Published in final edited form as:

J Interpers Violence. 2010 September ; 25(9): 1669–1683. doi:10.1177/0886260509354589.

Domestic Violence and Longitudinal Associations With Children's Physiological Regulation Abilities

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Abstract

The present study examined the impact of domestic violence (DV) on children's emotion regulation abilities measured via baseline vagal tone (VT). Specifically, the authors examined the relationship between DV exposure and children's regulatory functioning over time, investigating whether DV exposure was related to the trajectory of children's physiological regulatory abilities from the preschool period to middle childhood. Covariates, including marital dissatisfaction and conduct-problem status, along with potential gender differences, were examined. Though all children increased in baseline VT from Time 1 to Time 2, children exposed to DV displayed less increase in baseline VT over time as compared to nonexposed children. Results in terms of the long-term outcomes of DV on children and implications for interventions were taken into consideration and discussed in the article.

Keywords

domestic violence; emotion regulation; vagal tone

Domestic violence (DV) is a widespread problem in American families. Many couples who experience DV are also parents, and research indicates that each year approximately 15.5 million children are exposed to DV (McDonald, Jouriles, Ramisetty-Mikler, Caetano, & Green, 2006). Exposure to DV can have negative effects on children's adjustment (Fantuzzo & Mohr, 1999). Children exposed to DV are at a higher risk for self-esteem difficulties (Hughes, 1988), lower IQ scores (Koenen, Moffitt, Caspi, Taylor, & Purcell, 2003), problematic peer relations (McCloskey & Stuewig, 2001), and increased internalizing and externalizing behavior problems (Jouriles, Norwood, McDonald, & Peters, 2001) than their nonexposed peers.

Though much research has been devoted to identifying negative sequelae of DV, it is important to understand not only the behavioral manifestations but also whether DV is associated with variations in children's internal processes, such as their ability to modulate physiological arousal. Being able to regulate physiological arousal may be particularly important for DV-exposed children, as conflict between parents is likely to be threatening and unpredictable and DV-exposed children are often powerless to stop the violence they witness. The ability to modulate their own arousal may be the most effective way for children to manage their reactions to this uncontrollable stressor (Compas, Connor-Smith, Saltzman, Thomsen, & Wadsworth,

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Declaration of Conflicting Interests

The authors declared no potential conflicts of interests with respect to the authorship and/or publication of this article.

2001). For children, the ability to physiologically self-soothe is an important skill as it is associated with positive adjustment, whereas poor physiological regulation has been linked to increased maladjustment (e.g., Gottman & Katz, 2002). Additionally, individual differences in physiological functioning have been linked to emotion regulation (ER) abilities (Beauchaine, 2001). Thus, examining children's physiological regulatory abilities may provide insight into children's skill at managing negative affect.

This article will examine relationships between DV exposure and children's physiological regulatory functioning. There is evidence that DV is associated with concurrent changes in physiological functioning (Saltzman, Holden, & Holahan, 2005); however, little has been done to investigate the consequences of DV on children's physiological functioning over time. We will consider both concurrent and longitudinal associations to address this gap in the literature.

Physiological Functioning and Children's ER Abilities

Theorists have posited that ER involves subjective, behavioral, and physiological components (e.g., Thompson, 1994). One way child ER has been assessed physiologically is via vagal tone (VT; Porges, Doussard-Roosevelt, & Maiti, 1994). Typically VT has been examined either by assessing baseline VT and/or vagal reactivity to a stressor (e.g., Beauchaine, 2001; Salomon, 2005) and has been conceptualized in part as an index of individual differences in ER (Porges et al., 1994). Baseline VT reflects the tonic firing of the vagus nerve, the primary nerve of the parasympathetic nervous system (PNS). The vagus nerve originates in the brainstem, in the nucleus ambiguous, one of the nuclei within the medulla oblongata, with its fibers innervating the heart's sinoatrial node. The sinoatrial node functions as the heart's pacemaker and responds to fluctuations in the firing of the vagus. In general, when the vagus is activated heart rate decreases and when it is suppressed heart rate increases.

