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Exposure to Violence and Neglect Images Differentially Influences
Fear Learning and Extinction

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Highlights

- Examined threat and neglect exposure prior to fear conditioning and extinction
- Threat exposure increased autonomic reactivity to the CS+ and impaired safety learning retention
- Neglect exposure attenuated autonomic reactivity to both CSs throughout the task
- There were no effects on subjective distress or CS evaluations
- Different patterns of fear learning and extinction might underlie different adverse experiences

Abstract

The mechanisms by which exposure to adversity contributes to psychopathology development are poorly understood. Recent models link experiences of threat of harm and deprivation to psychopathology via disruptions in learning mechanisms underlying fear acquisition and extinction. We empirically tested dimensional elements of this model, by examining whether exposure to images of community violence or neglect differentially influenced fear learning and extinction relative to exposure to neutral images. Participants

were randomly allocated to one of three exposure conditions: viewing images depicting neglect ($n = 25$), violence ($n = 25$) or control images ($n = 24$). All participants then completed a fear conditioning and extinction task in which the CS+ was paired with an aversive tone, and the CS- was presented alone during conditioning. Both CSs were presented alone during extinction and extinction retest. Skin conductance responses (SCR) and subjective ratings were assessed. Relative to control images, viewing scenes of neglect attenuated SCRs to the CSs during conditioning, extinction and extinction retest. Exposure to images of community violence accentuated SCRs during US anticipation on CS+ trials and impaired the retention of safety learning (larger SCRs to the CS+ compared to the CS- at retest and the CS+ at the end of extinction). No significant group differences emerged in subjective ratings. Findings lend preliminary support for suggestions that adverse experiences may be linked to impairments in fear and safety learning and provide key evidence suggesting that the expression of these impairments may differ as a function of the type of adversity.

Keywords: conditioning, extinction, violence, neglect,

It is widely acknowledged that children who experience adversity and stressful environments during their formative years are at increased risk of developing psychopathology (Lambert, King, Monahan, & McLaughlin, 2017; McLaughlin et al., 2016; Uink, Modecki, Barber, & Correia, 2018). For example, children who endure stressful environments have an elevated risk of developing internalising disorder; maltreated children have an estimated 23% lifetime prevalence of depressive disorders (Chapman et al., 2004; Heim & Binder, 2012; Heim & Nemeroff, 2001). Additionally, maltreated children also have an elevated risk of developing externalising disorders, and as such, are twice as likely to be suspended from school, and display double the amount of aggressive and delinquent behaviours than their non-maltreated peers (Lansford et al., 2002; Price, Higa-McMillan, Kim, & Frueh, 2013). Despite this risk, the mechanisms through which children's exposure to adverse environments increases their likelihood of psychopathological problems remains poorly understood (McCrory & Viding, 2015).

A novel dimensional model of adversity and psychopathology (McLaughlin & Sheridan, 2016) implicates disruptions in learning mechanisms underpinning fear acquisition and extinction among key processes that may tie different early adverse experiences to later problems. McLaughlin and Sheridan (2016) differentiate between adversity that is characterised primarily by threat of harm and that which is characterised primarily by deprivation. Here, experiences of threat of harm include observing or being the victim of community violence, physical abuse, sexual abuse, and/or domestic violence. Experiences involving deprivation include those such as childhood neglect, living in poverty, and institutionalization (McLaughlin & Sheridan, 2016). In an effort to elucidate the mechanisms that link different experiences of early adversity with later psychopathology, McLaughlin and Lambert (2017) further propose that disruptions in fear learning and extinction, in particular, may underpin these different risk pathways.

In support, a considerable body of research has shown that early experiences of inadequate environmental input (e.g., neglect, deprivation), and exposure to harmful input (e.g., threat, violence, abuse), result in different neural structures and circuitry among affected children (Busso, McLaughlin, & Sheridan, 2017; Humphreys & Zeanah, 2015; McLaughlin et al., 2016; Teicher & Samson, 2016; see Londsorf & Merz, 2017). However, to date very few studies have explored whether threat of harm and deprivation are linked to aberrations in fear acquisition and extinction and, more specifically, none have examined whether they relate to different patterns of impairment in these learning mechanisms.

According to learning models, fear and trauma can develop due to aversive conditioning mechanisms, whereby an association forms between a conditioned stimulus (CS+) (e.g., a parent) and an aversive unconditional stimulus (US) (e.g., abuse) which elicits a fear conditioned response (CR) (e.g., fear) (see Boschen, Neumann, & Waters, 2009). After conditioning, the CS+ is capable of eliciting a CR even in the absence of the US and thus, fear can generalise to a wide range of stimuli. Extinction involves the repeated presentation of the CS+, or stimuli categorically or perceptually similar to the CS+, without the US, and should result in the gradual reduction of fear associated with new learning that the CS+ is now safe (Vervliet, Craske, & Hermans, 2013). In most studies, fear conditioning and extinction learning are indexed by increases followed by declines, respectively, in subjective expectancies of the US, negative evaluations of the CS+, and skin conductance responses (SCRs). To date, the evidence from studies of children and adults experiencing threat of harm highlight that these individuals are more likely to exhibit elevated fear conditioned responses, more generalisation of fear responses from the CS+ to the CS- and more impairment in extinguishing conditioned responses (see McLaughlin, Sheridan, Gold et al., 2016; Gamwell et al., 2015; Jovanovic et al. 2011; Blechert et al., 2007).

