

# UC Davis

## UC Davis Previously Published Works

### Title

Children's autonomic functioning moderates links between maternal rejecting attitudes and preschool aggressive behaviors

### Permalink

<https://escholarship.org/uc/item/0kv3766b>

### Journal

Developmental Psychobiology, 60(6)

### ISSN

0012-1630

### Authors

Wagner, Nicholas J  
Hastings, Paul D  
Rubin, Kenneth H

### Publication Date

2018-09-01

### DOI

10.1002/dev.21747

Peer reviewed



Published in final edited form as:

*Dev Psychobiol.* 2018 September ; 60(6): 739–747. doi:10.1002/dev.21747.

## Children's Autonomic Functioning Moderates Links between Maternal Rejecting Attitudes and Preschool Aggressive Behaviors

**Nicholas J. Wagner,**

Psychological and Brain Sciences, Boston University, 64 Cummington Mall, Boston, MA 02215, njwagner@bu.edu, 252-290-7444

**Paul D. Hastings, and**

Department of Psychology, UC Davis, 267 Cousteau Place, Davis, CA 95618

**Kenneth H. Rubin**

Human Development and Quantitative Methodology, University of Maryland, Benjamin Building, RM 3304, 3942 Campus Dr., College Park, MD 20742

### Abstract

Substantial theoretical and empirical literature suggests that the extent to which children's early experiences contribute to the development of aggressive behaviors may depend on the psychophysiological regulatory capacities of the child. This study adds to this literature by examining the relations between mothers' rejecting child-rearing attitudes and children's aggressive behaviors, as well as whether children's parasympathetic regulation, both at rest and in response to anger-inducing films, moderate these links. Using data collected from 88 preschoolers ( $m_{age} = 51$  months), results revealed that the positive association between mothers' rejecting child-rearing attitudes and children's aggressive behaviors was moderated by RSA reactivity to anger. More rejecting child-rearing attitudes predicted more aggressive behaviors only for children who showed mild RSA suppression to RSA augmentation. Conversely, and consistent with the differential-susceptibility model, children who showed mild RSA suppression to RSA augmentation had the fewest aggressive behaviors when mothers reported less rejecting child-rearing attitudes.

### Keywords

Aggression; Parental Rejecting Attitudes; Autonomic Nervous System; Respiratory Sinus Arrhythmia; Reactivity

---

Aggression in early childhood is predictive of aggressive and delinquent behaviors in adolescence and adulthood. Identifying early mechanisms that foretell aggressive behaviors represents a significant step toward the development of early intervention and prevention

efforts (Lahey et al., 2008; Raine, 2002). Research on the topic suggests that the ways in which mothers exert influence on the development and expression of children's aggressive behaviors are many (Côté, Vaillancourt, LeBlanc, Nagin, & Tremblay, 2006; Davies, Sturge-Apple, Cicchetti, Manning, & Vonhold, 2012). Mothers' parenting attitudes, specifically rejecting attitudes, may constitute one risk factor for the emergence and exacerbation of aggressive behaviors in early childhood (e.g., Mills & Rubin, 1990; Rubin & Mills, 1992). Importantly, recent theoretical and empirical work has shown that the extent to which early experiences with parents contribute to children's psychopathology partially depends on the regulatory capacities of the child (Cicchetti & Natsuaki, 2014; Ellis & Boyce, 2008). As such, in the current study, we examined the direct and interactive influences of mothers' rejecting attitudes and children's autonomic regulation on aggressive behaviors in preschool.

