that during early extinction, responses to the CS+ were significantly higher ($M = 0.04$, $SE = 0.007$) than to the CS- ($M = 0.02$, $SE = 0.004$), $t(115) = 4.26$, $p < .001$. During late extinction, this difference is not significant anymore, $t(115) = 0.52$, $p = .61$. For the FPS, however, the interaction between stimulus type and phase did not reach statistical significance, $F(1, 97) = 0.33$, $p = .57$. For imaging data, no significant effects for the CS+>CS- contrast were observed in the whole-brain analysis, for the whole phase, but similarly when comparing (as preregistered) the contrast across early and late extinction training. Of note, it has been shown that higher CS-US reinforcement rates during acquisition, lead to faster extinction learning (24) and also the SCR data from the fear extinction phase indicate that the CR diminished very fast. More precisely, after only five trials, subjects did not differentiate in their SCR between CS+ and CS- anymore. In a corresponding fMRI analysis including only the first five stimulus presentations, the expected activation patterns are shown for the whole-brain. Of note, in line with that, also ACE severity was associated with a reduction in the CS+ > CS- contrast in the right anterior insula

($p_{FWE} = .036$), the left pallidum ($p_{FWE} = .047$) as well as the right amygdala ($p_{FWE} = .021$), but only during the first five trials of extinction training (i.e., fear recall). Despite successful extinction learning across the whole sample, the change in responses towards the CS+ and CS- from the end of extinction to the first ROF trial, differed between individuals with and without a history of ACEs. A respective 2x2x2 ANOVA revealed significant interactions between Phase (Extinction, ROF), ACEs and Stimulus for all ratings types, driven by reduced increase in the CS+ response in individuals with ACEs (see Table 2).

Return of Fear

During the Return of Fear test phase after reinstatement, participants responded on average higher towards the CS+ compared to the CS- across all ratings. (all p 's < .001). However, the SCRs for CS+ and CS- did not differ significantly during the return of fear phase ($p > 0.05$). See Figure S1 and Table S1 for details. For imaging data, significant effects for the CS+>CS- contrast were observed in the left anterior insula, the palladium, left putamen, thalamus and left hippocampus.