Illustratively, McLaughlin et al. (2016) observed that whereas children without maltreatment history exhibited differential conditioning to the CS+ vs CS –, based on SCR and self-reported fear, maltreated children exhibited blunted SCR to the CS+ and failed to exhibit differential SCR to the CS+ vs CS – during early conditioning. Moreover, the association of maltreatment with externalising psychopathology was mediated by this abnormal pattern of fear conditioning. Thus, blunted psychophysiological reactivity may be a central mechanism underlying maltreatment-related externalising disorders. Gamwell et al. (2015) observed that female children with PTSD following trauma exposure showed similarly larger responses to danger and safety signals during conditioning compared to age-matched males, suggesting that threat generalisation to safety stimuli may underlie maltreatment-related internalising psychopathology. Similarly, Lange et al. (2018) observed that in young adults with a history of childhood maltreatment, enhanced generalisation of US expectancies and self-reported fear were related to higher levels of internalising psychopathology whereas these associations were non-significant in participants with no or low levels of childhood maltreatment. Furthermore, fear conditioning studies in adults with PTSD following trauma exposure have observed heightened fear responses (Jovanovic & Norrholm, 2011), as well as impaired discrimination between danger and safety signals (Blechert, Michael, Vriends, Margraf, & Wilhelm, 2007; Shin, Rauch, & Pitman, 2006). Thus, initial evidence suggests that children and adults experiencing threat of harm exposure exhibit elevated reactivity to threat stimuli as well as generalised reactivity to safe stimuli relative to children and adults without threat of harm experiences. Threat generalisation may underlie threat of harm exposure and internalising psychopathology and blunted responding in the context of maltreatment may link threat of harm experiences with later externalising problems, although more work is required.

On the other hand, an early environment without stimulation and enrichment is proposed to constrain learning opportunities (McLaughlin & Sheridan, 2016). In contrast to harm experiences, deprivation (e.g., poverty; neglect) is associated with persistent deficits in multiple aspects of responsivity to environmental stimuli, cognitive control, and working memory including blunted physiological reactivity, withdrawal and deficits in reward processing (Lambert et al., 2017; Sheridan, Peverill, Finn, & McLaughlin, 2017). Although such deficits may reflect the direct impact of persistent neglectful environments on the development of adaptive environmental responsivity, blunting and withdrawal may be adaptive to avoid further danger arising from neglectful environments that fail to provide adequate safety (Nesse, 2000; Rottenberg, Gross, & Gotlib, 2005).

Recently, Milojevich, Norwalk, and Sheridan (2019) examined whether childhood threat of harm and neglect experiences differentially predicted avoidance and self-regulation at age 18 years. Greater exposure to threat, but not deprivation, predicted greater use of avoidant strategies, which partially mediated the longitudinal association between exposure to threat in early childhood and symptoms of internalizing psychopathology in late adolescence. However, to date, no studies have directly examined the relation between experiences of neglect and subsequent effects on fear learning and extinction. Indirect evidence stems from fear conditioning and extinction studies in offspring of depressed parents, which may be characterised by neglectful and withdrawn parenting (Lovejoy, Graczyk, O'Hare, & Neuman, 2000).

In these experimental conditioning studies, exposure to maternal depression has been linked to diminished physiological reactivity during the anticipation of threat among offspring of mothers with a principal depressive disorder relative to offspring of mothers with a principal anxiety disorder and low risk offspring (Waters, Peters, Forrest, & Zimmer-Gembeck, 2014). Although indirect, these findings may suggest that offspring exposed to

some degree of neglectful environments by way of disengaged/withdrawn parenting may be characterised by blunted or context insensitive emotional responding (Nesse, 2000; Rottenberg et al., 2005). Similarly, Quevedo et al. (2015) evaluated effects of early neglect on startle reflex in adopted youths aged 12-13, finding that while non-adopted youths demonstrated a heightened startle reflex in response to threatening compared to neutral images, youths with a history of neglect exhibited smaller startle responses to threat compared to neutral images, with severity of neglect associated with greater degree of blunted startle potentiation. Notably, blunted reactivity in adults, as indexed by SCR, has been linked with early childhood exposure to multiple types of trauma (D'Andrea, Pole, DePerrio, Freed, & Wallace, 2013). Thus, psychophysiological blunting may be characteristic of neglect experiences and the accumulation of multiple adverse events over time (Waters & Craske, 2016).

Though this body of work provides initial support for the idea that disrupted learning mechanisms underpinning fear acquisition and extinction processes may be differentially linked to adverse experiences of threat/violence and neglect (McLaughlin & Sheridan, 2016), to our knowledge, there are no published studies that have directly compared responding during fear learning and extinction tasks as a function of prior exposure to threat versus deprivation experiences. Indeed, such a sample is difficult to recruit naturalistically, and numerous individual and environmental factors could arguably confound results (e.g., co-morbidity and psychopathology; parenting styles; severity of adverse events) (McLaughlin, DeCross, Jovanovic, & Tottenham, 2019). Thus, an alternative first-step is to explore emerging links between environmental exposure and fear learning within populations which are not recruited based on their clinical levels psychopathology or associated treatment (Otto et al., 2007). That is, a useful starting point for examining these emerging questions is to do so in normative populations (i.e., not recruited via clinical treatment), vis a vis an

experimental analogue to theoretically based observations. In this case, an experimental analogue study in which a fear conditioning and extinction task is preceded by exposure to relevant threat versus deprivation images provides a productive alternative to test hypotheses about elevated conditioned threat reactivity and generalisation to safe stimuli linked to threat exposure, as well as blunting and reduced conditioned responding in relation to deprivation exposure.

Thus, the aim of the present study was to conduct an experimental analogue of how exposure to two dimensions of adverse experiences (threat and neglect) might affect fear conditioning and extinction. If threat of harm exposure increases reactivity to threat stimuli and safe stimuli associated with threat (i.e., threat generalisation) (e.g., Lange et al., 2018), it was expected that relative to the control group, the violence group would exhibit larger skin conductance responses to the CS+ and the CS- during conditioning, and attenuated extinction of these responses that persists at extinction retest. They were also expected to exhibit higher distress ratings and valence and arousal ratings of the CS+ and CS- after conditioning, extinction and extinction retest. By contrast, if deprivation attenuates reactivity to salient environmental cues (e.g., Quevedo et al., 2015), then relative to controls, the neglect group was expected to exhibit smaller skin conductance responses to the CS+ but not the CS- during conditioning, extinction and extinction retest, and attenuated distress ratings and subjective valence and arousal responses to the CS+ compared to the CS- after conditioning, extinction and retest.

