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Childhood Maltreatment and Electrodermal Reactivity to Stress Among Pregnant Women

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ABSTRACT

There are competing theoretical hypotheses regarding the consequences of early adversity, such as childhood maltreatment, for individuals' autonomic nervous system activity. Research examining potential implications of child maltreatment for sympathetic nervous system activity, specifically, is scarce. In this preregistered study, we examined whether childhood maltreatment history is associated with pregnant adults' sympathetic responses to different stressors. This population is particularly relevant, given potential intergenerational consequences of pregnant individuals' physiological responses to stress. Pregnant women's ($N = 162$) electrodermal levels were recorded while completing the Trier Social Stress Test (TSST), which elicits social-evaluative threat, and while watching a video of an unfamiliar infant crying, which was intended to activate the attachment system. Pregnant women's retrospective reports of childhood maltreatment were negatively associated with their electrodermal reactivity to the TSST and to the video of the infant crying. Follow-up analyses indicated that these associations were specific to reported experiences of childhood abuse and not childhood neglect. Altogether, these findings indicate that self-reported childhood maltreatment experiences, and childhood abuse in particular, may result in blunted activity of the sympathetic nervous system in response to multiple types of stressors.

1 | Introduction

Childhood maltreatment has harmful consequences across key developmental domains, including social skills, academic performance, emotional well-being, and physical health, that endure across the lifespan (Cicchetti and Toth 2005; Fergusson, Boden, and Horwood 2008; Gilbert et al. 2009; Nivison et al. 2024). One of the potential mechanisms underlying these effects is alterations to individuals' neurobiological development, including their autonomic nervous system responses to stressful events (Cicchetti 2016; Holochwost et al. 2021; Young-Southward et al. 2020). There are several gaps in the research literature on this

topic. First, compared to research examining the parasympathetic branch of the autonomic nervous system, there are relatively few studies investigating the consequences of childhood maltreatment for sympathetic nervous system activity (e.g., Holochwost et al. 2021; Sigrist et al. 2021; Wesarg et al. 2022). Second, there are competing theoretical claims regarding the expected direction of the association between childhood maltreatment and individuals' sympathetic nervous system responses to challenges (Hammen, Henry, and Daley 2000; Juster, McEwen, and Lupien 2010). Third, there is a lack of research investigating the possibility that the effects of childhood maltreatment on sympathetic nervous system activity may depend on the

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psychological demands of a given task (Bourassa and Sbarra 2022; Gunnar 2016).

The current study addressed these gaps by examining associations between pregnant women's self-reported experiences of childhood maltreatment and their sympathetic nervous system responses to two psychologically distinct tasks. The Trier Social Stress Test (TSST; Kirschbaum, Pirke, and Hellhammer 1993) was selected because it is commonly used in the health psychology literature to assess individuals' physiological responses to stress, and a videotaped observation of an unfamiliar infant crying also was selected because this stimulus is used in the developmental psychology literature to assess individuals' physiological responses to an attachment-related challenge (e.g., Ablow et al. 2013; Groh and Roisman 2009; Leerkes et al. 2015). Electrodermal activity, which is a marker of the sympathetic nervous system, was measured during both tasks. In this way, the current study tested whether childhood maltreatment is associated with sympathetic nervous reactivity in adulthood and evaluated the possibility that the direction of the association may differ across tasks.

1.1 | Maltreatment and Sympathetic Nervous System Activity

Of the two branches of the autonomic nervous system, the sympathetic nervous system may be especially impacted by childhood maltreatment, given the sympathetic nervous system's role in mobilizing the body to respond to perceived threats (Koss and Gunnar 2018). However, there is a relative lack of research focused on examining the implications of maltreatment for sympathetic nervous system outcomes compared to the extensive number of studies examining the parasympathetic nervous system (e.g., Sigrist et al. 2021; Wesarg et al. 2022). In addition, many other studies use nonspecific measures of the autonomic nervous system such as heart rate or blood pressure (e.g., Ford et al. 2010; Gooding et al. 2016; Hill et al. 1989; Koopman et al. 2004; Leitzke, Hilt, and Pollak 2015; MacMillan et al. 2009). Because these measures are influenced by both the sympathetic and parasympathetic branches of the nervous system, they do not provide clear insights regarding the effects of maltreatment on the sympathetic nervous system specifically.

1.2 | Theoretical Perspectives

There are also conflicting theoretically driven hypotheses about the direction of the effect of childhood experiences of adversity on autonomic nervous system activity. The stress sensitization perspective suggests that experiencing early adversity programs the autonomic nervous system to exhibit heightened reactions to later stressful events (Hammen, Henry, and Daley 2000; Holochwost et al. 2021). Specifically, this model suggests that early adversity results in increased levels of vigilance to threat, which causes heightened autonomic responses to environmental challenges (Holochwost et al. 2021).

In contrast, the allostatic load model proposes that chronic exposure to adverse childhood experiences downregulates the various stress response systems, including the autonomic nervous system (McEwen 1998). Specifically, the allostatic load model suggests that repeated exposure to childhood adversity results

in wear and tear on the physiological systems that underlie stress reactivity, which ultimately results in a blunted autonomic response to later stressful events to help maintain physiological homeostasis (Juster, McEwen, and Lupien 2010).

A third possibility is that the consequences of maltreatment for sympathetic nervous system activity may differ across tasks. Gunnar (2016) argued that measures of stress physiology are not simply "emotion juice" (p. 179), and that the psychological and behavioral implications of a physiological measure depend on the nature of the stressor used to elicit the physiological response (see also Bourassa and Sbarra 2022). Holochwost et al. (2021) also suggested that the direction of the associations between maltreatment and autonomic nervous system reactivity may depend on the type of task used to measure individuals' autonomic responses to stress. That said, we are not aware of any studies that have directly tested this idea by examining the associations between maltreatment and individuals' sympathetic nervous system responses to different types of stressors. That is the primary goal of our study.

1.3 | The TSST

One common way of assessing individuals' physiological responses to stress is with the TSST (Kirschbaum, Pirke, and Hellhammer 1993). During the TSST, individuals are asked to prepare and deliver a speech and complete a verbal arithmetic task in front of a group of unfamiliar research assistants who remain affectively neutral. The TSST elicits a social-evaluative threat because completing the task generally is experienced as threatening to individuals' perceived self-efficacy (Dickerson and Kemeny 2004). Children and adults typically respond to the TSST and similar tasks with increases in sympathetic nervous system activity, including measures of electrodermal activity (Gilissen et al. 2008; Man et al. 2023; Reinhardt et al. 2012; Seddon et al. 2020; Shiban et al. 2016; Weissman and Mendes 2021). However, individuals who have experienced childhood maltreatment or similar adverse childhood experiences generally respond to the TSST and other social-evaluative tasks with less pronounced (i.e., blunted) sympathetic nervous system increases (Busso, McLaughlin, and Sheridan 2017; Heleniak et al. 2016; Leitzke, Hilt, and Pollak 2015; McLaughlin, Sheridan, et al. 2014; McLaughlin et al. 2015; c.f., McLaughlin, Alves, and Sheridan 2014). The findings from the extant literature are consistent with the allostatic load model (Juster, McEwen, and Lupien 2010; McEwen 1998) and suggest that experiences of childhood maltreatment may result in the downregulation of sympathetic nervous system activity, at least in response to social-evaluative threats. Specifically, individuals' sympathetic nervous systems may adapt to persistent and/or severe stress during childhood by becoming less sensitive to these social-evaluative stressors to buffer them from the potentially damaging effects of chronic stress.

Importantly, although these studies utilized measures of sympathetic nervous system activity, none assessed electrodermal activity. Electrodermal activity is a unique measure of sympathetic nervous system activity because it is innervated by cholinergic nerve fibers as opposed to adrenergic fibers (Stern, Ray, and Quigley 2001). In addition, electrodermal activity is theorized to reflect behavioral inhibition and therefore may be especially

responsive to cues of punishment (Fowles 1980; Matthys et al. 2004; Young-Southward et al. 2020). For these reasons, childhood maltreatment may have an especially pronounced impact on electrodermal responses to stressors later in life.