Figure S1



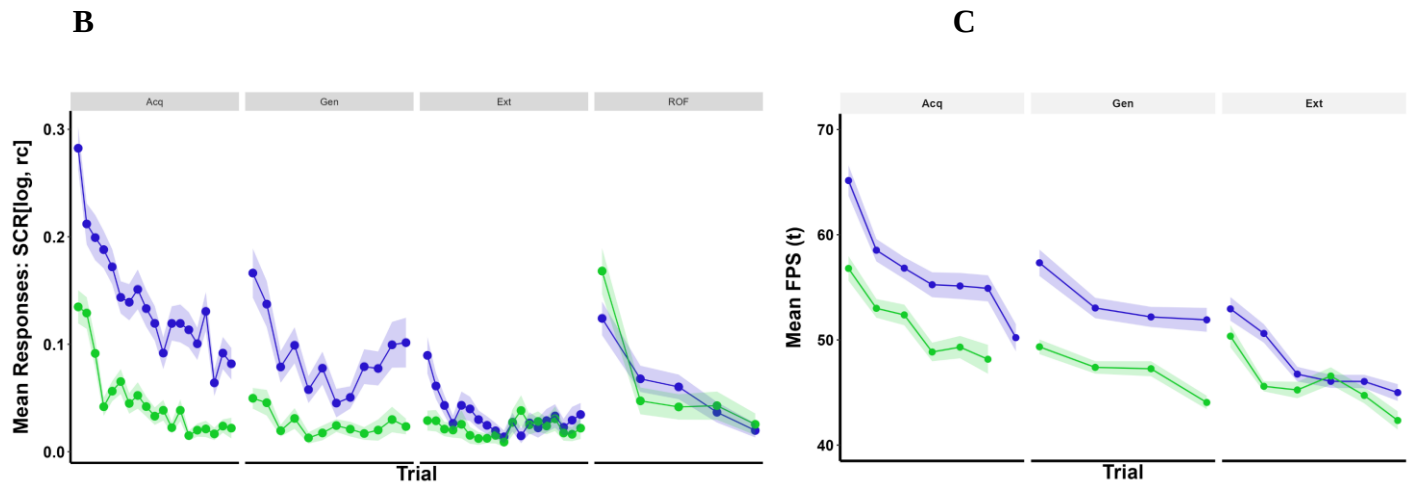


Figure S1. **A.** Mean arousal ratings across all experimental phases for the CS+ (blue) and CS- (green). Error bars represent the standard error of the mean. **B.** Trial-by-trial SCR data across all experimental phases for the CS+ (blue) and CS- (green). Ribbons represent the standard error of the mean. **C.** Trial-by-trial FPS data across all experimental phases for the CS+ (blue) and CS- (green). For the Return of Fear (ROF) test phase, there were insufficient valid data points. Ribbons represent the standard error of the mean.