Method

Participants

The study consisted of a sample of men ($n = 18$) and women ($n = 56$), ages 18 - 25 ($M = 19.50$, $SD = 2.17$). Participants were recruited from a University undergraduate student subject pool and they completed the experiment in return for course credit equal to 1.5 hours

of research participation. Pre-screening exclusion criteria for the study included pregnancy and having significant hearing or vision impairment; however no exclusions were made in pre-screening. One participant was later excluded from the neglect group for missing SCR data. All participants completed the ASR internalizing and externalizing syndrome scales (Achenbach & Rescorla, 2003; see Supplementary Section) as a check for equality across group conditions and for validity checks. Within our university-based sample, 40.5% or individuals scores above the T score for internalizing and 9.5% for externalizing. Participants were randomly allocated to one of three conditions using a computer-generated schedule (www.randomisation.com); control ($n = 24$), neglect ($n = 25$), or violence ($n = 25$) (see Figure 1). There were no significant differences in ASR symptomology across groups.

Insert Figure 1

Materials and Measures

Experimental Manipulation Stimuli and Materials. A picture viewing (PV) task was used as the experimental manipulation prior to the fear conditioning and extinction experiment and presented using a Microsoft PowerPoint presentation and an image set derived from the International Affective Picture System (IAPS; Lang, Bradley & Cuthbert, 1997). The IAPS is a standardised image set consisting of emotionally-evocative stimuli that was developed using a dimensional model of emotion consisting of three dimensions: valence, arousal, and dominance. The images are rated for each dimension on a 0-9 scale with higher scores indicating higher perceptions of pleasantness or arousal. Previous research has shown the IAPS has good reliability (split half coefficients $r = .94$) and cross cultural validity (Drace, Efendic, Kusturica, & Landzo, 2013).

From the IAPS catalogue, the authors identified images for high neglect (neglect), and high community violence (violence), or neutral content (control) based on the IAPS ratings

(see Figure 1). For neglect images¹, the mean valence rating was 3.09 ($SD = 0.56$) and mean arousal rating was 4.77 ($SD = 0.44$). For the violence group², the mean valence rating was 2.90 ($SD = 0.42$) and mean arousal rating was 5.84 ($SD = 0.20$). For the control group³, the mean valence rating was 5.35 ($SD = 0.34$) and mean arousal rating was 3.04 ($SD = 0.54$).

Evaluations of the assigned PV condition. Participant's evaluations of the PV task were measured by asking "*How bad do you think it would be to be in an environment like those you saw in the picture viewing task?*", "*If you were in an environment like that, how sure do you think you would be that you could cope?*", and "*If you lived in an environment like that, how likely do you think it is that you would be harmed?*" The participants provided their responses using an 8-point emotional intensity ratings scale (0 = not at all to 8 = very much).

Fear Conditioning Stimuli and Materials. The task was programmed and presented in Presentation on a Dell 19" colour monitor at approximately 1m distance from the participant. The CSs were a geometrical shape; a pastel cream triangle (14.5cm top to bottom) or pastel pink trapezoid (14cm top to bottom), and the UCS was the sound of slate on metal. The UCS was delivered for one second, at 1000Hz via Sennheisser HD380 Pro headphones at 95dB.

During the conditioning phase, participants were presented with 24 randomised trials: 12 CS+ (CS presented with UCS) and 12 CS- (CS presented alone). Each CS was presented for 8 seconds in the centre of the screen, with the onset of the UCS at 7 seconds after CS onset (Figure 2). A white fixation cross was presented in the centre of the screen during the inter-trial interval, which varied randomly between 15-25 seconds. The extinction phase

¹ IAPS image numbers 2278, 2345, 2457, 2520, 2718, 9046, 9332, 9341, 9342, 9520.

² IAPS image numbers 2691, 6213, 6571, 6832, 6838, 9424, 9425, 9426, 9427, 9428.

³ IAPS image numbers 5390, 7002, 7009, 7026, 7036, 7057, 7100, 7140, 7175, 7192

parameters were the same as acquisition, however the UCS was not presented with the CS.

During retest, eight trials were presented; four of each CS without the UCS on any trial.

Skin Conductance Response (SCR). Skin conductance was recorded using Biopac (EL507) pre-gelled electrodes placed on the palm of the participant's non-dominant hand. SCRs were acquired using a Biopac data acquisition system (Model MP150) with a sampling frequency of 2000 Hz via an EDA100C amplifier. Respiration was recorded using a Biopac TSD201 transducer connected to an RSP100C transducer amplifier, to monitor for respiratory influences on SCRs. Data were analysed using Acqknowledge software Version 4.4.0

The magnitude of the phasic SCRs elicited during each CS presentation were scored within three latency windows as the distance between the trough and apex of the curve and expressed in microsiemens (μS). First interval responses (FIR) were those that began 1 to 4 sec following CS onset, second interval responses (SIR) began 4 to 7 sec following CS onset and third interval responses (TIR) began 7 to 11 sec after CS onset (see Figure 3) (Prokasy & Kumpfer, 1973). First interval responses reflect the initial orienting response to the CS (see Prokasy, 1977; Öhman & Bohlin, 1973; Öhman, 1983), SIRs reflect responding in anticipation of the US, and TIRs reflect responses to the US on CS+ trials and its absence on CS- trials (Prokasy & Kumpfer, 1973; Prokasy, 1977). Responses were scored trial-by-trial, scored as zero if no response occurred (less than 3.5% of trials). An absence of responses within each window resulted in scores of zero. The data was scored using AcqKnowledge v4.4, by the second author and a research assistant who were both blinded to the condition the participant had been assigned at the time of scoring. As further validation, we explored ASR (Achenbach & Rescorla, 2003) correlations within picture viewing conditions by phase and CS, given fear conditioning and extinction data are arguably impacted by preceding picture viewing condition. Full correlations are provided in the Supplementary Section. Broadly consistent with expectations, within the neglect condition, SCRs were negatively correlated

with internalizing for CS+ with some indication of attenuation on SIRs (i.e., smaller responses in anticipation of threat = withdrawal). Within the violence condition, externalizing was positively correlated with anticipation of the CS- (i.e.; non-threat, absence of US), with some indication of overgeneralisation.

CS and UCS Evaluative Ratings. Prior to the start of each phase, participants provided valence and arousal ratings of the CSs by pointing to their response using a hardcopy self-assessment manikin (SAM; Bradley & Lang, 1994). The SAM assesses valence and arousal ratings via two rows of images ranging from 1 (*unpleasant/calm*) to 5 (*pleasant/really worked up*). Participants also provided intensity and pleasantness ratings of the UCS using the SAM ranging from 1 (*not at all intense/unpleasant*) to 5 (*extremely intense/pleasant*).⁴

Subjective Distress Ratings. Distress ratings were provided via an intensity rating scale rated from 0 (*not at all distressed*) to 8 (*extremely distressed*) before and after each task.