## Rejecting Child-Rearing Attitudes

Most etiological models of aggressive and antisocial behavior include or begin with the parent-child relationship. Many aspects of this relationship, including both positive and negative behavioral qualities (e.g., Wagner, Mills-Koonce, Willoughby, Zvara, & Cox, 2015; Wagner, Hastings, & Rubin, 2017), have been implicated in these processes. There is also research suggesting that parents' rejecting attitudes toward their children are likely to undermine the ability of the caregiving environment to meet the emotional and regulatory needs of the child, thus posing risk for aggressive behaviors (Fraleay, Roisman, & Haltigan, 2013; Sroufe, Coffino, & Carlson, 2010; Wagner et al., 2015). Parents who have rejecting child-rearing attitudes are characterized by often feeling angry or resentful about their relationship with their children, feeling disappointed, devaluing the importance of affectionate responses while interacting with their children, and making their children aware of these attitudes through behavioral expression. Mothers' rejecting child-rearing attitudes may contribute to children's aggressive behaviors by influencing the formation of uncertain or rejecting internal models of relationships (Bretherton & Munholland, 1999; Fraley, 2002). Early experiences with caregivers guide children in seeking and interpreting future social experiences (Fury, Carlson, & Sroufe, 1997), and children raised by parents with rejecting child-rearing attitudes may anticipate similar aversive experiences from others, priming them to be antagonistic. Guided by the extant research, we examined whether maternal rejecting attitudes contribute to children's expression of aggressive behavior.

## Children's Parasympathetic Regulation

The processes underlying the emergence of aggressive behaviors in early life are embedded within a network of biological and contextual influences. A developmental psychopathology approach suggests that an individual's psychophysiological functioning directly affects the expression of children's aggressive behaviors and may either potentiate or attenuate the impacts of early experience (Cicchetti & Rogosch, 1996). Children's parasympathetic nervous system (PNS) functioning, a component of the autonomic system, plays an important role in the emergence of children's self-regulatory capacities by facilitating the maintenance of homeostasis and the consolidation of internal resources in response to external demands (Calkins, Propper, & Mills-Koonce, 2013). Respiratory sinus arrhythmia (RSA) is a measure of the variability in heart rate that occurs at the frequency of breathing

and is commonly used to index PNS activity (Porges, 2007). Relatively high baseline RSA is typically associated with positive physiological and behavioral adaptation (Suess, Porges, & Dana, 1994), including attenuated stress responses, better cognitive control (Feldman, Rosenthal, & Eidelman, 2014), and positive social interactions (Patriquin, Lorenzi, Scarpa, Calkins, & Bell, 2014). Low baseline RSA, on the other hand, is associated with hostility, anxiety, and aggression (see Beauchaine, 2001). Lower baseline RSA in children has been associated with the display of aggressive behaviors (e.g., Perry et al., 2014; Wagner et al., 2015).

The maintenance of baseline RSA is itself a dynamic and regulatory process (Propper & Holochwost, 2013), and provides insight into potential constraints on the magnitude of regulatory responses, whereas RSA reactivity provides specific insight into individuals' actual regulatory capacity in emotionally salient contexts (Porges, 2007). The Polyvagal Theory provides a neurobiological framework for understanding the role of the parasympathetic system in supporting adaptive social engagement with the environment. Porges (2007, 2011) proposed that the direction and magnitude of changes in PNS activity connote how stimuli or contexts are interpreted as personally relevant, which he termed *neuroception*. Mild to moderate augmentation of parasympathetic influence (i.e., increased RSA) supports social engagement in safe, non-threatening contexts, whereas mild to moderate parasympathetic suppression (i.e., decreased RSA) supports orientation to stimuli and preparedness for active responding (Hastings, Kahle, & Han, 2014). Stronger suppression of PNS regulatory influences on the heart potentiates the expression of sympathetic influence, a system that fosters mobilization behaviors (e.g., fight or flight) in response to threat or challenge (Calkins & Keane, 2004).

As such, RSA suppression during emotionally challenging tasks (e.g., the direct induction of anger) has been associated with fewer aggressive behavior problems (Calkins & Dedmon, 2000; Calkins & Keane, 2004). Furthermore, moderate RSA suppression could be a normatively expected autonomic response when indirectly perceiving or experiencing emotions in others, like video presentations of anger, if those stimuli are viewed as necessitating an active response and allocation of attention. However, theory suggests that RSA augmentation in these contexts might also be an expected response such that the child perceives the situation as non-threatening and requiring attention or social engagement (Porges 2007, 2011). In fact, a dynamic pattern of mild RSA suppression followed by RSA augmentation or recovery during an anger-inducing film was positively associated with children's control of aggression in a sample of children aged 4 to 7 (Miller et al., 2013).