1.4 | Attachment-Related Stressors

A second common method of eliciting a physiological response is with tasks that activate individuals' attachment systems. Examples of these tasks include asking adults to discuss their childhood memories of attachment-relevant experiences (Dozier and Kobak 1992; Roisman, Tsai, and Chiang 2004), participate in conflict discussions with romantic partners (e.g., Raby et al. 2015; Roisman 2007), and view or listen to recordings of emotionally distressed infants (e.g., Ablow et al. 2013; Groh and Roisman 2009; Leerkes et al. 2015). These interpersonally focused tasks are thought to activate individuals' mental representations of attachment relationships. Indeed, individuals with highly secure attachment representations tend to exhibit minimal changes in electrodermal activity during these tasks, whereas individuals with insecure attachment representations typically respond to these attachment-relevant stressors with heightened electrodermal responses (Ablow et al. 2013; Dozier and Kobak 1992; Groh and Roisman 2009; Roisman 2007; c.f., Leerkes et al. 2015). Because maltreatment undermines individuals' feelings of safety and security (Cyr et al. 2010; Egeland and Sroufe 1981; Nivison et al. 2021; Raby et al. 2017; Roisman et al. 2017), it is plausible that individuals who have experienced childhood maltreatment may respond to these attachment-relevant tasks with heightened electrodermal responses. However, we are aware of only two studies that have directly tested the association between childhood maltreatment and electrodermal responses to attachment-relevant stimuli (Casanova et al. 1994; Reijman et al. 2014), and both these studies focused on nonpregnant women with young children. It is important to examine the implications of childhood maltreatment for sympathetic nervous system activity during pregnancy given that there are marked changes in women's physiological responses to stress during pregnancy (Christian 2012). Moreover, individual differences in pregnant women's physiological stress responses may be harbingers for subsequent health outcomes for the mother and child (Christian 2012; Davis and Narayan 2020).

1.5 | The Present Study

The central aim of the present study is to examine whether childhood maltreatment is associated with pregnant adults' sympathetic nervous system responses to stress and test whether the direction of the association varies for different types of stressful tasks. To accomplish these aims, we examined individuals' electrodermal responses to: (1) the TSST, which is commonly used in clinical and health psychology and elicits social-evaluative stress, and (2) a video of an infant crying, which is an attachment-related stressor commonly used in developmental psychology research and is intended to draw on the individual's sense of security in close relationships. To our knowledge, no study has directly tested sympathetic nervous system responses to different types of stressful tasks among the same sample of adults. Therefore, a unique feature of the current study is the ability to test whether maltreatment has differential associations

with sympathetic nervous system responses (as assessed by electrodermal activity) to a social-evaluative versus an attachment stressor among the same group of individuals. A positive association between childhood maltreatment and electrodermal activity during both tasks would lend support for the stress sensitization perspective (Hammen, Henry, and Daley 2000; Holochwost et al. 2021), whereas a negative association between childhood maltreatment and electrodermal activity during both tasks would lend support for the allostatic load model (Juster, McEwen, and Lupien 2010). A significant association between childhood maltreatment and electrodermal activity during only one task (or significant associations in opposite directions in the two tasks) would lend support to the idea that the consequences of maltreatment for sympathetic nervous system reactivity are task-specific.

A second unique feature of this study is our measurement of electrodermal responses among pregnant women. As we previously noted, all studies examining associations between childhood maltreatment and individuals' sympathetic nervous system responses have focused on nonpregnant individuals, though one study has assessed the association between pregnant women's adverse childhood experiences more generally and their sympathetic nervous system responses to an attachment-related task (see Oosterman et al. 2019). It is important to examine the implications of childhood maltreatment for sympathetic nervous system activity among this population because pregnancy represents a unique stage of the adult lifespan and because of potential intergenerational consequences of the stress response. Pregnant women's electrodermal responses to stress may alter their developing fetus' neurological and physiological development (Barker 2007; Glover 2011; Gluckman and Hanson 2006). Additionally, pregnant women's electrodermal responses to these tasks may predict their later parenting behaviors (e.g., Badovinac et al. 2023) and their children's socioemotional development (e.g., Speck et al. 2023).

In addition to examining the sympathetic nervous system consequences of overall childhood maltreatment, we investigated whether distinct experiences of childhood maltreatment, such as abuse and neglect, were associated with pregnant women's electrodermal responses to each task. Although this aim was exploratory, it was based on the idea that threatening experiences, such as childhood abuse, and experiences of deprivation, such as childhood neglect, represent two distinct dimensions of early adversity that may have unique impacts on individuals' development (McLaughlin and Sheridan 2016). Because the sympathetic nervous system has a central role in mobilizing responses to threats and challenges, it may be especially susceptible to the effects of early experiences of abuse. The study's aims and methods were preregistered with the Open Science Framework (https://osf.io/sg9qm/?view_only=242441ba272b4dd2a4d9881820cd3b7f).

2 | Methods

2.1 | Participants

Third-trimester pregnant women ($N = 162$) participated in this study. Women were recruited through flyers, brochures, and

TABLE 1 | Demographic characteristics of participating women.

Average age in years (SD)	29.0 (5.2)
Race/Ethnicity (%)	
White/Non-Hispanic	53.7
Hispanic	25.3
Asian	9.3
Native American or Alaskan Native	2.5
Black	1.2
Native Hawaiian or Pacific Islander	1.2
Other	6.8
Relationship status (%)	
Married	76.9
Single and never married	16.9
Separated or divorced	6.3
Educational attainment (%)	
Less than a high school degree	3.1
High school degree or GED	13.2
Some college	32.1
Baccalaureate degree	32.1
Postbaccalaureate degree	19.5
Household income (%)	
Less than \$9000	4.4
\$9000–\$14,999	5.7
\$15,000–\$24,999	6.9
\$25,000–\$39,999	14.5
\$40,000–\$79,999	35.7
\$80,000–\$99,999	10.7
\$100,000 or more	15.1
Refused to answer or unsure	7.0

Abbreviation: GED, general education development.

social media posts, and women of color were intentionally oversampled. In addition, women with high scores on the Difficulties in Emotion Regulation Scale (DERS) (Gratz and Roemer 2004) were intentionally oversampled to achieve a uniform distribution of emotion dysregulation, which was a central focus of the grant for which these data were collected. Because most women report low to moderate levels of emotion dysregulation, this recruitment strategy resulted in the current sample having an average DERS score that was higher than a typical community sample. Specifically, the average score on the DERS in the current sample was 80.19 (range of 36–155), which is higher than the mean score of 77.99 reported by Gratz and Roemer (2004). Additional information on recruitment criteria is further described in (Lin et al. 2019). This study was approved by the University of Utah Institutional Review Board. Table 1 contains participants' demographic information. With this sample size, the study had 80% power to detect an effect of $r = 0.21$, which is approximately a medium-sized effect according to Funder and Ozer (2019).

2.2 | Procedures

After consenting to participate in the study, pregnant women completed a battery of online questionnaires. Later, participants visited a university research laboratory where they were fitted with electrodes to collect electrodermal and electrocardiogram data. Participants completed a 10-min resting baseline, followed by the TSST (Kirschbaum, Pirke, and Hellhammer 1993). The TSST included three elements. First, participants were given 3 min to prepare a speech for a panel of “behavioral coding experts” on their qualifications for a job of their choice. Second, after preparing their speech, they spoke for 5 min to two research assistants who wore white lab coats and observed with neutral expressions without providing feedback. Third, participants completed a difficult verbal arithmetic task in front of the research assistants for 5 min. After the TSST, participants rested for 9 min, which was intended to allow their physiological responses to recover. Next, participants watched a series of 1-min videos. This included a video of a seascape, which was intended to elicit a relaxed state; a video of an unfamiliar female infant playing with a female adult caregiver, which was intended to be a neutral stimulus; a video of the same infant sitting alone on the floor crying, which was intended to elicit an attachment-relevant stress response; and the seascape video once more.

2.3 | Measures

2.3.1 | Electrodermal Activity

Skin conductance level (SCL) data were collected by placing two electrodes with a 0.5% NaCl solution to the thenar and hypothenar eminences of each individual's nondominant hand. These data were collected continuously during the initial baseline, the three episodes of the TSST, the recovery period, and the infant video stimuli. Electrodermal activity data were sampled at 500 Hz using MindWare Technology's mobile devices (MindWare Technologies Ltd.; Biolab software version 3.1). The SCL data were monitored throughout the task to ensure accurate data collection. After data collection, MindWare Technology's electrodermal activity analysis software was used to score the data. The software automatically flagged peaks and troughs in the electrodermal signals, which then were visually inspected for accuracy (and edited as needed) by trained research assistants. When edits were made, the data were splined to preserve the amplitude of the data while removing unwanted phasic components. SCL was calculated by averaging the SCL in microsiemens across each 30-s epoch of each task. The SCL data were manually reviewed for outliers, which were identified as cases that had any epoch of data that was more than two standard deviations above or below the mean. When outliers were identified, they were referred to our physiology team lead, who then closely inspected the raw electrodermal signal for any anomalous features, such as signs of poor sensor connection. If the signal was deemed compromised, then the data were excluded. If the signal quality was appropriate, then the physiology team lead cleaned the data themselves to maximize our confidence in the accuracy of the data.