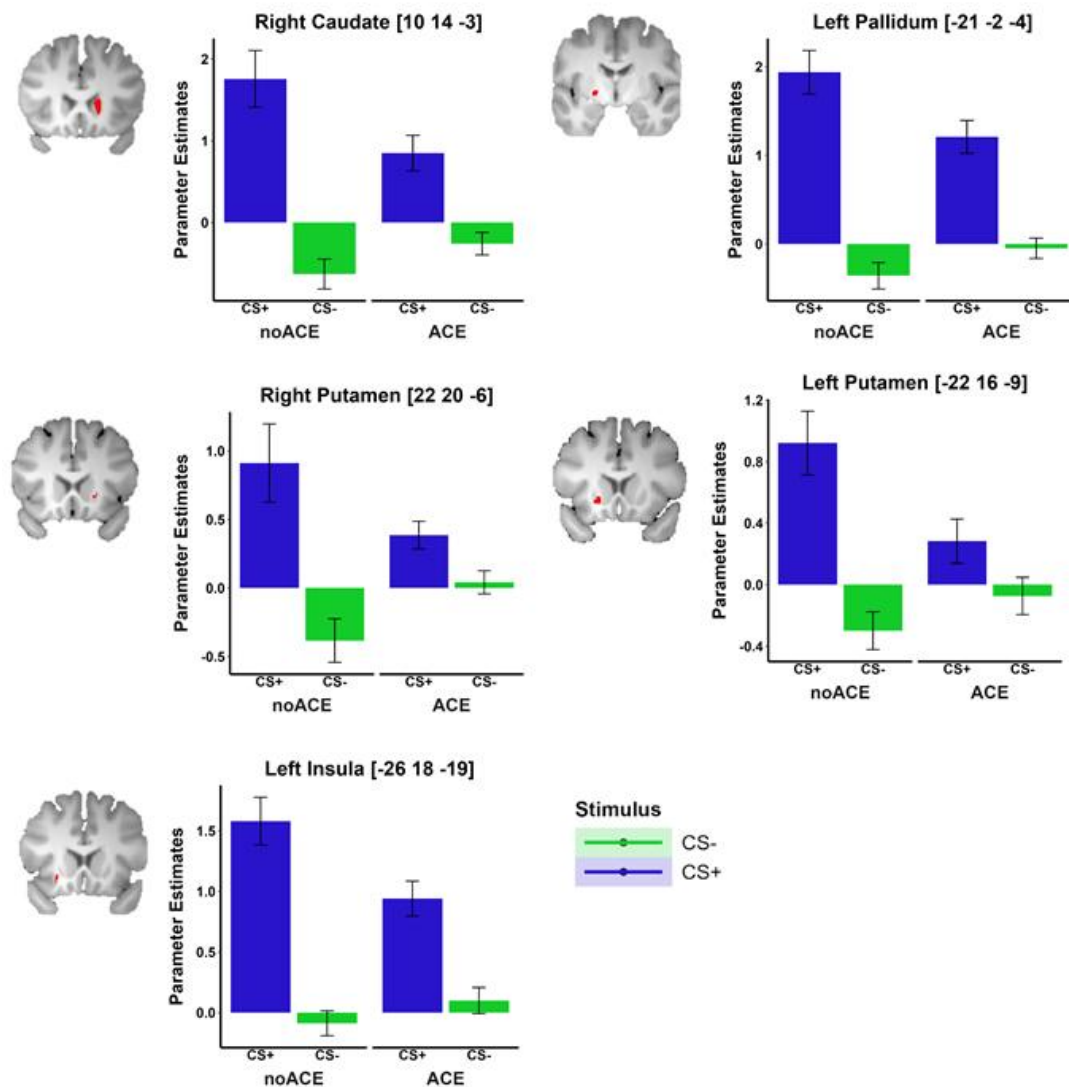
Figure S2

Figure S2. CS+ > CS- contrast during fear acquisition for individual with and without ACEs. Betas were extracted from each clusters' peak voxel. Visualization threshold was set to $p = .01$. Error bars represent the standard error of the mean.

Generalization - Linear Deviation Score

No significant effects of exposure to ACEs or ACE load on the LDS were observed for any outcome measure (all p 's > .05, see Figure S3). In arousal ratings there was a trend-wise significant difference for the LDS ($p = .056$) between individuals with and without ACEs. More precisely, on a descriptive level, individuals with a history of ACEs showed a smaller (i.e., more

linear) generalization gradient compared to individuals without. At a neural level, extracted parameter estimates from the ROIs were used to calculate the LDS per subject. While there were no significant ACE-related differences in LDS, however, these gradients confirm that individuals with and without ACEs differ specifically in response to the CS+ (and GS+), see Figure 3.

Figure S3

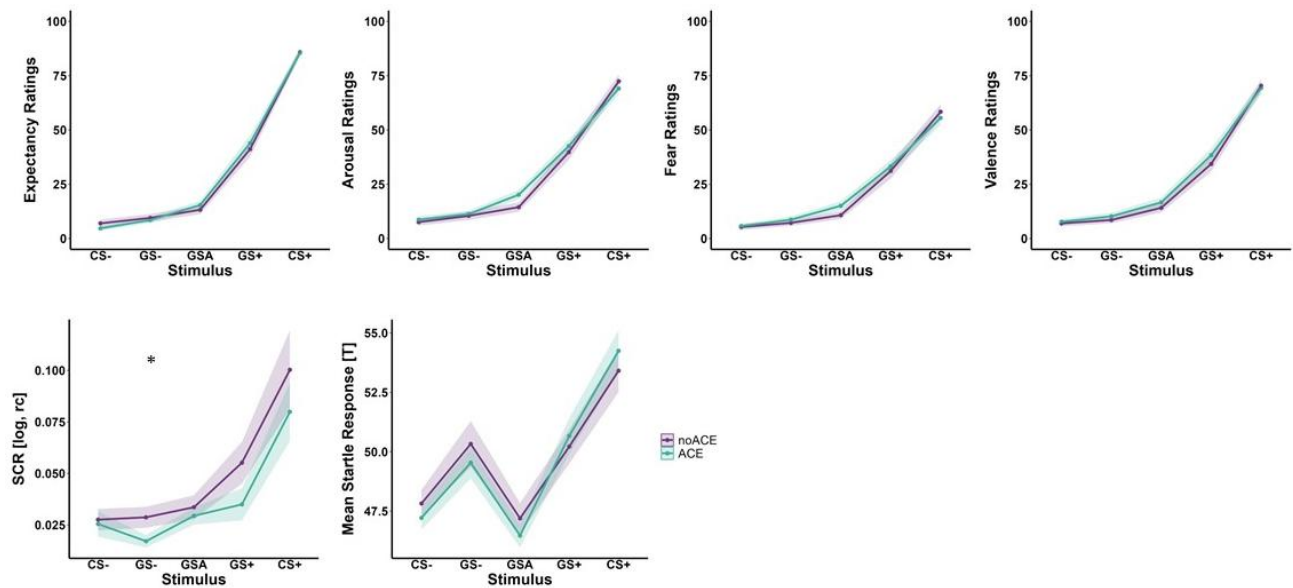


Figure S2. Generalization gradients for ratings, SCR and FPS illustrating group differences in individuals with ACEs and without ACEs in responding to the CS-, CS+ as well as three generalization stimuli (GS-, GSA, GS+)