To consider the role of children's autonomic functioning when investigating links between mothers' rejecting child-rearing attitudes and children's aggressive behaviors, the current study is drawn from substantial empirical and theoretical research that has provided a framework for understanding how children's psychophysiology and regulatory capacities may moderate the influences of early experience. For example, the diathesis-stress model suggests that environmental risk (e.g., rejecting child-rearing attitudes) is more likely to negatively impact the development of individuals who possess vulnerability factors (e.g., poor self-regulation) but less likely to impact nonvulnerable individuals (Boyce & Ellis, 2005; Pluess, 2015). On the other hand, differential susceptibility models posit that

vulnerability factors are better understood as plasticity factors, which may not only increase risk for negative outcomes in risk contexts but may also increase the likelihood of positive outcomes in less risky contexts (Pluess & Belsky, 2010; Roisman et al., 2012; Wagner, Mills-Koonce, Willoughby, & Cox, 2017).

Theoretical and empirical research by Porges and others suggests that low resting parasympathetic functioning and low suppression in response to salient environmental cues may indicate a degree of underarousal, thus contributing to difficulties with inhibiting aggressive behaviors (Blair, 2015; Gao, Raine, Venables, Dawson, & Mednick, 2010; Porges, 2011). For children whose early experiences with rejecting child-rearing attitudes have potentially increased the propensity for aggression across relationships, patterns of parasympathetic under-arousal could exacerbate this risk by reducing the effectiveness of a potential regulatory barrier to aggressive behaviors. Given that low PNS reactivity, or RSA augmentation, may facilitate engagement with contexts perceived as safe (Porges, 2011), it could pose a risk for children who manifest such physiological responses in a socializing context characterized by rejecting child-rearing attitudes, increasing the likelihood that they would learn from and emulate that aversive interpersonal style in their interactions with others. Conversely, children who show a parasympathetic response to emotionally salient stimuli that supports calm engagement and who are being raised in the context of a parent-child relationship void of rejecting attitudes may be more able to internalize and benefit from the positive aspects of their parenting experiences, thus demonstrating lower levels of aggression, than children who demonstrate RSA suppression during emotional experiences.

Despite the body of research examining the links between parenting behaviors and aggressive behaviors, researchers have yet to study the influences of rejecting child-rearing attitudes on young children's aggressive behaviors. Furthermore, the extent to which children's RSA functioning may moderate these associations has not been examined. In the current study, we attempted to address this gap in the literature using measures of RSA functioning, both at rest and in response to a film designed to elicit feelings of anger. We expected that mothers' rejecting child-rearing attitudes would directly predict higher levels of aggressive behaviors in preschool. Further, we expected that lower baseline RSA and reduced RSA suppression or RSA augmentation in response to an anger-inducing film would predict higher levels of aggressive behaviors in preschool. Finally, consistent with a differential susceptibility hypothesis, we expected that, for children exhibiting lower baseline RSA and reduced RSA suppression, or RSA augmentation, caregivers' rejecting child-rearing attitudes would predict children's aggressive behaviors for better (i.e., less aggression with less rejecting caregivers) and worse (i.e., more aggression with more rejecting caregivers).

## Methods

### Sample

Participants were drawn from a study of children's socio-emotional development (Hastings, Rubin, & DeRose, 2005). Data from 88 children (girls = 42) were collected when children were approximately 4 years of age ( $M = 51$  months,  $SD = 1.33$ ). Families were recruited from an urban community of approximately 300,000 living in southwestern Ontario,

Canada. Most participants were Caucasian (97%) and married (96%) and had some college education (63.8% at least one year of college).

## Procedure

Details on study procedures for age 4 data collection have been widely published and are briefly summarized here (Hastings et al., 2005). Mothers provided informed consent for their own and their children's participation in the study. Mothers also provided demographic data and completed questionnaires at the age 4 lab visit.