SCL reactivity to each portion of the TSST was individually calculated, as well as an overall TSST reactivity variable. First,

reactivity to the speech preparation portion of the TSST was calculated by subtracting participants' average SCLs during the speech preparation task from their average levels during the initial 10-min baseline task, then reactivity to the speech task was calculated by subtracting participants' average SCLs during the speech task from their average levels during the baseline, and finally, participants' reactivity to the math task was calculated by subtracting participants' average SCLs during the math task from their average levels during the baseline. Then, overall reactivity to the TSST was separately calculated by (1) averaging SCLs during the three stressful episodes of the TSST (i.e., the speech prep, speech, and math episodes) and (2) subtracting the average SCL during the initial 10-min baseline from that overall averaged value. In addition to the TSST reactivity scores, two SCL reactivity scores for the infant videos were created. One was created by subtracting women's average SCL during the initial 10-min baseline that was completed prior to the TSST from their average levels during the mother–infant play video, and the other was created by subtracting their average levels during the infant cry video from the baseline task.

2.3.2 | Self-Reported Childhood Maltreatment Experiences

Women's retrospective reports of their childhood maltreatment experiences were assessed using the Childhood Trauma Questionnaire—Short Form (CTQ-SF; Bernstein et al. 2003). The CTQ-SF is a 28-item questionnaire designed to assess five types of childhood maltreatment experiences: emotional abuse, physical abuse, sexual abuse, emotional neglect, and physical neglect. Each type of maltreatment was measured with five items. The CTQ-SF also includes three items that measure minimization and denial of abuse, which were not used in the current study. All items were scored on a five-point scale (1 = *Never True* to 5 = *Very Often True*). The 25 items used were averaged to create an overall childhood maltreatment score ($\alpha = 0.94$). In addition, a measure of childhood abuse was created by averaging the 15 items related to emotional, physical, and sexual abuse ($\alpha = 0.93$), and a measure of childhood neglect was created by averaging the 10 items related to emotional and physical neglect ($\alpha = 0.89$).

2.3.3 | Covariates

Self-report measures of childhood adversity may be biased by participants' current mental state (Roisman, Fortuna, and Holland 2006). Specifically, current levels of distress, as well as experiences of stress related to socioeconomic status may alter participants' reports of prior trauma, and similarly, current mental health and emotion regulation difficulties may also bias these reports. Individuals' emotional states and current stress levels may also affect their physiological responses to laboratory tasks (Reuben et al. 2016). For these reasons, we preregistered that we would include two covariates in the current study. The first was women's self-reported family socioeconomic status, which was calculated by averaging the standardized variables for women's education levels, household income, and ratings of household occupational prestige (Hout, Smith, and Marsden 2016; $\alpha = 0.61$). The second was women's self-reported emotion dysregulation, collected via the DERS (Gratz and Roemer 2004).

2.4 | Missing Data

Three women (2% of the total sample) were missing self-reported childhood maltreatment data, and approximately 2% of the SCL data was missing (0% for TSST baseline, 1% for TSST speech preparation, 3% for TSST speech, 2% for TSST math, 3% for the seascape video baseline, 6% for the mother–infant play video, and 3% for the infant cry video). For the covariates, no women were missing socioeconomic status data, but 1% was missing DERS data. Missing data were managed using Full Information Maximum Likelihood in Mplus.

3 | Results

3.1 | Preliminary Analyses

A series of paired samples *t*-tests were conducted to assess changes in women's average SCLs across the laboratory visit (see Figure 1). SCLs increased from baseline to speech prep ($t(161) = 17.44$, $p < 0.001$) and increased from speech prep to speech ($t(161) = 9.54$, $p < 0.001$). Although SCLs did not significantly change from the speech to the math episode of the TSST ($t(161) = 1.24$, $p = 0.22$), they did increase across the TSST as a whole when comparing baseline SCL to math SCL ($t(161) = 20.50$, $p < 0.001$). SCLs decreased from the math episode of the TSST to the post-TSST recovery rest ($t(161) = -6.60$, $p < 0.001$), and they did not significantly change from the post-TSST resting period to the pre-cry seascape video ($t(161) = -0.25$, $p = 0.81$). In the context of the infant videos, SCLs decreased from the post-TSST seascape video to the mother–infant play video ($t(161) = -10.25$, $p < 0.001$) and increased from the mother–infant play video to the infant cry video ($t(161) = 2.03$, $p = 0.04$). They subsequently decreased from the mother–infant cry video to the seascape recovery video ($t(161) = -4.60$, $p < 0.001$). In other words, participants exhibited a sympathetic nervous system response to the infant cry video but not the mother–infant play video. These findings align with results reported in 2023 which utilized data from a smaller subset of the same sample.

See Table 2 for descriptive statistics and correlations among study variables. Importantly, adults' self-reported experiences of abuse and neglect were positively correlated, which reflects the fact that these adverse childhood experiences often co-occur. Additionally, the various measures of SCL reactivity were positively correlated with one another. Experiences of maltreatment were negatively correlated with SCL reactivity to the TSST speech prep, and experiences of abuse were also negatively correlated with SCL reactivity to the TSST speech prep task as well as overall TSST reactivity. Experiences of neglect, however, were not significantly correlated with SCL reactivity to any of the tasks. Socioeconomic status was negatively correlated with maltreatment, and DERS was positively correlated with overall maltreatment, abuse, and neglect.

3.2 | Is Self-Reported Childhood Maltreatment Associated With Sympathetic Nervous System Reactivity to the TSST?

An initial set of ordinary least squares regression was conducted to test whether self-reported childhood maltreatment experiences

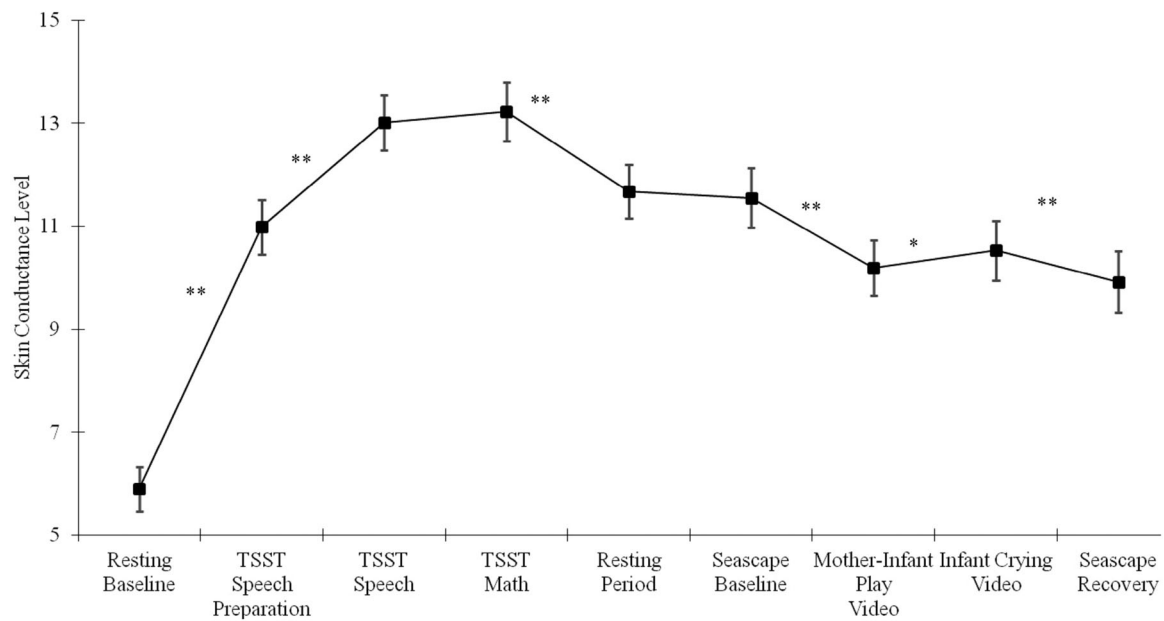


FIGURE 1 | Pregnant women's average skin conductance levels during the laboratory visit. TSST, Trier Social Stress Test. * $p < 0.05$, ** $p < 0.01$.