Supplementary Table 1: Main effect of task

Outcome		Measure	t	df	p	Cohen's d	CI 95%
CS Discrimination	Acquisition training						
		Expectancy ratings	40.95	168	<.001	3.15	[73.0 - 80.4]
		Arousal ratings	27.46	168	<.001	2.11	[53.72 - 62.04]
		Valence ratings	28.52	168	<.001	2.19	[54.2 - 62.3]
		Fear ratings	19.97	168	<.001	1.54	[41.6 - 50.7]
		SCR	10.14	126	<.001	0.90	[0.07 - 0.11]
		FPS	7.83	117	< .001	0.72	[3.89 - 6.5]
	Generalization						
		Expectancy ratings	46.25	162	<.001	3.62	[76.58 - 83.42]
		Arousal ratings	29.08	162	<.001	2.28	[58.11 - 66.58]
		Valence ratings	29.17	162	<.001	2.29	[58.18 - 66.63]
		Fear ratings	22.66	162	<.001	1.73	[46.78 - 55.7]
		SCR	6.38	120	<.001	0.5	[0.04 - 0.08]
		FPS	8.803	108	<.001	0.84	[4.98 – 7.87]
	Extinction						
		Expectancy ratings	13.46	158	<.001	1.07	[22.83 - 30.68]
		Arousal ratings	12.41	158	<.001	0.98	[19.73 - 27.21]
		Valence ratings	11.89	158	<.001	0.94	[18.78 - 26.25]
		Fear ratings	10.48	158	<.001	0.83	[14.98 - 21.93]
		SCR	3.01	115	.003	0.28	[0.004 - 0.021]
		FPS	3.81	107	<.001	0.37	[1.02 – 3.23]
	ROF						
		Expectancy ratings	12.19	154	<.001	0.98	[26.17 - 36.29]
		Arousal ratings	11.44	154	<.001	0.92	[21.89 - 31.04]
		Valence ratings	11.36	154	<.001	0.91	[22.4 - 31.82]
		Fear ratings	10.02	154	<.001	0.81	[16.67 - 24.85]
		SCR	0.19	111	0.84	-	[-0.02 - 0.02]

		Measure	F	df (GG)	p	η^2
Generalization ANOVA		Expectancy ratings	615.51	2.30, 372.40	<.001	0.696
		Arousal ratings	413.41	2.49, 403.97	<.001	0.540
		Valence ratings	397.14	2.47, 400.02	<.001	0.547
		Fear ratings	277.65	2.22, 360.25	<.001	0.441
		SCR	9.38	1.60, 72.05	<.001	0.087
		FPS	31.80	3.40, 364.03	<.001	0.191
		Measure	F	df	p	η^2
Extinction ANOVA		SCR	9.144	1, 115	.003	.006
		FPS	0.33	1, 97	.566	

Table S1. Complete statistical results for the effect of task for ratings, SCR and startle across all experimental phases.

Supplementary Table 2a: Linear Deviation Score - Group Differences

Outcome		Measure	t	df	p	Cohen's d	95 % CI
	Generalization						
LDS		Expectancy ratings	1.01	161	.312	-	[-2.49 , 7.77]
		Arousal ratings	1.92	161	.056	-	[-0.11, 8.55]
		Valence ratings	1.26	161	.21	-	[-1.63, 7.44]
		Fear ratings	1.76	161	.08	-	[-0.47, 8.15]
		SCR	-0.067	119	.947	-	[- 0.022, 0.021]
		FPS	-0.55	109	.58	-	[-2.31, 1.302]
		Insula	1.64	159	.103	-	[-0.04 - 0.45]
		Caudate	0.96	159	.34	-	[-0.103 - 0.299]
		Hippocampus	1.64	159	.102	-	[-0.034 - 0.37]
		Amygdala	0.09	159	.93	-	[-0.23 - 0.25]
		dACC	1.44	159	.15	-	[-0.08 - 0.53]
		dIPFC	1.34	159	.18	-	[-0.09 - 0.45]
		vmPFC	1.59	159	.11	-	[-0.04 - 0.324]
		Thalamus	0.08	159	.94	-	[-0.25 - 0.27]

Table S2a. Results of independent-samples *t*-tests comparing linear deviation scores (LDS) between individuals with and without a history of ACEs. Reported are *t* statistics, degrees of freedom, and *p*-values.