Past research has suggested that baseline VT can be an index of child behavioral reactivity (Porges et al., 1994). High baseline VT has been associated with positive behavioral outcomes in children (e.g., Doussard-Roosevelt, Porges, Scanlon, Alemi, & Scanlon, 1997), whereas low baseline VT has been associated with poor child outcomes (e.g., El-Sheikh, Erath, & Keller, 2007). Furthermore, Porges (1992, 1995) suggested that baseline VT is an index of stress vulnerability with high baseline VT reflecting a greater capacity for physiologically adjusting to stress and low baseline VT being indicative of a PNS that is less physiologically adaptive to stress.

DV and ER

Emerging evidence suggests children's ER abilities may be negatively affected by DV exposure. DV-exposed children show less ability to regulate negative emotions, more difficulty soothing themselves, and need more external support for ER (Katz, Hessler, & Annest, 2007). Also, DV-exposed children display more negative emotional expression and have higher reports of negative emotions than their peers (Graham-Bermann, 1998; Lee, 2001). However, little is known about how DV exposure may alter internal physiological regulatory processes.

In the marital conflict literature, findings have lent support to examining physiological markers of regulatory abilities in children living in stressful home environments. El-Sheikh (1994) found altered physiological arousal in preschoolers from homes with high levels of marital conflict. In particular, girls displayed increased heart rate reactivity, whereas boys showed decreased heart rate reactivity in response to interadult conflict. Additionally, Katz and Gottman (1997) found in children exposed to marital conflict, baseline VT and vagal suppression acted as buffers against later behavior problems.

Studies of the interaction between environmental and biological processes also support the idea that children's physiological functioning may be altered by social–environmental variables. There is evidence that child maltreatment and its associated stress may alter the stress response pathways. Compared to controls, maltreated children with posttraumatic stress disorder (PTSD) diagnoses showed increases in baseline activity of both the sympathetic nervous system (SNS) and hypothalamic–pituitary–adrenal (HPA) axis stress–response pathways (De Bellis et al., 1999a). Additionally, child maltreatment may negatively influence brain development. Maltreated children with PTSD showed differences in brain anatomy with decreased volumes in some neuro-anatomical structures and increased volumes in others, as compared to controls (De Bellis et al., 1999b, 2002). Related to DV, Saltzman, Holden, and Holahan (2005) found DV-exposed children had increased heart rate at baseline and after an interview on a stress-provoking topic (i.e., family violence), as well as higher salivary cortisol levels prior to and following the interview. These findings raise the possibility that an adverse environmental stressor like DV can lead to changes in physiological markers of adjustment important to children's well-being.

Of interest are both concurrent associations between DV and children's physiological functioning and the impact of DV on children's physiological regulation over time. DV-exposed children show poor long-term adjustment in many domains. Adults who were exposed to DV as children are more at risk for current psychological distress (Henning, Leitenberg, Coffey, Bennet, & Jankowski, 1997) as well as adjustment problems such as anxiety, conduct disorder, and delinquent acts (Fergusson & Horwood, 1998). Given that there is evidence for both concurrent and long-term negative psychological outcomes in children exposed to DV, physiological functioning both concurrently and longitudinally is an important area of inquiry.

Current Study

The current study examined relationships between DV and children's ability to regulate their physiological arousal over time. Baseline VT was examined given its association with child regulatory abilities (Porges et al., 1994). A longitudinal design was used with baseline VT and DV assessed at approximately ages 5 and 9. Two main research questions were addressed:

> *Research question 1:* Is DV exposure associated with changes in children's baseline VT over time?

> *Research question 2:* Are there gender differences in VT over time as a function of DV exposure?