TABLE 2 | Descriptive statistics and correlations among study variables.

Variable	M	SD	1	2	3	4	5	6	7	8	9	10	11
1. Self-report childhood maltreatment	1.58	0.65	—										
2. Self-report childhood abuse	1.52	0.72	0.93**	—									
3. Self-report childhood neglect	1.67	0.74	0.83**	0.57**	—								
4. SCL reactivity to the TSST speech preparation	5.09	3.71	−0.20*	−0.23**	−0.11	—							
5. SCL reactivity to the TSST speech	7.12	4.26	−0.07	−0.11	−0.04	0.79**	—						
6. SCL reactivity to the TSST math	7.33	4.51	−0.11	−0.14	−0.04	0.76**	0.89**	—					
7. SCL reactivity to the TSST	6.51	3.89	−0.13	−0.16*	−0.06	0.89**	0.96**	0.95**	—				
8. SCL reactivity to the mother–infant play video	10.19	6.65	−0.10	−0.11	−0.05	0.63**	0.70**	0.75**	0.74**	—			
9. SCL reactivity to the infant cry video	10.53	7.42	−0.12	−0.14	−0.06	0.62**	0.66**	0.70**	0.71**	0.91**	—		
10. Socioeconomic status	0.04	0.83	−0.16*	−0.15	−0.13	0.04	−0.06	−0.03	−0.03	−0.03	−0.05	—	
11. DERS	80.10	26.70	0.27**	0.24**	0.24**	0.05	0.09	0.10	0.09	0.11	0.12	−0.16*	—

Note: $N = 162$.

Abbreviations: DERS, difficulties in emotion regulation score; SCL, skin conductance level; TSST, Trier Social Stress Test.

* $p < 0.05$; ** $p < 0.01$.

were associated with SCL reactivity to the TSST after accounting for covariates. Results indicated that self-reported childhood maltreatment was associated with blunted overall reactivity to the TSST (see Table 3, Model 1). Follow-up analyses were conducted predicting SCL reactivity to each episode of the TSST. Results

indicated that women who reported high levels of childhood maltreatment exhibited blunted SCL reactivity to the speech preparation portion of the TSST. The associations between maltreatment and SCL reactivity to the speech and math episodes of the TSST were not statistically significant (see Table 3).

TABLE 3 | Ordinary least squares analyses predicting skin conductance reactivity during the Trier Social Stress Task.

	Overall TSST		TSST speech preparation		TSST speech		TSST math	
	β (SE)	<i>p</i>	β (SE)	<i>p</i>	β (SE)	<i>p</i>	β (SE)	<i>p</i>
Model 1								
Maltreatment	− 0.18 (0.08)*	0.029	− 0.25 (0.08)**	0.002	− 0.13 (0.08)	0.115	− 0.16 (0.08)	0.052
Socioeconomic status	− 0.04 (0.08)	0.622	0.02 (0.08)	0.772	− 0.10 (0.08)	0.225	− 0.03 (0.08)	0.697
DERS	0.14 (0.08)	0.090	0.13 (0.08)	0.120	0.12 (0.08)	0.152	0.15 (0.08)	0.078
Model 2								
Abuse	− 0.22 (0.10)*	0.025	− 0.27 (0.09)**	0.004	− 0.15 (0.10)	0.114	− 0.21 (0.10)*	0.031
Neglect	0.03 (0.10)	0.802	0.01 (0.10)	0.935	0.01 (0.10)	0.896	0.04 (0.10)	0.691
Socioeconomic status	− 0.04 (0.08)	0.615	0.02 (0.08)	0.775	− 0.10 (0.08)	0.220	− 0.03 (0.08)	0.690
DERS	0.14 (0.08)	0.095	0.13 (0.08)	0.129	0.12 (0.08)	0.159	0.14 (0.08)	0.083

Note: *N* = 162.

Abbreviations: DERS, difficulties in emotion regulation score; TSST, Trier Social Stress Test.

p* < 0.05; *p* < 0.01.

A second set of additional ordinary least squares regressions was conducted to determine whether self-reported childhood experiences of abuse or neglect were uniquely associated with SCL reactivity to the TSST after accounting for covariates. Results indicated that self-reported childhood abuse, but not neglect, was negatively associated with overall SCL reactivity to the TSST (see Table 3, Model 2). Follow-up analyses indicated that women who reported high levels of childhood abuse (but not neglect) exhibited blunted SCL reactivity to the speech preparation and math episodes of the TSST. Neither abuse nor neglect was significantly associated with SCL reactivity to the TSST speech episode.

3.3 | Is Self-Reported Childhood Maltreatment Associated With Sympathetic Nervous System Reactivity to Attachment-Relevant Stressors?

A third set of ordinary least squares regression analyses was conducted to test whether self-reported childhood maltreatment experiences were associated with women's SCL responses to the attachment-related videos after accounting for covariates (see Table 4, Model 1). Results indicated that self-reported childhood maltreatment experiences were associated with blunted SCL reactivity to the video of the infant crying alone but were not significantly associated with SCL reactivity to the video of the mother–infant play interaction.

A fourth and final set of ordinary least squares regressions was conducted to determine whether self-reported childhood abuse or neglect predicted SCL reactivity to the video of the infant crying when accounting for covariates. Results indicated that self-reported childhood abuse (but not neglect) was significantly associated with blunted SCL reactivity to the video of the infant crying (see Table 4, Model 2). In other words, pregnant women who reported higher levels of childhood abuse tended to exhibit less SCL activity in response to the infant cry video. The analyses

predicting SCL reactivity to the video of the mother–infant playing interaction were not statistically significant.

4 | Discussion

The overarching purpose of this preregistered study was to address competing theoretically informed hypotheses regarding the direction of the effect of early experiences of adversity on autonomic nervous system activity. Results were in alignment with the allostatic load model (Juster, McEwen, and Lupien 2010; McEwen 1998). Specifically, childhood maltreatment was associated with blunted electrodermal responses to both the TSST (i.e., a social-evaluative stressor) and the video of an infant crying (i.e., an attachment-related stressor). Additionally, exploratory analyses indicated that both associations were specific to women's reported experiences of childhood abuse rather than neglect. These associations were significant only when controlling for women's socioeconomic status and self-reported emotion dysregulation, which highlights the utility of controlling for these potential sources of bias in retrospective reports of childhood maltreatment. Nonetheless, these findings contribute meaningfully to the existing body of literature on enduring consequences of childhood maltreatment in several ways. First, a sympathetic nervous system measure was explored (electrodermal responding) because of the relatively sparse research assessing associations between maltreatment and the sympathetic nervous system compared to the parasympathetic nervous system (Sigrist et al. 2021; Wesarg et al. 2022). Second, two psychologically distinct tasks were used to address the possibility that the direction of the association between maltreatment and sympathetic nervous system reactivity may differ across tasks. To our knowledge, this is the first study to assess individuals' electrodermal responses to both types of stressors within the same sample.

TABLE 4 | Ordinary least squares analyses predicting skin conductance reactivity during attachment-related video stimuli.

	Infant crying video		Mother–infant play video	
	β (SE)	<i>p</i>	β (SE)	<i>p</i>
Model 1				
Maltreatment	− 0.18 (0.08)*	0.022	− 0.14 (0.08)	0.070
Socioeconomic status	− 0.05 (0.08)	0.527	− 0.04 (0.08)	0.591
DERS	0.16 (0.08)*	0.049	0.16 (0.09)	0.063
Model 2				
Abuse	− 0.19 (0.10)*	0.047	− 0.15 (0.10)	0.124
Neglect	− 0.01 (0.10)	0.897	− 0.01 (0.10)	0.887
Socioeconomic status	− 0.05 (0.08)	0.524	− 0.04 (0.08)	0.588
DERS	0.16 (0.08)	0.051	0.15 (0.09)	0.065

Note: *N* = 162.

Abbreviation: DERS, difficulty with emotion regulation score.