Contingency Awareness. At the end of the acquisition phase, participants were asked if they noticed if there was one shape paired with the sound. If the participant responded with “Yes” they were then asked to identify which shape they believed was paired with the sound. Contingency awareness was considered to have taken place if the participant correctly identified which shape was paired with the sound.

Childhood Adversity. A brief 8-item measure of childhood adversity was used for validity purposes, to ensure no group differences existed between groups in experiences of childhood adversity and to test ecological validity of our experimental task. The measure was adapted from the National Survey of Children’s Exposure to Violence (NatSCEV) screeners questionnaire (Finkelhor, Turner, Shattuck, & Hamby, 2013), with items tapping both

⁴ There were no significant correlations between valence, arousal, or distress at each stage and internalizing or externalizing ASR scores (Achenbach & Rescorla, 2003).

personal experience of and witnessing of neglect and violence. Each question was answered with a *yes* or *no* response. This included a definition and example of childhood maltreatment, followed by the question “At any time in your life, would you say that you were neglected?” (0 = no, 1 = yes). Likewise, for violence history, “At any time in your life....were you attacked or hit on purpose?; robbed or mugged?; threatened by a gun, knife, or some other weapon?” Given our young adult sample, several original items regarding very serious events were omitted due to their sensitive nature. To conduct sensitivity tests (described below, Etiological Validity), we coded violence exposure in two ways (a) as 0 = none; 1 = moderate (1 event); 2 = high (2-3 events) violence exposure and (b) as 0 = none to moderate (0-1 event); 1 = high (2 or 3 events) violence exposure. Both neglect and violence scales showed good validity and were significantly correlated with ASR internalizing and externalizing scores (r 's from .26-.44, p 's < .03) (Achenbach & Rescorla, 2003).

Demographic Information. Participants' demographic information was gathered and included the participants age (in years) and sex (male, female).

Procedure

Upon Human Research Ethics Committee approval (Ref 2018/499), participants were recruited from the undergraduate psychology student subject pool and social media platforms. Upon arrival at the laboratory, participants completed informed consent and were oriented to the testing environment. A script was used throughout testing to ensure all participants received the same information and instructions relevant to each condition.

Picture Viewing. Next, prior to the PV task, participants provided distress ratings and were instructed to attend to the images and think about what experiences in the environments they were going to view would be like. The control group were instructed “*Soon you will view a series of images that people are exposed to in their communities. Please think about what these experiences and communities would be like for you while you view the images.*”

The Neglect group instructions were *“Soon you will view a series of images depicting neglect. Some people are exposed to experiences of neglect in their communities. Please think about what these experiences and communities would be like for you while you view the images.”* The Violence group instructions were *“Soon you will view a series of images depicting community violence. Some people are exposed to experiences of violence in their communities. Please think about what these experiences and communities would be like while you view the images.”*

Each image was presented twice for 8 seconds each, with a 10 sec intertrial interval and in random order. After the PV task, participants provided distress ratings and answered three questions regarding their evaluations of the PV task (a) *“How bad do you think it would be to be in an environment like those you saw in the picture viewing task?”*, (b) *“If you were in an environment like that, how sure do you think you would be that you could cope?”*, and (c) *“If you lived in an environment like that, how likely do you think it is that you would be harmed?”*. Each question was answered using the emotional intensity ratings scale.

Etiological Validity of Picture Viewing Task. Given that our PV task was designed as an experimental analogue to environmental exposure, we additionally assessed its validity (beyond experimental effects). That is, we assessed whether the association between participants’ distress ratings post PV (prior to conditioning) was conditioned by personal experience of violence or neglect. If the brief PV task were to induce exposure similar to the etiological mechanisms we sought to investigate (childhood neglect or violence), we would expect that a history of adverse experience would affect initial reactions to a given PV task. Put another way, the combination of history of exposure and randomization to exposure group (e.g. history of violence and violence group membership) should result in significantly higher distress, relative to no previous exposure history. (Recall that these were randomly assigned experimental groups, and as described below, with no exposure differences between

groups; hence prior history does not impact the experiment.) Because experience of violence and neglect are often comorbid⁵, data for comparing neglect vs. no violence were within the sample range, but were relatively sparse, thus we ran regression-based tests with two codes described above for violence exposure (a) as a three-point scale and (b) as a dichotomous indicator of none-moderate versus high exposure, as a sensitivity test. Results from the later comparison (all cell n 's ≥ 4) are provided in italics (and though the higher order interactions were not statistically significant in this case, the pattern of results were generally the same).

More specifically, within a moderated regression framework, experimental condition was Helmert coded (X_1 = control vs. experimental conditions; X_2 = violence vs. neglect conditions) and history of violence and neglect were entered as moderators predicting pre-conditioning distress ratings. As hypothesized, there was a significant interaction between condition X neglect history ($F(2, 64) = 3.84, p = .026$; $F(2, 64) = 2.62, p = .08$) and between condition X violence history ($F(2, 64) = 3.51, p = .036$; $F(2, 64) = 1.63, p = .20$)

Probing of the interactions indicated that with no violence or neglect history, experimental groups as a whole had higher distress ratings than controls (e.g. $X_1: t = 3.45, p = .001, 95\% CI: .88-3.30$; $X_1: t = 3.82, p = .0003, 95\% CI: .96-3.06$), with no differences in distress ratings between violence vs. neglect groups (e.g. $X_2: t = -.89, p = .37, 95\% CI: -1.80-.69$; $X_2: t = .34, p = .73, 95\% CI: -.92-1.30$).

However, with no history of neglect, at both moderate and high levels of violence (e.g. endorsing one (moderate) or two (high) experiences), violence group distress scores were significantly higher than neglect.⁶ (For a sensitivity comparison, no neglect with high violence exposure grouping, violent picture viewing was associated with trend more distress than neglect viewing: $X_2: t = 1.86, p = .068, 95\% CI: -.27-7.5$)

⁵ We thank an anonymous reviewer for highlighting this point.