In marital conflict research, gender differences in VT have been found (e.g., El-Sheikh & Whitson, 2006), suggesting this may emerge in a sample with DV exposure. Two additional issues were also addressed. First, given the possibility that observed effects may be due to marital distress instead of DV exposure, we tested whether any differences in VT were due to marital distress. Second, because children included in this sample were part of a larger study on family interactions and conduct-problem (CP) behavior, we examined whether differences in baseline VT functioning might be due to CP behavior rather than DV.

Method

Participants

A total of 130 families were recruited through postings in doctors' offices, preschools, and newspaper advertisements. Married parents who had a 4- to 6-year-old child were eligible to participate and compensated $150. Based on the original study design, half of the children were included in the CP group and the remainder in the control group. Inclusion was based on a telephone version of the Eyberg Child Behavior Inventory (ECBI; Robinson, Eyberg, & Ross, 1980). Following established cutoffs, children in the CP group received a score of 11 or higher, and those in the control group received a score of 7 or lower.

At Time 1 the mean age of the children was 4.43 years (*SD* = 0.51, range 4–6 years) and 62.3% were male. Four years later the families were recontacted, and 68 families participated in the current assessments. Half (*n* = 34) of the children were placed in the CP group based on the ECBI scores from the Time 1 screening. At Time 2, child mean age was 9.03 years (*SD* = 0.44) and 63.2% of them were boys. The majority identified as White (92.1%), followed by African American (4.8%), and bi- or multiracial (3.2%). There were 7.4% of the participants who did not report ethnicity. All analyses reported here are based on the final sample of 68 families.

To assess whether there were any differences in sample composition from Time 1 to Time 2 due to attrition, participants were compared with those who attrited using a chi-square test. There were no significant differences in child gender: $\chi^2(1) = 0.51$, $p = .47$; ethnicity: $\chi^2(2) = 0.33$, $p = .85$; CP group status: $\chi^2(1) = 0.30$, $p = .58$; and husband and wife report of DV: $\chi^2(1) = 1.97$, $p = .16$, and $\chi^2(1) = 1.30$, $p = .25$, respectively, suggesting there were no demographic differences between those who continued to participate and those who did not.

Procedures

Parents completed questionnaires at home. Upon entry to the lab, physiological sensors were applied to the child. Three Beckman silver–silver chloride electrodes were placed on the children's chest and abdomen to measure their cardiac interbeat interval (IBI). At both time points child IBI was measured during a 2-min period while the child listened to a neutral story on headphones. A Coulbourn bioamplifier was used to collect electrocardiogram data (EKG), and the EKG waveform was digitized at 128 Hz using a MetraByte A-D converter along with ASYST software (Asyst Technologies, 1992) which averaged IBI into 1-s intervals. All procedures were approved by the institutional review board.

Measures

DV—At Time 1 and Time 2 parents completed the Conflict Tactics Scale (CTS; Straus, 1979). The physical aggression subscale was used to assess levels of DV. Parents reported on violent acts perpetrated by themselves and their spouse in the prior 12 months. Examples include the following: pushed, grabbed, or shoved the other, and threatened the partner with a knife or a gun. Four dichotomous DV variables were created: husband's report of own and wife's aggression (HDV) at Time 1 and Time 2 (two variables), and wife's report of own and husband's aggression (WDV) at Time 1 and Time 2 (two variables). The physical aggression subscales were summed and a score of 1 or more was categorized as DV and a score of 0 was categorized as non-DV. A child was considered as exposed to DV if either WDV or HDV was 1 or more. Because of the possibility of male underreporting (Straus & Gelles, 1990), having both HDV and WDV ensures a more complete picture of the presence of aggression between spouses. The severity of DV was low. The majority of violent behaviors consisted of pushing, grabbing, or shoving the other, or throwing something at the partner, and no instances of using weapons were reported. At Time 1, 32% of husbands and 35% of wives reported a violent act perpetrated by themselves or their partners; at Time 2 these percentages were 35% and 23%, respectively. DV from Time 1 to Time 2 remained stable for husbands, $\chi^2(1) = 11.73$, $p < .01$, and for wives, $\chi^2(1) = 16.04$, $p < .01$.