**p* < 0.05.

Evidence from this study indicated that pregnant women who reported experiencing frequent and/or severe childhood abuse exhibited blunted electrodermal activity in response to the TSST and the video of the infant crying. This suggests that the woman's sympathetic nervous system responses may have adapted to the chronic stress of childhood abuse by downregulating when faced with stressful events later in life. These findings are generally consistent with predictions from the allostatic load model (Juster, McEwen, and Lupien 2010; McEwen 1998), as well as previous research indicating that individuals who have been maltreated exhibited blunted sympathetic nervous system responses to the TSST (Busso, McLaughlin, and Sheridan 2017; Heleniak et al. 2016; Leitzke, Hilt, and Pollak 2015; McLaughlin, Sheridan, et al. 2014; McLaughlin et al. 2015).

That said, the finding that childhood maltreatment was associated with blunted electrodermal responses to the video of the infant crying was somewhat unexpected considering some prior research on consequences of maltreatment for sympathetic responses to attachment-based challenges (Buisman et al. 2018, 2019; Oosterman et al. 2010). There could be many explanations for these discrepant findings. The few studies that have identified a positive association between childhood maltreatment and sympathetic nervous system reactivity to attachment-related stressors focused on pre-ejection period (Buisman et al. 2018, 2019; Oosterman et al. 2010; c.f., Oosterman et al., 2019). In contrast, the current study focused on electrodermal activity. Although both measures reflect sympathetic nervous system activity, electrodermal activity is a general measure of sympathetic activity that is innervated by cholinergic nerve fibers (Stern, Ray, and Quigley 2001). In contrast, pre-ejection period is specific to cardiac sympathetic control and is innervated by adrenergic fibers (Stern, Ray, and Quigley 2001). This suggests that both measures serve unique biological functions. Additionally, electrodermal activity and the pre-ejection period may serve different psychological and behavioral functions. Electrodermal activity is thought to be particularly sensitive to cues of punishment, whereas pre-ejection period may be particularly sensitive to reward valuation

(Young-Southward et al. 2020). Given these different underlying biological and psychological processes, future work should further investigate the association between childhood maltreatment and electrodermal and pre-ejection period responses to various stressors.

A second possible explanation may be the fact that the current study focused exclusively on pregnant women. Pregnancy induces significant changes to individuals' physiological functioning to accommodate the developing fetus (Soma-Pillay et al. 2016). Women may also be especially sensitive to infants' attachment-related cues, including the infant cry videos, during pregnancy (Pearson, Lightman, and Evans et al. 2011). More work is needed to evaluate whether pregnancy alters the direction of the association between maltreatment and sympathetic nervous system responses to attachment-related challenges. A third possible explanation is that there may have been potential carryover effects from the TSST in our sample. Although there was a 9-min rest period between the TSST and the presentation of the infant videos, it is nonetheless possible that the psychological stress elicited by the TSST affected individuals' sympathetic nervous system responses to the video of the infant crying. One solution to this issue would be to counterbalance the task order in future studies.

Heightened sympathetic nervous system responses to attachment-related tasks, rather than blunted activity, are generally expected to be associated with poor caregiving and child outcomes (e.g., Ham and Tronick 2006; Speck et al. 2023). That said, there is no consistent evidence that sympathetic responses (including electrodermal activity) are associated with parenting outcomes (Badovinac et al. 2023). It may be that electrodermal blunting is associated with poorer parenting and child development outcomes under certain conditions, such as less effective parasympathetic nervous system functioning (Leerkes et al. 2017; Leerkes et al. 2023). Blunted autonomic activity more broadly has been associated with poorer physical health, including worse self-reported

health, higher inflammation levels, faster biological aging, and higher risk for early mortality (Bourassa et al. 2021). These findings raise the possibility that associations between stress reactivity and subsequent functioning are nonlinear. According to the adaptive calibration model (Del Giudice, Ellis, and Shirtcliff 2011), both the “unemotional profile”—which is characterized by low sympathetic nervous system (as well as parasympathetic nervous system and hypothalamic–pituitary–adrenal axis) responses to environmental stressors—and the “vigilant profile”—which is characterized by hyperactivity of these physiological systems—are associated with emotional and behavioral outcomes traditionally associated with poorer psychological functioning. Carroll et al. (2017) proposed a similar model with a focus on physical health outcomes. It may be fruitful for future research to examine the possibility of nonlinear associations between electrodermal responses to stressors and later psychological, behavioral, and health outcomes.

In our study, we captured retrospective reports of childhood maltreatment. Retrospective reports of maltreatment have well-established limitations, including the possibility that the events in question have been forgotten or that adults’ reports could be biased by current mental health or relationships (Widom 2019). Prospective measures of childhood maltreatment also have their own limitations, including the possibility that not all experiences of maltreatment are detected by others and reported to Child Protective Services (Newbury et al. 2018). Having recognized that, retrospective reports of maltreatment experiences correlate positively with prospective assessments of childhood maltreatment (Baldwin et al. 2019), although the magnitude of the association between the two measures of maltreatment is modest. In the current study, we attempted to minimize some potential biases associated with retrospective reports by statistically controlling for sources of psychological and environmental stress. However, a critically important direction for future research will be to attempt to replicate these findings using alternative measures of childhood maltreatment, such as interview measures or prospectively gathered measures of maltreatment. In addition, although the current study’s focus on adult populations is useful for understanding potential long-term effects of childhood maltreatment, future research should investigate these processes among younger age groups. This will allow for a better understanding of when the effects of childhood maltreatment on sympathetic nervous system reactivity first appear.

The present study focused on a community sample of pregnant women, a majority of whom identified as White/non-Hispanic. A byproduct of our focus on pregnant individuals in this sample is that all participants were biological females. Participants in this study also reported slightly higher rates of childhood maltreatment than a typical community sample (Scher et al. 2001), which likely is because pregnant women who exhibited high levels of emotion dysregulation were intentionally oversampled in this study (Lin et al. 2019). That said, participants’ rates of childhood maltreatment were lower than rates reported in clinical samples (Chaney et al. 2014; Grilo and Masheb 2002; Huh et al. 2017). Additional research that includes participants who are members of more diverse groups in terms of biological sex, self-identified gender, race, ethnicity, and risk status would be valuable in determining the generalizability of these findings. Research focused on the potential associations between fathers’

experiences of childhood maltreatment and their sympathetic nervous system responses to various types of stressors is especially needed.

In summary, the current study offers novel evidence that self-reported experiences of childhood maltreatment, particularly childhood abuse, are associated with blunted electrodermal responses to social-evaluative and attachment stressors. To our knowledge, this is the first study to test the association between childhood maltreatment and pregnant women’s electrodermal activity to two psychologically distinct stressors. These results address a gap in the literature regarding the effects of maltreatment on sympathetic nervous system activity. By utilizing a measure of electrodermal activity, which is a robust indicator of sympathetic nervous system activity, and by integrating two commonly used but psychologically distinct tasks, the present study provides much needed evidence for the potential long-term effects of childhood maltreatment on sympathetic nervous system responses among pregnant women.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

References

- Ablow, J. C., A. K. Marks, S. S. Feldman, and L. C. Huffman. 2013. “Associations Between First-Time Expectant Women’s Representations of Attachment and Their Physiological Reactivity to Infant Cry.” *Child Development* 84: 1373–1391. <https://doi.org/10.1111/cdev.12135>.
- Badovinac, S. D., C. Chow, M. G. Di Lorenzo-Klas, H. Edgell, D. B. Flora, and R. R. P. Riddell. 2023. “Parents’ Physiological Reactivity to Child Distress and Associations With Parenting Behaviour: A Systematic Review.” *Neuroscience and Biobehavioral Reviews* 151: 105229. <https://doi.org/10.1016/j.neubiorev.2023.105229>.
- Baldwin, J. R., A. Reuben, J. B. Newbury, and A. Danese. 2019. “Agreement Between Prospective and Retrospective Measures of Childhood Maltreatment: A Systematic Review and Meta-Analysis.” *JAMA Psychiatry* 76: 584–593. <https://doi.org/10.1001/jamapsychiatry.2019.0097>.
- Barker, D. J. P. 2007. “The Origins of the Developmental Origins Theory.” *Journal of Internal Medicine* 261: 412–417. <https://doi.org/10.1111/j.1365-2796.2007.01809.x>.
- Bernstein, D. P., J. A. Stein, M. D. Newcomb, et al. 2003. “Development and Validation of a Brief Screening Version of the Childhood Trauma Questionnaire.” *Child Abuse and Neglect* 27: 169–190. [https://doi.org/10.1016/S0145-2134\(02\)00541-0](https://doi.org/10.1016/S0145-2134(02)00541-0).
- Bourassa, K. J., T. E. Moffitt, H. Harrington, et al. 2021. “Lower Cardiovascular Reactivity Is Associated With More Childhood Adversity and Poorer Midlife Health: Replicated Findings From the Dunedin and MIDUS Cohorts.” *Clinical Psychological Science* 9: 961–978. <https://doi.org/10.1177/2167702621993900>.
- Bourassa, K. J., and D. A. Sbarra. 2022. “Cardiovascular Reactivity, Stress, and Personal Emotional Salience: Choose Your Tasks Carefully.” *Psychophysiology* 59: e14037. <https://doi.org/10.1111/psyp.14037>.
- Buisman, R. S., M. J. Bakermans-Kranenburg, K. Pittner, et al. 2019. “Parents’ Experiences of Childhood Abuse and Neglect Are Differentially Associated With Behavioral and Autonomic Responses to Their