⁶ For moderate violence history, $X_2: t = 2.18, p = .03, 95\% CI = .14-3.08$; for high violence history $X_2: t = 2.64, p = .01, 95\% CI = .92-6.64$.

Likewise, with no history of violence, neglect experience (a dichotomous variable) was associated with significantly higher distress ratings within the neglect group, ($X_2: t = -2.74, p = .008, 95\% CI: -8.07 - -1.27$) versus the violence group. (For a sensitivity comparison, no to moderate violence exposure with history of neglect: $X_2: t = -2.05, p = .04, 95\% CI: -6.52 - -.09$).

Yet individuals experiencing both high history of violence and neglect showed no significant differences in distress reports between violence vs neglect experimental conditions ($X_2: t = -.31, p = .76, CI: -2.47 - 1.81$; $X_2: t = .10, p = .92, CI: -2.37 - 2.62$). Thus, the experimental PV task showed good validity in the context of interaction effects with participants' history of exposure.

Conditioning. Next, two Ag/AgCl electrodes were placed on the palm of the participant's non-dominant hand and a respiration belt was connected around the chest. The emotional intensity rating scale was used to obtain distress ratings, and the SAM was used to obtain valence and arousal ratings of the CS+ and CS-. Participants were informed that they would see some shapes on the screen, one at a time, and a sound through the headphones. The headphones were then placed on the participant and the fear conditioning task commenced. Participants were observed using a closed-circuit camera and any behaviours that could interfere with responding were recorded, such as drowsiness, coughing, or deep breathing.

Participants were presented with 12 CS+ and 12 CS- trials in random order with the caveat that the CS+ and CS- were presented in the first two trials and no more than two trials of each CS was presented in consecutive order. Following acquisition, participants provided pleasantness and intensity ratings of the UCS, in addition to CS valence and arousal ratings, and distress ratings.

Extinction. The extinction phase parameters were the same as the acquisition phase, however, the CS+ was presented without the UCS. Participants were informed that the task

would continue and to focus upon the computer screen. After the extinction phase, CS valence and arousal ratings, and distress ratings were again collected. The electrodes were removed, and participants then completed a word search filler task outside of the laboratory to provide a break between extinction and extinction retest. After seven to ten minutes, the participant was brought back into the lab to complete the retest phase.

Retest. The electrodes were refitted, and the retest phase involved the same parameters as the extinction phase, however it consisted of only eight trials; four CS+ and four CS- without the US on any trial. CS valence and arousal ratings, and distress ratings were collected at the beginning and conclusion of this phase. Electrodes were removed and participants completed the childhood adversity questionnaire. They were verbally debriefed and the session lasted for approximately 75 minutes.

Data Analytic Plan

Subjective Ratings of Distress, Valence, and Arousal. A 3 (condition: control, neglect, violence) x 7 (time: prePV, postPV, pre-acquisition, post-acquisition, post-extinction, pre-retest, post-retest) factorial ANOVA was conducted to examine the main effect of time, and the interaction between time and condition on subjective distress ratings. Two separate 3 (Condition: Control, Neglect, Violence) x 2 (CS type: CS+, CS-) x 5 (Time: Pre-acquisition, post-acquisition, post extinction, pre-retest, post-retest) mixed factorial ANOVAs were conducted to examine the effects of condition, CS type, and experimental phase on participants' subjective ratings of valence and arousal. Greenhouse-Geisser correction was applied when Mauchly's test of sphericity was violated. Post-hoc comparisons for each dependent variable applied Bonferroni corrections to control for accumulation of error.

Skin Conductance Response. Trials were averaged into six blocks of two trials during acquisition and extinction and into two blocks of two trials during retest. To

normalise the distributions, all SCR data was transformed using a square root transformation (Venables & Christie, 1980). Analyses were conducted separately for the different experimental stages; i.e., FIR, SIR, and TIR. For the acquisition and extinction phases, a 3 (Condition: Control, Neglect, Violence) x 2 (Stimulus: CS+, CS-) x 6 (Block: One - Six) linear mixed models ANOVA for repeated measurements and a Satterthwaite's approximation for degrees of freedom was applied. The same analysis was used for the retest phase, however, the model was 3 (Condition: Control, Neglect, Violence) x 2 (Stimulus: CS+, CS-) x 2 (Block: One, Two). Post-hoc comparisons for each dependent variable applied Bonferroni corrections to control for accumulation of error.

Results

Control Analysis

Chi Square (or Fisher's Exact Probability Test, where assumptions were violated) analysis was conducted to examine differences between groups. Results are described in Table 1, indicating successful random allocation to condition. Importantly, there were no significant differences in exposure history between groups.

Insert Table 1

Subjective Ratings

Distress. A 3 (condition) x 7 (time) mixed factorial ANOVA, with Greenhouse-Geisser correction, revealed a significant main effect of time, $F(3.86, 274.18) = 44.25, p < .001$, partial $\eta^2 = .38$, and a significant interaction between time and condition, $F(7.72, 274.18) = 4.69, p < .001$, partial $\eta^2 = .12$ (see Figure 2).

Follow-up pairwise comparisons (applying a Bonferroni adjustment) indicated that participants in the control group had significantly lower subjective ratings of distress at the post-PV stage compared to the neglect group, $\text{Mean}_{\text{diff}} = -1.76, p = .002$, 95% CI (-2.97, -0.55) and violence group, $\text{Mean}_{\text{diff}} = -1.72, p = .002$, 95% CI (-2.93, -0.51). There were no

other significant differences between conditions at any other time points.

Insert Figure 2

CS Valence. A 3 (Condition) x 2 (CS type) x 5 (Time) mixed factorial ANOVA (see Figure 3) with Greenhouse-Geisser correction, showed a significant main effect of time $F(2.64, 187.58) = 17.35, p < .001$, partial $\eta^2 = .20$, and a main effect of CS, $F(46.03, 71) = 43.81, p < .001$, partial $\eta^2 = .38$ and a significant interaction between time and CS, $F(2.41, 171.67) = 51.62, p < .001$, partial $\eta^2 = .42$. All other effects were non-significant (p 's $> .53$).