Marital satisfaction—Marital satisfaction was assessed at Time 1 and Time 2 using the Locke–Wallace Marital Adjustment Test (Locke & Wallace, 1959). An average marital satisfaction score for each couple was used in analyses (Time 1: $M = 108$, Time 2: $M = 101.19$).

Child baseline VT—VT was calculated using spectral time–series analysis by measuring the amount of variance in the IBI spectrum that was within the child's respiratory sinus frequency band (0.33–0.42 Hz) over the total amount of power across all frequency bands (Behrman & Kliegman, 2002). This method of measuring VT correlates highly with output from Porges' MXEDIT program (r = .9; Gottman, Katz, & Hooven, 1997). Average baseline VT across the 2-min baseline was used as the measure of child baseline VT. Children's baseline VT from Time 1 to Time 2 was not stable, r = .16, p = .21.

Results

Descriptive statistics and correlations are presented in Tables 1 and 2, respectively. To examine whether DV exposure is associated with alterations in children's baseline VT over time, a repeated-measures analysis of variance (RM ANOVA) was performed. Two 2 × 2 × 2 RM ANOVA's (DV Time 1 × Gender × Baseline VT), one based on HDV (N = 68, boys = 43), and the other based on WDV (N = 67, boys = 43), were performed. The 2 × 2 × 2 RM ANOVA (DV × Gender × Baseline VT) using HDV at Time 1 showed a significant DV × Baseline VT interaction, $F(1, 64) = 6.59$, $p = .01$, $\eta_p^2 = .09$, where DV-exposed children increased significantly less in baseline VT from Time 1 to Time 2 than their nonexposed counterparts. WDV did not show significant differences in VT over time $F(1, 67) = 0.32$, $p = .57$, $\eta_p^2 = .002$.

Follow-up t tests found there were no significant differences in baseline VT between DV-exposed and nonexposed children based on HDV at Time 1, $t(36.74) = -0.90$, $p = .37$, suggesting the change in baseline VT was due to change over time, and not an artifact of Time 1 differences. To rule out that it was not concurrent DV exposure at age 9 driving the differences in baseline VT change over time, a RM analysis of covariance (ANCOVA; DV at Time 1 × Baseline VT) was performed controlling for Time 2 DV exposure. The interaction between HDV at Time 1 and baseline VT remained significant, $F(1, 51) = 6.54$, $p = .01$, $\eta_p^2 = .11$ (n = 54), suggesting that early DV exposure was driving the differences in baseline VT change over time rather than concurrent DV exposure.

A three-way interaction between gender, baseline VT, and DV was examined to assess gender differences in VT as a function of DV. There was a significant interaction based on WDV, $F(1,67) = 4.24$, $p = .04$, $\eta_p^2 = .07$; however, LSD post hoc analyses revealed none of the pairwise comparisons reached significance, suggesting the omnibus results were spurious. The three-way interaction was not significant for HDV, $F(1, 64) = 0.04$, $p = .84$, $\eta_p^2 = .001$.

To test whether the differences in VT over time were due to marital dissatisfaction rather than exposure to violence per se, a RM ANCOVA (DV Time 1 × Baseline VT) based on HDV was performed, controlling for marital satisfaction at both time points. Baseline VT differences between DV-exposed and nonexposed children remained significant after controlling for marital satisfaction at Time 1 and Time 2, $F(1, 39) = 10.25$, $p < .01$, $\eta_p^2 = .21$, suggesting marital dissatisfaction did not play a significant role in children's change in baseline VT over time. In addition, a RM ANCOVA (DV Time 1 × Baseline VT) controlling for CP status at Time 1 was performed to test whether the differences in VT over time were due to the presence of child behavior problems. HDV remained significant, $F(1, 64) = 8.02$, $p = .01$, $\eta_p^2 = .11$, and the three-way interaction between CP status, baseline VT, and DV was not significant, $F(1, 64) = 1.47$, $p = .23$, $\eta_p^2 = .02$, suggesting DV significantly predicts change in baseline VT change over time even after taking CP status into account.