- Offspring." *Developmental Psychobiology* 61: 888–902. <https://doi.org/10.1002/dev.21822>.
- Buisman, R. S. M., K. Pittner, C.-D. Block, et al. 2018. "The Past Is Present: The Role of Maltreatment History in Perceptual, Behavioral and Autonomic Responses to Infant Emotional Signals." *Child Abuse and Neglect* 77: 23–34. <https://doi.org/10.1016/j.chiabu.2017.12.020>.
- Busso, D. S., K. A. McLaughlin, and M. A. Sheridan. 2017. "Dimensions of Adversity, Physiological Reactivity, and Externalizing Psychopathology in Adolescence: Deprivation and Threat." *Psychosomatic Medicine* 79: 162–171. <https://doi.org/10.1097/PSY.0000000000000369>.
- Carroll, D., A. T. Ginty, A. C. Whittaker, W. R. Lovallo, and S. R. de Rooij. 2017. "The Behavioural, Cognitive, and Neural Corollaries of Blunted Cardiovascular and Cortisol Reactions to Acute Psychological Stress." *Neuroscience and Biobehavioral Reviews* 77: 74–86. <https://doi.org/10.1016/j.neubiorev.2017.02.025>.
- Casanova, G. M., J. Domanic, T. R. McCanne, and J. S. Milner. 1994. "Physiological Responses to Child Stimuli in Mothers With and Without a Childhood History of Physical Abuse." *Child Abuse and Neglect* 18: 995–1004. [https://doi.org/10.1016/0145-2134\(94\)90124-4](https://doi.org/10.1016/0145-2134(94)90124-4).
- Chaney, A., A. Carballedo, F. Amico, et al. 2014. "Effect of Childhood Maltreatment on Brain Structure in Adult Patients With Major Depressive Disorder and Healthy Participants." *Journal of Psychiatry and Neuroscience* 39: 50–59. <https://doi.org/10.1503/jpn.120208>.
- Christian, L. M. 2012. "Physiological Reactivity to Psychological Stress in Human Pregnancy: Current Knowledge and Future Directions." *Progress in Neurobiology* 99, no. 2: 106–116. <https://doi.org/10.1016/j.pneurobio.2012.07.003>.
- Cicchetti, D. 2016. "Socioemotional, Personality, and Biological Development: Illustrations From a Multilevel Developmental Psychopathology Perspective on Child Maltreatment." *Annual Review of Psychology* 67: 187–211. <https://doi.org/10.1146/annurev-psych-122414-033259>.
- Cicchetti, D., and S. L. Toth. 2005. "Child Maltreatment." *Annual Review of Clinical Psychology* 1: 409–438. <https://doi.org/10.1146/annurev.clinpsy.1.102803.144029>.
- Cyr, C., E. Euser, M. Bakermans-Kranenburg, and M. Van IJzendoorn. 2010. "Attachment Security and Disorganization in Maltreating and High-Risk Families: A Series of Meta-Analyses." *Development and Psychopathology* 22: 87–108. <https://doi.org/10.1017/S0954579409990289>.
- Davis, E. P., and A. J. Narayan. 2020. "Pregnancy as a Period of Risk, Adaptation, and Resilience for Mothers and Infants." *Development and Psychopathology* 32, no. 5: 1625–1639. <https://doi.org/10.1017/S0954579420001121>.
- Del Giudice, M., B. J. Ellis, and E. A. Shirtcliff. 2011. "The Adaptive Calibration Model of Stress Responsivity." *Neuroscience and Biobehavioral Reviews* 35: 1562–1592. <https://doi.org/10.1016/j.neubiorev.2010.11.007>.
- Dickerson, S. S., and M. E. Kemeny. 2004. "Acute Stressors and Cortisol Responses: A Theoretical Integration and Synthesis of Laboratory Research." *Psychological Bulletin* 130: 355–391. <https://doi.org/10.1037/0033-2909.130.3.355>.
- Dozier, M., and R. R. Kobak. 1992. "Psychophysiology in Attachment Interviews: Converging Evidence for Deactivating Strategies." *Child Development* 63: 1473–1480. <https://doi.org/10.1111/j.1467-8624.1992.tb01708.x>.
- Egeland, B., and L. A. Sroufe. 1981. "Attachment and Early Maltreatment." *Child Development* 52, no. 1: 44–52. <https://doi.org/10.2307/1129213>.
- Fergusson, D. M., J. M. Boden, and L. J. Horwood. 2008. "Exposure to Childhood Sexual and Physical Abuse and Adjustment in Early Adulthood." *Child Abuse and Neglect* 32: 607–619. <https://doi.org/10.1016/j.chiabu.2006.12.018>.
- Ford, J. D., L. A. Fraligh, D. B. Albert, and D. F. Connor. 2010. "Child Abuse and Autonomic Nervous System Hyporesponsivity Among Psychiatrically Impaired Children." *Child Abuse and Neglect* 34: 507–515. <https://doi.org/10.1016/j.chiabu.2009.11.005>.
- Fowles, D. C. 1980. "The Three Arousal Model: Implications of Gray's Two-Factor Learning Theory for Heart Rate, Electrodermal Activity, and Psychopathy." *Psychophysiology* 17: 87–104. <https://doi.org/10.1111/j.1469-8986.1980.tb00117.x>.
- Funder, D. C., and D. J. Ozer. 2019. "Evaluating Effect Size in Psychological Research: Sense and Nonsense." *Advances in Methods and Practices in Psychological Science* 2: 156–168. <https://doi.org/10.1177/2515245919847202>.
- Gilbert, R., C. Widom, K. Browne, D. Fergusson, E. Webb, and S. Janson. 2009. "Burden and Consequences of Child Maltreatment in High-Income Countries." *Lancet* 373: 68–81. [https://doi.org/10.1016/S0140-6736\(08\)61706-7](https://doi.org/10.1016/S0140-6736(08)61706-7).
- Gilissen, R., M. J. Bakermans-Kranenburg, M. H. Van IJzendoorn, and M. Linting. 2008. "Electrodermal Reactivity During the Trier Social Stress Test for Children: Interaction Between the Serotonin Transporter Polymorphism and Children's Attachment Representation." *Developmental Psychobiology* 50: 615–625. <https://doi.org/10.1002/dev.20314>.
- Glover, V. 2011. "Annual Research Review: Prenatal Stress and the Origins of Psychopathology: An Evolutionary Perspective." *Journal of Child Psychology and Psychiatry* 52: 356–367. <https://doi.org/10.1111/j.1469-7610.2011.02371.x>.
- Gluckman, P. D., and M. A. Hanson. 2006. "The Developmental Origins of Health and Disease." In *Early Life Origins of Health and Disease*, edited by E. M. Wintour and J. A. Owens, 1–7. Boston, MA: Springer. https://doi.org/10.1007/0-387-32632-4_1.
- Gooding, H. C., C. E. Milliren, S. B. Austin, M. A. Sheridan, and K. A. McLaughlin. 2016. "Child Abuse, Resting Blood Pressure, and Blood Pressure Reactivity to Psychosocial Stress." *Journal of Pediatric Psychology* 41: 5–14. <https://doi.org/10.1093/jpepsy/jsv040>.
- Gratz, K. L., and L. Roemer. 2004. "Multidimensional Assessment of Emotion Regulation and Dysregulation: Development, Factor Structure, and Initial Validation of the Difficulties in Emotion Regulation Scale." *Journal of Psychopathology and Behavioral Assessment* 26: 41–54. <https://doi.org/10.1007/s10862-008-9102-4>.
- Grilo, C. M., and R. M. Masheb. 2002. "Childhood Maltreatment and Personality Disorders in Adult Patients With Binge Eating Disorder." *Acta Psychiatrica Scandinavica* 106: 183–188. <https://doi.org/10.1034/j.1600-0447.2002.02303.x>.
- Groh, A. M., and G. I. Roisman. 2009. "Adults' Autonomic and Subjective Emotional Responses to Infant Vocalizations: The Role of Secure Base Script Knowledge." *Developmental Psychology* 45: 889–893. <https://doi.org/10.1037/a0014943>.
- Gunnar, M. R. 2016. "Early Life Stress: What Is the Human Chapter of the Mammalian Story?" *Child Development Perspectives* 10: 178–183. <https://doi.org/10.1111/cdep.12182>.
- Ham, J., and E. Tronick. 2006. "Infant Resilience to the Stress of the Still-Face: Infant and Maternal Psychophysiology Are Related." *Annals of the New York Academy of Science* 1094: 297–302. <https://doi.org/10.1196/annals.1376.038>.
- Hammen, C., R. Henry, and S. E. Daley. 2000. "Depression and Sensitization to Stressors Among Young Women as a Function of Childhood Adversity." *Journal of Consulting and Clinical Psychology* 68: 782–787. <https://doi.org/10.1037/0022-006X.68.5.782>.
- Heleniak, C., K. A. McLaughlin, J. Ormel, and H. Riese. 2016. "Cardiovascular Reactivity as a Mechanism Linking Child Trauma to Adolescent Psychopathology." *Biological Psychology* 120: 108–119. <https://doi.org/10.1016/j.biopsycho.2016.08.007>.
- Hill, S. E., B. Blechfield, R. D. Brunstetter, J. E. Herbert, and S. Steckler. 1989. "Cognitive and Physiological Responsiveness of Abused Children." *Journal of the American Academy of Child and Adolescent Psychiatry* 28: 219–224. <https://doi.org/10.1097/00004583-198903000-00012>.
- Holochwost, S. J., G. Wang, J. Kolacz, W. R. Mills-Koonce, J. B. Klika, and S. R. Jaffee. 2021. "The Neurophysiological Embedding of Child Maltreatment." *Development and Psychopathology* 33: 1107–1137. <https://doi.org/10.1017/S0954579420000383>.