Participant valence ratings of the CS+ were significantly more negative post-acquisition compared to pre-acquisition, $\text{Mean}_{\text{diff}} = -1.19, p < .001$, 95% CI (-1.60, -0.78), post-extinction $\text{Mean}_{\text{diff}} = -1.04, p < .001$, 95% CI (-1.41, -0.68), pre-retest $\text{Mean}_{\text{diff}} = -1.19, p < .001$, 95% CI (-1.56, -0.82), and post-retest $\text{Mean}_{\text{diff}} = -1.23, p < .001$, 95% CI (-1.66, -0.80). Differences across time for valence ratings of the CS- were non-significant (p 's $> .14$).

Insert Figure 3

CS Arousal. A 3 (Condition) x 2 (CS type) x 5 (Time) mixed factorial ANOVA with a Greenhouse-Geisser correction, revealed significant main effects of time, $F(2.55, 181.03) = 34.32, p < .001$, partial $\eta^2 = .33$, and CS, $F(1, 26) = 42.91, p < .001$, partial $\eta^2 = .38$. However, there was also a significant interaction between time and CS type, $F(2.03, 143.79) = 49.59, p < .001$, partial $\eta^2 = .41$. All other effects were non-significant (all $p > .16$) (see Figure 4).

Insert Figure 4

Participant arousal ratings of the CS+ significantly differed at the post-acquisition phase in comparison to pre-acquisition, $\text{Mean}_{\text{diff}} = 1.26, p < .001$, 95% CI (0.84, 1.68), post-extinction, $\text{Mean}_{\text{diff}} = 1.07, p < .001$, 95% CI (0.70, 1.44), pre-retest, $\text{Mean}_{\text{diff}} = 1.22, p < .001$, 95% CI (0.84, 1.60), and post-retest, $\text{Mean}_{\text{diff}} = 1.34, p < .001$, 95% CI (0.93, 1.75). Arousal ratings of the CS+ were also significantly higher at the post-extinction phase

compared to the post-retest time point, $\text{Mean}_{\text{diff}} = 0.27$, $p = .001$, 95% CI (0.07, 0.46). There were no significant differences across time for the CS- (all p 's $> .12$).

Skin Conductance Responses

Acquisition

FIR. As illustrated in Figure 6, upper left panel, the mixed models analysis of FIRs revealed a significant main effect of CS, $F(1, 791.93) = 36.47$, $p < .001$, indicating that differential conditioning occurred. A significant main effect of condition was also found, $F(2, 407.44) = 3.26$, $p = .04$. There were no significant interaction effects, and the main effect of block was not significant (all $p > .24$).

Follow-up comparisons of the condition main effect using Bonferroni adjustments revealed that the neglect group had significantly smaller SCRs in comparison to the control group, $\text{Mean}_{\text{diff}} = -.043$, $p = .04$, 95% CI (-.084, -.002), but not the violence group ($p = .29$), which in turn, did not significantly differ from the control group ($p = .99$).

SIR. Analysis of SIRs showed a significant main effect for CS, $F(1, 746.59) = 3.86$, $p = .05$ and for the interaction between condition and CS, $F(2, 746.60) = 3.51$, $p = .03$ (Figure 6, middle left panel). All other main effects and interactions were non-significant (p 's $> .31$).

Follow-up pairwise comparisons using Bonferroni adjustments revealed that the violence group exhibited larger SIRs to the CS+ relative to the CS-, $\text{Mean}_{\text{diff}} = .037$, $p = .001$, 95% CI (.016, .059), which was not observed in the other groups (all p 's $> .95$). Also, the violence group had significantly larger SCRs to the CS+ compared to the neglect group, $\text{Mean}_{\text{diff}} = -.037$, $p = .04$, 95% CI (-.072, -.002). However, neither the neglect nor the violence group differed significantly from the control group on either CS type (all p 's $> .60$).

TIR. Analysis of TIRs identified a significant main effect of condition, $F(2, 417.65) = 3.91$, $p = .02$, CS $F(1, 765.04) = 86.37$, $p < .001$, and block, $F(5, 871.66) = 4.63$, $p < .001$. There were no significant interaction effects (all p 's $> .35$) (see Figure 6, lower left panel).

Follow-up pairwise analyses using Bonferroni adjustments revealed that participants in the neglect group exhibited significantly smaller SCRs compared to the control group, $\text{Mean}_{\text{diff}} = -.066$, $p = .02$, 95% CI $(-.112, -.008)$, but not the violence group ($p = .57$). There were no other significant differences between groups. SCRs to the CS+ were significantly larger than to the CS-, $\text{Mean}_{\text{diff}} = .102$, $p < .001$, 95% CI $(.080, .123)$. Magnitudes of TIRs were significantly larger in block one than in block four, $\text{Mean}_{\text{diff}} = .083$, $p = .05$, 95% CI $(.000, .165)$, five, $\text{Mean}_{\text{diff}} = .083$, $p = .03$, 95% CI $(.003, .163)$, and six, $\text{Mean}_{\text{diff}} = .113$, $p < .001$, 95% CI $(.034, .192)$. The magnitude of responses was also significantly larger in block two than block six, $\text{Mean}_{\text{diff}} = .093$, $p = .01$, 95% CI $(.011, .175)$.

Extinction

FIR. A mixed model analysis of FIRs revealed no significant main effects or interactions (see Figure 5, upper middle panel) (all p 's $> .17$).

SIR. Analysis of SIR's revealed a significant main effect of condition $F(2, 481.50) = 3.36$, $p = .04$. This was qualified by a significant higher order interaction between condition and CS $F(2, 684.91) = 3.83$, $p = .02$. No other effects were significant (all p 's $> .35$) (see Figure 5, middle panel).

Follow-up pairwise comparisons using Bonferroni adjustments identified that the neglect group exhibited significantly smaller SCRs to the CS+ compared to the CS-, $\text{Mean}_{\text{diff}} = .027$, $p = .03$, 95% CI $(.002, .052)$ and compared to the CS+ in the violence group, $\text{Mean}_{\text{diff}} = .045$, $p = .005$, 95% CI $(.011, .079)$, but not the control group ($p = .49$).

TIR. Inspection of the results for TIR indicated there were no significant main effects or interaction effects (all p 's $> .22$) (see Figure 5, lower middle panel).