Supplementary Table 2b: Linear Deviation Score - ACE load

Outcome		Measure	B	SE	95 % CI	t	df	p	R ² partial
	Generalization								
LDS		Expectancy ratings	-0.12	.089	[-0.3, 0.052]	-1.39	161	.17	-
		Arousal ratings	-.09	.076	[-0.24, 0.06]	-1.29	161	.24	-
		Valence ratings	-.06	.079	[-0.22, 0.093]	-.801	161	.42	-
		Fear ratings	-.13	.075	[-0.27, 0.024]	-1.66	161	.099	-
		SCR	-.0006	.0004	[-0.001, 0.0002]	-1.55	119	.124	-
		FPS	.01	.03	[-0.038, 0.081]	.32	132	.75	-
		Insula	-.003	.004	[-0.011, 0.005]	-0.69	159	.49	
		Caudate	-.005	.004	[-0.012, 0.002]	-1.43	159	.15	
		Hippocampus	-.006	.004	[-0.013, 0.001]	-1.65	159	.102	
		Amygdala	-.002	.004	[-0.01, 0.006]	-0.5	159	.62	
		dACC	-.004	.005	[-0.01, 0.007]	-0.68	159	.5	
		dIPFC	-.006	.005	[-0.025, 0.004]	-1.164	159	.246	
		vmPFC	-.005	.003	[-0.011, 0.002]	-1.49	159	.14	
		Thalamus	-.003	.005	[-0.012, 0.007]	-0.548	159	.58	

Table S2a. Results of simple linear regression analyses predicting linear deviation scores (LDS) from ACE load. Reported are regression coefficients (B), standard errors (SE), 95% confidence intervals (CI), *t* statistics, degrees of freedom (df), *p* values, and partial *R*².

Supplementary Table 3: Mediation Analysis

Outcome	Measure	Effect	Estimate	p	95 % CI
	Acquisition				
Mediation	Arousal ratings	ACME	-0.0358	.004	[-0.1061, -0.0006]
		ADE	-0.3597	<.001	[-0.5070, -0.1979]
		Total effect	-0.3954	<.001	[-0.5465, -0.2502]
		Proportion mediated	0.0905	.044	[0.0015, 0.2865]

Table S3. Results of the mediation analysis examining whether CS discrimination during acquisition mediated the association between ACE load and global level of functioning (GAF). Reported are the average causal mediation effect (ACME), average direct effect (ADE), total effect, proportion mediated as well as corresponding estimates, *p* values, and 95% confidence intervals (CI).

Supplementary Table 4: Deviations from Pre-registration

pre-registered specification	deviations	rationale
hair cortisol	hair cortisol has not been analyzed yet	
startle pre processing	startle pre processing was performed in a custom made program (EDAvision) instead of BrainVision Analyzer	We applied the preprocessing and scoring procedure that has been established like this in our lab. Further, that way we used the same scoring tool as for SCR.
FPS data: Exclusion of the first CS+ and CS- presentation of acquisition and extinction training	no trials were excluded	No exclusion was necessary, because the first startle probe was never delivered during first CS+ / CS- presentations
FPS: Participants will be classified as physiological startle non-responders if they show responses to the startle	Of those trials that are non-missing, we exclude people if they have more than 67% zero-responses	We streamlined the preprocessing approaches across other project within the lab.

probes in less than 67% of trials of the startle probes across startle habituation and fear acquisition training (i.e., in more than 11 out of 18 trials; Kuhn et al., 2020).		
Severity analyses: linear regression with KERF sumscore as predictor and CS-discrimination as criterion	Linear regression with an interaction term KERF_sumscore*Stimulus Type Linear mixed models for SCR and FPS data including the KERF sumscore, stimulus type and their interaction as fixed effects, with random intercept for subject and random slope for CS type.	We wanted to be able to derive from the results, which stimulus drives the effect.
fMRI GLM for fear acquisition: Separate regressors for the first CS+ and CS- trials as well as the remaining CS+, the CS - trials will be included and a parametric regressor containing an exponential function to model the increase of the response to the CS+ and CS- over time.	We did not include a parametric regressor.	

Table S4. Deviations from the pre-registration, all of which we consider rather minor, are transparently.

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