- Hout, M., T. W. Smith, and P. V. Marsden. 2016. "Prestige and Socioeconomic Scores for the 2010 Census Codes." *GSS Methodological Report* 124: 1–18.
- Huh, H. J., K. H. Kim, H. Lee, and J. Chae. 2017. "The Relationship Between Childhood Trauma and the Severity of Adulthood Depression and Anxiety Symptoms in a Clinical Sample: The Mediating Role of Cognitive Emotion Regulation Strategies." *Journal of Affective Disorders* 213: 44–50. <https://doi.org/10.1016/j.jad.2017.02.009>.
- Juster, R. P., B. S. McEwen, and S. J. Lupien. 2010. "Allostatic Load Biomarkers of Chronic Stress and Impact on Health and Cognition." *Neuroscience & Biobehavioral Reviews* 35: 2–16. <https://doi.org/10.1016/j.neubiorev.2009.10.002>.
- Kirschbaum, C., K. M. Pirke, and D. H. Hellhammer. 1993. "The 'Trier Social Stress Test'—A Tool for Investigating Psychobiological Stress Responses in a Laboratory Setting." *Neuropsychobiology* 28: 76–81. <https://doi.org/10.1159/000119004>.
- Koopman, C., V. Carrion, L. D. Butler, S. Sudhakar, L. Palmer, and H. Steiner. 2004. "Relationships of Dissociation and Childhood Abuse and Neglect With Heart Rate in Delinquent Adolescents." *Journal of Traumatic Stress* 17: 47–54. <https://doi.org/10.1023/B:JOTS.0000014676.83722.35>.
- Koss, K. J., and M. R. Gunnar. 2018. "Annual Research Review: Early Adversity, the Hypothalamic–Pituitary–Adrenocortical Axis, and Child Psychopathology." *Journal of Child Psychology and Psychiatry* 59: 327–346. <https://doi.org/10.1111/jcpp.12784>.
- Leerkes, E. M., S. A. Girod, C. Buehler, L. H. Shriver, and L. Wideman. 2023. "Interactive Effects of Maternal Physiological Arousal and Regulation on Maternal Sensitivity: Replication and Extension in an Independent Sample." *Developmental Psychobiology* 65: e22375. <https://doi.org/10.1002/dev.22375>.
- Leerkes, E. M., J. Su, S. D. Calkins, M. O'Brien, and A. J. Supple. 2017. "Maternal Physiological Dysregulation While Parenting Poses Risk for Infant Attachment Disorganization and Behavior Problems." *Development and Psychopathology* 29: 245–257. <https://doi.org/10.1017/S0954579416000122>.
- Leerkes, E. M., A. J. Supple, M. O'Brien, et al. 2015. "Antecedents of Maternal Sensitivity During Distressing Tasks: Integrating Attachment, Social Information Processing, and Psychobiological Perspectives." *Child Development* 86: 94–111. <https://doi.org/10.1111/cdev.12288>.
- Leitzke, B. T., L. M. Hilt, and S. D. Pollak. 2015. "Maltreated Youth Display a Blunted Blood Pressure Response to an Acute Interpersonal Stressor." *Journal of Clinical Child & Adolescent Psychology* 44: 305–313. <https://doi.org/10.1080/15374416.2013.848774>.
- Lin, B., P. R. Kaliush, E. Conradt, et al. 2019. "Intergenerational Transmission of Emotion Dysregulation: Part I. Psychopathology, Self-Injury, and Parasympathetic Responsivity Among Pregnant Women." *Development and Psychopathology* 31, no. 3: 817–831. <https://doi.org/10.1017/S0954579419000336>.
- MacMillan, H. L., K. Georgiades, E. K. Duku, et al. 2009. "Cortisol Response to Stress in Female Youths Exposed to Childhood Maltreatment: Results of the Youth Mood Project." *Biological Psychiatry* 66: 62–68. <https://doi.org/10.1016/j.biopsych.2008.12.014>.
- Man, I. S., R. Shao, W. K. Hou, et al. 2023. "Multi-Systemic Evaluation of Biological and Emotional Responses to the Trier Social Stress Test: A Meta-Analysis and Systematic Review." *Frontiers in Neuroendocrinology* 68: 101050. <https://doi.org/10.1016/j.ynfrne.2022.101050>.
- Matthys, W., S. H. M. Van Goozen, H. Snoek, and H. Van Engeland. 2004. "Response Perseveration and Sensitivity to Reward and Punishment in Boys With Oppositional Defiant Disorder." *European Child and Adolescent Psychiatry* 13: 362–364. <https://doi.org/10.1007/s00787-004-0395-x>.
- McEwen, B. S. 1998. "Stress, Adaptation, and Disease: Allostasis and Allostatic Load." *Annals of the New York Academy of Sciences* 840: 33–44. <https://doi.org/10.1111/j.1749-6632.1998.tb09546.x>.
- McLaughlin, K. A., and M. A. Sheridan. 2016. "Beyond Cumulative Risk: A Dimensional Approach to Childhood Adversity." *Current Directions in Psychological Science* 25, no. 4: 239–245. <https://doi.org/10.1177/0963721416655883>.
- McLaughlin, K. A., S. Alves, and M. A. Sheridan. 2014. "Vagal Regulation and Internalizing Psychopathology Among Adolescents Exposed to Childhood Adversity." *Developmental Psychobiology* 56: 1036–1051. <https://doi.org/10.1002/dev.21187>.
- McLaughlin, K. A., M. A. Sheridan, S. Alves, and W. B. Mendes. 2014. "Child Maltreatment and Autonomic Nervous System Reactivity: Identifying Dysregulated Stress Reactivity Patterns by Using the Biopsychosocial Model of Challenge and Threat." *Psychosomatic Medicine* 76: 538–546. <https://doi.org/10.1097/PSY.0000000000000098>.
- McLaughlin, K. A., M. A. Sheridan, A. L. Gold, et al. 2016. "Maltreatment Exposure, Brain Structure, and Fear Conditioning in Children and Adolescents." *Neuropsychopharmacology* 41: 1956–1964. <https://doi.org/10.1038/npp.2015.365>.
- McLaughlin, K. A., M. A. Sheridan, F. Tibu, N. A. Fox, C. H. Zeanah, and C. A. Nelson. 2015. "Causal Effects of the Early Caregiving Environment on Development of Stress Response Systems in Children." *Proceedings of the National Academy of Sciences* 112: 5637–5642. <https://doi.org/10.1073/pnas.1423363112>.
- Newbury, J. B., L. Arseneault, T. E. Moffitt, et al. 2018. "Measuring Childhood Maltreatment to Predict Early-Adult Psychopathology: Comparison of Prospective Informant-Reports and Retrospective Self-Reports." *Journal of Psychiatric Research* 96: 57–64. <https://doi.org/10.1016/j.jpsychires.2017.09.020>.
- Nivison, M., C. Facompré, K. Raby, J. Simpson, G. Roisman, and T. Waters. 2021. "Childhood Abuse and Neglect Are Prospectively Associated With Scripted Attachment Representations in Young Adulthood." *Development and Psychopathology* 33: 1143–1155. <https://doi.org/10.1017/S0954579420000528>.
- Nivison, M. D., M. H. Labella, K. L. Raby, et al. 2024. "Insights Into Child Abuse and Neglect: Findings From the Minnesota Longitudinal Study of Risk and Adaptation." *Development and Psychopathology* 22: 1–13. <https://doi.org/10.1017/S0954579424000865>.
- Oosterman, M., C. Schuengel, M. L. Forrer, and M. H. M. De Moor. 2019. "The Impact of Childhood Trauma and Psychophysiological Reactivity on At-Risk Women's Adjustment to Parenthood." *Development and Psychopathology* 31, no. 1: 127–141. <https://doi.org/10.1017/S0954579418001591>.
- Oosterman, M., J. C. De Schipper, P. Fisher, M. Dozier, and C. Schuengel. 2010. "Autonomic Reactivity in Relation to Attachment and Early Adversity Among Foster Children." *Development and Psychopathology* 22: 109–118. <https://doi.org/10.1017/S0954579409990290>.
- Pearson, R. M., S. L. Lightman, and J. Evans. 2011. "Attentional Processing of Infant Emotion During Late Pregnancy and Mother-Infant Relations After Birth." *Archives of Women's Mental Health* 14: 23–31. <https://doi.org/10.1007/s00737-010-0180-4>.
- Raby, K., M. Labella, J. Martin, E. Carlson, and G. Roisman. 2017. "Childhood Abuse and Neglect and Insecure Attachment States of Mind in Adulthood: Prospective, Longitudinal Evidence From a High-Risk Sample." *Development and Psychopathology* 29: 347–363. <https://doi.org/10.1017/S0954579417000037>.
- Raby, K. L., G. I. Roisman, J. A. Simpson, W. A. Collins, and R. D. Steele. 2015. "Greater Maternal Insensitivity in Childhood Predicts Greater Electrodermal Reactivity During Conflict Discussions With Romantic Partners in Adulthood." *Psychological Science* 26: 348–353. <https://doi.org/10.1177/0956797614563340>.
- Reijman, S., L. R. Alink, L. H. C. D. Block, et al. 2014. "Autonomic Reactivity to Infant Crying in Maltreating Mothers." *Child Maltreatment* 19: 101–112. <https://doi.org/10.1177/107755951453815>.
- Reinhardt, T., C. Schmahl, S. Wüst, and M. Bohus. 2012. "Salivary Cortisol, Heart Rate, Electrodermal Activity and Subjective Stress Responses to the