Insert Figure 5

Extinction to Retest

FIR. Analysis of the FIRs from extinction to retest revealed significant main effects of Block, $F(1, 316.98) = 5.16, p = .024$ and CS, $F(1, 258.92) = 6.02, p = .015$, and a significant CS x Block interaction, $F(1, 308.84) = 8.76, p = .003$. FIRs were significantly larger to the CS+ than the CS- in block 1 of retest, $\text{Mean}_{\text{diff}} = .09, p < .001, 95\% \text{ CI } (.041, .130)$, but not during block 6 of extinction, $\text{Mean}_{\text{diff}} = -.01, p = .67, 95\% \text{ CI } (-.053, .034)$. FIRs were also significantly larger to the CS+ during block 1 of retest than block 6 of extinction, $\text{Mean}_{\text{diff}} = -.094, p < .001, 95\% \text{ CI } (.043, .145)$ but differences were not significant for the CS-, $\text{Mean}_{\text{diff}} = .001, p = .97, 95\% \text{ CI } (-.051, .052)$ (see Figure 5).

SIR. The extinction to retest analysis of SIRs revealed a significant main effect of CS, $F(1, 256.62) = 6.47, p = .012$, reflecting larger SIRs to the CS+ compared to the CS- (see Figure 5). No other main or interaction effects were significant (all p 's $> .12$).

TIR. The extinction to retest analysis of TIRs revealed a significant main effect of CS, $F(1, 205.31) = 4.98, p = .027$, and a significant Condition x CS x Block interaction, $F(2, 271.44) = 4.14, p = .017$ (see Figure 5). The interaction reflected that TIRs were significantly larger to the CS+ during block 1 of retest compared to block 6 of extinction and to the CS- in block 1 of retest in the violence group, $\text{Mean}_{\text{diff}} = .081, p = .025, 95\% \text{ CI } (.01, .152)$ and $\text{Mean}_{\text{diff}} = .091, p = .0008, 95\% \text{ CI } (.024, .158)$ respectively, but not in the other groups or in response to the CS- (all $p < .19$). Thus, the violence group exhibited a return of SCRs to the CS+ during retest at the timing of the delivery of the US during conditioning.

Retest

FIR. Analysis of FIRs during retest identified significant main effects of condition, $F(2, 160.05) = 3.20, p = .04$, CS, $F(1, 230.63) = 16.98, p < .001$, and block, $F(1, 293.95) = 6.02, p = .02$. There were no significant interaction effects (see Figure 5, upper right panel). Post-hoc analysis using Bonferonni correction indicated that participants in the neglect group had significantly smaller SCRs than the control group, $\text{Mean}_{\text{diff}} = -.059, p = .05, 95\% \text{ CI } (-$

.117, .000). Furthermore, the magnitude of SCRs to the CS+ were significantly larger than the CS-, $\text{Mean}_{\text{diff}} = .06$, $p < .001$, 95% CI (.031, .089). Also, SCRs were significantly larger during block 1 compared to block 2, $\text{Mean}_{\text{diff}} = .045$, $p = .02$, 95% CI (.009, .082).

SIR. Analysis of SIRs indicated a significant main effect of CS, $F(1, 228.40) = 4.25$, $p = .04$, but no other significant effects. Follow-up analysis using Bonferroni adjustments, identified the magnitude of SCRs to the CS+ was significantly larger than those to the CS-, $\text{Mean}_{\text{diff}} = .024$, $p = .04$, 95% CI (.001, .046) (see Figure 5, middle right panel).

TIR. Examination of TIRs revealed a Condition x CS x Block interaction, $F(2, 281.82) = 3.34$, $p = .037$. The interaction reflected that TIRs were significantly larger to the CS+ than the CS- in block 1 of retest in the violence group, $\text{Mean}_{\text{diff}} = .088$, $p = .008$, 95% CI (.024, .153) but not in the other groups (all $p < .11$). Differences in TIRs from block 1 to block 2 did not reach significance (all $p > .051$) (see Figure 5, lower right panel).

Discussion

New dimensional models of adversity and psychopathology (i.e., McLaughlin & Sheridan, 2016) implicate disruptions in learning mechanisms underpinning fear acquisition and extinction among the key processes that may tie different early adverse experiences to later problems. However, the hypothesis that disrupted learning mechanisms underpinning fear acquisition and extinction processes may be differentially linked to adverse experiences of threat/violence and neglect has not yet been tested via direct comparisons of responding during fear learning and extinction tasks. This empirical gap is likely attributable to challenges in recruitment and retention of high-risk samples and potential confounds due to comorbidity of violence and neglect, and concomitant psychopathology (Widom, DuMont, & Czaja, 2007). Moreover, a task design is required that is sufficiently aversive to illicit responding but neither unethical nor overly traumatic, especially for individuals with accompanying maltreatment history (McLaughlin, DeCross, Jovanovic, & Tottenham, 2019).

To address these challenges, the present study used an experimental analogue to emerging theories of maltreatment exposure and fear learning. Deploying an ecologically valid task (eliciting different levels of distress among individuals with different maltreatment histories), several notable findings emerged.

First and consistent with hypotheses, participants exposed to neglect images demonstrated attenuated SCRs during conditioning compared to controls, smaller SCRs to the CS+ compared to the CS- during extinction, and smaller SCRs during extinction retest compared to controls. Further, in partial support of hypotheses, participants exposed to violence images exhibited larger SCRs to the CS+ compared to the CS- during conditioning, and also exhibited a return of larger SCRs at retest to the CS+ compared to the CS- and compared to the end of extinction, which was not observed in the other groups. In contrast to hypotheses, there were no significant group differences in between-phase subjective distress ratings or CS valence and arousal ratings.