Discussion

It is well established that DV has negative effects on children's adjustment both concurrently and longitudinally (e.g., Fantuzzo & Mohr, 1999; Fergusson & Horwood, 1998). The aim of the present study was to extend these findings to the physiological domain and investigate whether there are differences in physiological regulatory functioning in children exposed to DV. We also sought to delineate whether DV-exposed children show alterations in the trajectory of their physiological functioning over time. Our findings suggest physical conflict in the family environment is associated with less adaptive biological development in children.

Evidence was found for differences in the trajectory of VT over time between DV-exposed and nonexposed children. Compared to their nonexposed counterparts, DV-exposed children showed smaller increases in baseline VT. This suggests that DV exposure may adversely affect the development of children's internal regulatory abilities and that social–environmental factors may disrupt children's ability to regulate their emotions. Moreover, these findings highlight that not only does DV have short-term negative consequences for children but also may impede the development of their regulatory functioning over time, putting them at a disadvantage in terms of risk status for later problems with ER.

Interestingly, at age 5, no group differences in VT were found. However, by age 9, DV-exposed children had lower VT than their nonexposed counterparts, even after controlling for concurrent levels of DV. These findings might be a result of incomplete maturation of children's ER abilities at age 5. The influence of family environmental stressors (e.g., DV) may have a damaging effect while ER skills are being learned and fine-tuned between the ages 5 and 9. Alternatively, the absence of group differences in baseline VT at age 5 may be due to the fact that baseline VT is still developing. Katz (2007) found at age 5 DV-exposed children displayed increased vagal reactivity in response to a laboratory stressor. Though the current findings suggest no differences in baseline VT at age 5, Katz's findings suggest differences in vagal reactivity may emerge under stress. These transitory-state effects over time may become more stable or trait-like in DV-exposed children and result in differences in baseline measures of VT or their trajectory over time.

Marital distress did not play a significant role in the children's baseline VT over time, suggesting that exposure to a discordant marriage is not driving these outcomes. Additionally, children's CP status was examined, and DV exposure still predicted children's baseline VT trajectory over time even after taking CP status into account. This provides additional evidence that there is something unique about the effect of DV exposure on children's physiology.

Wife report of DV was not associated with child physiology. One possible explanation is husbands may tend to underreport violence, and any violence actually reported may reflect more overt or severe violence. From the child's perspective, exposure may be of a more traumatic nature, resulting in fear for their physical well-being. This raises the hypothesis that changes in child's physiology may most likely occur when the violence is overt and severe. Assessments of VT in a sample that varies more broadly in violence severity are needed to assess this hypothesis.

In our sample, boys and girls were exposed to similar levels of DV, and no gender differences were found in baseline VT at Time 1 or in the trajectory of baseline VT over time as a function of DV exposure. Lack of differences may be due to the younger age of our sample. Though there is some disagreement regarding associations between heart rate and gender, gender differences in heart rate in early childhood have not been observed in some studies (e.g., Durant et al., 1992). Thus, it would follow that gender differences may not be observed in baseline VT, given its relationship to heart rate. Alternatively, the relative underrepresentation of girls may have limited power to detect gender differences.

These findings raise additional questions about what is driving the difference in VT between DV-exposed and nonexposed children. One possibility is that it is the chronicity of the stress that is associated with the slower growth in the trajectory of VT over time. Only when children are consistently exposed to DV over time will effects on their physiological functioning be observed. DV-exposed children may become sensitized to stress, so instead of physiologically habituating to stressful events, they may continue to show increased arousal to the stress over time, and their physiological resources become depleted as evidenced by low baseline VT (e.g., McEwen & Wingfield, 2003). However, this interpretation must be viewed with caution, as DV was not measured at consistent intervals during the study to determine the degree of chronicity of DV in this sample.