- Mannheim Multicomponent Stress Test (MMST).” *Psychiatry Research* 198: 106–111. <https://doi.org/10.1016/j.psychres.2011.12.009>.
- Reuben, A., T. E. Moffitt, A. Caspi, et al. 2016. “Lest We Forget: Comparing Retrospective and Prospective Assessments of Adverse Childhood Experiences in the Prediction of Adult Health.” *Journal of Child Psychology and Psychiatry* 57: 1103–1112. <https://doi.org/10.1111/jcpp.12621>.
- Roisman, G., F. Rogosch, D. Cicchetti, et al. 2017. “Attachment States of Mind and Inferred Childhood Experiences in Maltreated and Comparison Adolescents From Low-Income Families.” *Development and Psychopathology* 29: 337–345. <https://doi.org/10.1017/S0954579417000025>.
- Roisman, G. I. 2007. “The Psychophysiology of Adult Attachment Relationships: Autonomic Reactivity in Marital and Premarital Interactions.” *Developmental Psychology* 43: 39–53. <https://doi.org/10.1037/0012-1649.43.1.39>.
- Roisman, G. I., K. Fortuna, and A. Holland. 2006. “An Experimental Manipulation of Retrospectively Defined Earned and Continuous Attachment Security.” *Child Development* 77: 59–71. <https://doi.org/10.1111/j.1467-8624.2006.00856.x>.
- Roisman, G. I., J. L. Tsai, and K. H. S. Chiang. 2004. “The Emotional Integration of Childhood Experience: Physiological, Facial Expressive, and Self-Reported Emotional Response During the Adult Attachment Interview.” *Developmental Psychology* 40: 776–789. <https://doi.org/10.1037/0012-1649.40.5.776>.
- Scher, C. D., M. B. Stein, G. J. Asmundson, D. R. McCreary, and D. R. Forde. 2001. “The Childhood Trauma Questionnaire in a Community Sample: Psychometric Properties and Normative Data.” *Journal of Traumatic Stress* 14: 843–857. <https://doi.org/10.1023/A:1013058625719>.
- Seddon, J. A., V. J. Rodriguez, Y. Provencher, et al. 2020. “Meta-Analysis of the Effectiveness of the Trier Social Stress Test in Eliciting Physiological Stress Responses in Children and Adolescents.” *Psychoneuroendocrinology* 116: 104582. <https://doi.org/10.1016/j.psyneuen.2020.104582>.
- Shiban, Y., J. Diemer, S. Brandl, R. Zack, A. Mühlberger, and S. Wüst. 2016. “Trier Social Stress Test In Vivo and in Virtual Reality: Dissociation of Response Domains.” *International Journal of Psychophysiology* 110: 47–55. <https://doi.org/10.1016/j.ijpsycho.2016.10.008>.
- Sigrist, C., I. Mürner-Lavanchy, S. K. Peschel, S. J. Schmidt, M. Kaess, and J. Koenig. 2021. “Early Life Maltreatment and Resting-State Heart Rate Variability: A Systematic Review and Meta-Analysis.” *Neuroscience and Biobehavioral Reviews* 120: 307–334. <https://doi.org/10.1016/j.neubiorev.2020.10.026>.
- Soma-Pillay, P., C. Nelson-Piercy, H. Tolppanen, and A. Mebazaa. 2016. “Physiological Changes in Pregnancy: Review Articles.” *Cardiovascular Journal of Africa* 27: 89–94. <https://doi.org/10.5830/CVJA-2016-021>.
- Speck, B., J. Isenhour, M. M. Gao, E. Conradt, S. E. Crowell, and K. L. Raby. 2023. “Pregnant Women’s Autonomic Responses to an Infant Cry Predict Young Infants’ Behavioral Avoidance During the Still-Face Paradigm.” *Developmental Psychology* 59: 2237–2247. <https://doi.org/10.1037/dev0001632>.
- Stern, R. M., W. J. Ray, and K. S. Quigley. 2001. *Psychophysiological Recording*. Oxford: Oxford University Press.
- Weissman, D. G., and W. B. Mendes. 2021. “Correlation of Sympathetic and Parasympathetic Nervous System Activity During Rest and Acute Stress Tasks.” *International Journal of Psychophysiology* 162: 60–68. <https://doi.org/10.1016/j.ijpsycho.2021.01.015>.
- Wesarg, C., A. L. Van den Akker, N. Y. Oei, et al. 2022. “Childhood Adversity and Vagal Regulation: A Systematic Review and Meta-Analysis.” *Neuroscience and Biobehavioral Reviews* 143: 104920. <https://doi.org/10.1016/j.neubiorev.2022.104920>.
- Widom, C. S. 2019. “Are Retrospective Self-Reports Accurate Representations or Existential Recollections?” *JAMA Psychiatry* 76: 567–568. <https://doi.org/10.1001/jamapsychiatry.2018.4599>.
- Young-Southward, G., C. Svelnys, R. Gajwani, M. Bosquet Enlow, and H. Minnis. 2020. “Child Maltreatment, Autonomic Nervous System Responsivity, and Psychopathology: Current State of the Literature and Future Directions.” *Child Maltreatment* 25: 3–19. <https://doi.org/10.1177/1077559519848497>.