The finding of pervasive blunted SCRs in the neglect relative to the control group supports prior research indicating that exposure to environments of deprivation may lead to psychophysiological blunting to salient environmental cues and poor threat and safety discrimination (McLaughlin et al., 2016; Miller et al., 2018; Quevedo et al., 2015). Importantly, that attenuation of SCRs varied differentially from controls within first, second and third intervals across phases suggests that physiological attenuation was not reflective of a pre-existing group difference. Of note was that McLaughlin et al. (2016) observed blunted SCRs during conditioning in maltreated children (i.e., threat of harm exposure) relative to healthy controls whereas Waters et al. (2014) found blunted SCRs in offspring of depressed mothers, which may be an indirect risk factor for neglect by virtue of withdrawn/disengaged parenting. Given that the youth in McLaughlin et al.'s study had experienced threat of harm-related trauma in earlier in childhood, psychophysiological blunting/withdrawal might

develop over time following extended periods of reactivity to threat of harm and multiple traumas (cf. D'Andrea et al., 2013; Waters & Craske, 2016). In accord, Milojevich et al. (2019) found that threat of harm maltreatment in childhood was associated with more avoidance and greater internalising symptoms in late-adolescence/young adulthood. Future experimental studies that employ longer intervals between picture viewing and fear conditioning and extinction could assist in clarifying temporal patterns of reactivity following adverse experiences.

In terms of violence exposure, the finding of differences in second interval SCRs to the CS+ compared to the CS- during conditioning suggests that the violence group experienced elevated physiological arousal in anticipation of the US. It is also noteworthy that the violence group exhibited a return of physiological arousal to the CS+ at retest (when threat salience had declined following extinction), during the temporal window in which the US was delivered during conditioning (i.e., TIR). Together, these findings suggest that exposure to community violence might predispose individuals to elevated autonomic reactivity in anticipation of threat and during safe situations when re-exposure to threat may be uncertain. Several previous studies have found associations between subjective and physiological reactivity to safe stimuli (i.e., threat generalisation) and threat of harm exposure (e.g., Gamwell et al., 2015; Lange et al., 2018). Although anticipatory- and uncertainty-driven threat reactivity may be functionally adaptive in violent and unpredictable environments for safety and survival purposes, chronic reactivation of autonomic reactivity when circumstances are in fact safe may be an important mechanism linking community violence exposure to internalizing psychopathology (McLaughlin et al., 2016; Waters & Craske, 2016), potentially via the development of maladaptive self-regulation strategies, such as avoidance over time (Milojevich et al., 2019).

In contrast to expectations, there were no group effects on subjective distress ratings

or CS evaluations. As subjective ratings were taken between phases rather than during trials, they may be reflective of relief rather than distress in the exposure conditions; i.e., exposure to the neglect and violence images may have a stronger effect when directly exposed to threat conditioned stimuli. Alternatively, subjective ratings may simply be more pronounced in individuals who have lived experience with high levels of exposure to community violence and neglect. Further studies that are based on individuals who have experienced adversity and assess trial-by-trial US expectancies, CS evaluations, and subjective distress would help clarify these results.

Indeed, the non-selected sample is a primary limitation of the present study and further research with samples who have been recruited based on their experience of adversity, and potentially those with and without psychopathology because of their experiences (e.g., Modecki, Zimmer-Gembeck, & Guerra, 2017), is important for determining whether aberrant fear conditioning and extinction parameters play a role in the consequent development of psychopathology. In our experimental study design, fear conditioning, extinction and retest phases followed immediately after the picture-viewing phase. Because all task phases were conducted on the same day, this does not allow for consolidation of learning. As a first step, a longer delay would help clarify if fear conditioning and extinction differs depending on the passage of time since adversity. Similarly, a longer delay between extinction and retest would clarify long-term safety learning deficits following violence exposure. Finally, although the IAPS images are reliable and valid for eliciting emotional responses, and our PV task showed very good convergent and discriminant validity, it is also possible that more immersive procedures such as observing violent versus neglect-related films, use of mental imagery, and increasing the number and length of exposures may produce stronger effects, particularly on between-phase subjective distress and CS evaluation ratings.

In sum, the current study provides preliminary evidence for the proposition that

exposure to violence and neglect experiences might be related to impairments in fear and safety learning (McLaughlin & Sheridan, 2016) and adds an important layer to this work by indicating that the expression of these impairments may differ as a function of the type of adversity exposure. Based on an ecologically-valid experimental analogue to emerging theory, findings indicated that relative to control images, viewing scenes of neglect attenuated autonomic arousal to the CS+ and CS- during subsequent conditioning and extinction phases, whereas exposure to images of community violence accentuated autonomic reactivity in anticipation of threat and when its occurrence was uncertain. These findings point to provocative next steps in which research might elucidate later longitudinal mechanisms on psychopathology—that is, whether blunting following neglect exposure and impaired reactivity during threat anticipation and uncertainty following harm exposure are, in fact, differentially linked to the development of psychopathology.

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Figure 1. Flow of participants through the study

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Figure 2. Mean distress ratings throughout the experiment as a function of condition. Ratings range from 0 (*not at all distressed*) to 8 (*extremely distressed*). Error bars represent +/- 1 standard error (PV = picture viewing; Acq = Acquisition; Ext = Extinction; Test = Retest).

Figure 3. Mean valence ratings throughout the experiment as a function of condition.

Ratings range from 1 (*very unpleasant*) to 5 (*very pleasant*). Error bars represent +/- 1 standard error (Acq = Acquisition; Ext = Extinction; Test = Retest).

Figure 4. Mean arousal ratings throughout the experiment as a function of condition. Ratings range from 1 (*very calm*) to 5 (*very aroused*). (Acq = Acquisition; Ext = Extinction; Test = Retest). Error bars represent +/- 1 standard error.

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Figure 5. Mean skin conductance responses (SCR) for first, second, and third intervals during the CS+ and CS- as a function of experimental condition. * = significant differences.

Table 1

Key Demographic Breakdown of Participants by Group (N = 74)

Demographic Variable	<i>n</i> (%)	Control <i>n</i> = 24	Neglect <i>n</i> = 25	Violence <i>n</i> = 25	χ^2	<i>p</i>
Participant Gender					5.78	.056
Male	24%	7	2	9		
Female	76%	17	23	16		
Contingency Awareness					.43	1.0
Yes*	96%	23	24	24		
No*	4%	1	1	1		
Reported experiencing/witnessing neglect					0.26	.94
Yes	23%	6	6	5		
No	77%	17	19	20		
Reported experiencing/witnessing physical violence					3.48	.17
Yes	49%	15	10	11		
No	51%	8	15	14		

Note. *Fishers Exact Probability Test.