Another possible explanation for the difference in baseline VT between DV-exposed and nonexposed children concerns the severity of the stress. Children's physiological functioning may be more adversely affected when there are more severe or higher levels of violence. However, because this sample was a community-based sample with few severe acts of violence, it was not possible to test this hypothesis with the current sample. Studies with clinical samples may better address this question.

Limitations of the study warrant notice. The small sample may have reduced power to detect effects related to mother's report of DV and in post hoc gender comparisons. Lack of ethnic and geographic diversity of the sample is also a concern, particularly in terms of generalizability. Additionally, levels of violence were low, and DV was not assessed continuously between ages 5 and 9, making it difficult to disentangle whether the change over time in baseline VT is due to early exposure to DV or to chronic exposure of DV occurring during the 4-year gap between collection points. Lastly, we cannot rule out whether VT in part reflects a participant's anticipation of impending lab procedures.

Future research could address whether ER ability is an underlying mechanism linking adverse social–environmental stressors to poor adjustment in children. Isolating this as a mechanism can assist in framing interventions for this population of children. It may be advantageous for interventions focusing on children exposed to DV to teach coping mechanisms that incorporate strategies that target one's physiological functioning. Teaching self-soothing strategies may prove especially useful for children exposed to DV due to the uncontrollable nature of this stressor. DV is something children are powerless to control; therefore, coping strategies that focus on regulating their emotions, something children *can* learn to control, may be a useful strategy to employ when children are exposed to DV.

Acknowledgments

Funding

The authors disclosed receipt of the following financial support for the research and/or authorship of this article: This research was funded by NIMH Grant No. R01-MH49141.

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Table 1

Means, Standard Deviations, and Ranges for Primary Variables

	Time 1					Time 2				
			Baseline Vagal Tone					Baseline Vagal Tone		
Variable	**Husband-Reported DV**	**Wife-Reported DV**	**Overall**	**Exp**	**Non-exp**	**Husband-Reported DV**	**Wife-Reported DV**	**Overall**	**Exp**	**Non-exp**
Mean										
Boys	.37	.37	11.47	13.24	9.61	.36	.24	35.96	36.89	34.97
Girls	.38	.50	14.97	17.08	13.02	.28	.17	36.34	33.92	38.57
Standard deviation										
Boys	.07	.07	10.90	13.45	7.25	.09	.08	12.29	11.78	13.03
Girls	.10	.10	12.50	13.26	12.80	.11	.09	13.01	13.23	12.91
Range										
Boys	—	—	0.90–50.06	0.90–50.06	1.87–32.89	—	—	11.12–59.13	11.12–59.13	13.35–53.64
Girls	—	—	2.16–51.28	2.85–46.56	2.16–51.28	—	—	14.10–62.95	14.10–62.95	20.63–58.43

Note: DV = domestic violence. All values are based on N = 68. Exposure to domestic violence, exposed at Time 1; nonexposure to domestic violence, nonexposed at Time 1.

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Table 2

Bivariate Correlations Among Primary Variables

Variable	Time 1			Time 2		
	Husband-Reported DV	Wife-Reported DV	Baseline Vagal Tone	Husband-Reported DV	Wife-Reported DV	Baseline Vagal Tone
Time 1						
Husband-reported DV	1.00	0.54***	0.12	0.47***	0.38**	−0.27*
Wife-reported DV	—	1.00	0.06	0.54***	0.54***	0.07
Baseline VT	—	—	1.00	0.16	0.12	0.16
Time 2						
Husband-reported DV	—	—	—	1.00	0.34*	−0.21
Wife-reported DV	—	—	—	—	1.00	−0.07
Baseline VT	—	—	—	—	—	1.00

Note: DV = domestic violence. All values are based on $N = 68$.

* $p < .05$.

** $p < .01$.

*** $p < .001$.