## Measures

**Baseline RSA and RSA Suppression**—Three adhesive electrodes applied to the ventral surface of the child's chest were connected, via an UFI iso/Fetrode signal amplifier, to a Delta-Biometrics Vagal Tone Monitor-II. Children sat on a chair beside and slightly in front of their mothers. Cardiac data were collected during a two-minute baseline period while children watched a low-action cartoon. Immediately following this, children watched a narrated comic-strip film which presented multiple emotionally salient stories (Cole, Teti, & Zahn-Waxler, 2003). The videotape included an introductory segment during which children were told they were going to watch a story about a child who lived on another planet. Two anger-inducing portions of the video, each one minute in length, depicted the child expressing anger toward an antagonistic peer, and the child having a heated argument with her/his mother. Both scenarios were accompanied by dramatic music, and both had a positive resolution.

Recording errors in the cardiac interbeat intervals were edited using MxEdit software. MxEdit also computed respiratory sinus arrhythmia (RSA) in the .24–1.04 Hz frequency bandwidth, using the full durations of the baseline and the two anger-themed scenarios, which was used as the index of children's parasympathetic influence on cardiac activity. RSA change was calculated by subtracting the average RSA value measured during the anger-inducing film from baseline RSA. As such, positive change scores indicate RSA suppression and negative change scores indicate RSA augmentation (an increase in RSA in response to the film).

**Rejecting child-rearing attitudes**—Mothers' rejecting child-rearing attitudes were assessed using the Child-Rearing Practices Report (CRPR; Block, 1961), a set of 91 index cards each bearing a description of a possible parenting practice or attitude. Mothers were asked to sort the cards into seven piles based on how well they described the mother-child relationship. Guided by previous research with this sample and with other samples (e.g., Hastings et al., 2005), an unweighted mean of five items (e.g., "*often feel angry with my child*") was used to create an index of rejecting child-rearing attitudes ( $\alpha = .23$ ). Despite the forced-ranking paradigm of the Q-sort methodology inherently contributing to low correlations among individual items, the CRPR has been validated for use in this sample (e.g., Hastings et al. 2005).

**Aggressive Behaviors**—The measure of children's aggressive behaviors was derived from the Child Behavior Checklist (CBCL; Achenbach, 1991). The CBCL was completed

by mothers and comprised 102 items on a 3-point Likert scale ranging from 0 (not true) to 2 (very true or often true). The aggressive behaviors composite comprised 20 aggressive items such as “cruelty or meanness” and “disobedient.” The aggressive behaviors composite has been used widely in the literature (e.g., Achenbach & Dumenci, 2001; Calkins, Graziano, & Keane, 2007; Mesman, Bongers, & Koot, 2001).

**Covariates**—Mothers reported children’s age, sex, and levels of maternal education upon entry into the study. Attention problems were derived from the CBCL and were included as a covariate to account for the comorbidity between attention and behavior problems often reported in the literature (Belsky, Pasco Fearon, & Bell, 2007; Oliver, Barker, Mandy, Skuse, & Maughan, 2011).

## Analysis Plan

The primary analytic approach involved estimating a series of linear regressions in which children’s aggressive behaviors were regressed on mothers’ rejecting child-rearing attitudes, children’s baseline RSA, and change in children’s RSA in response to an anger-inducing film. The first model examined the main effects of rejecting child-rearing attitudes and children’s RSA functioning on aggressive behaviors. The second model examined the extent to which children’s baseline RSA and RSA change moderate the links between rejecting child-rearing attitudes and children’s aggressive behaviors.

The nature of significant interactions was elucidated following the recommendations provided by Roisman and colleagues (Roisman et al., 2012). First, to estimate a snapshot of the association between the predictor and outcome at two specific reference points, significant interactions were probed at one standard deviation above and below the mean for the moderator variables (children’s RSA functioning). Second, regions of significance (RoS) analyses, which identify the exact range of values of the moderator for which the independent and dependent variables are significantly associated, were used to determine at which levels of RSA functioning do rejecting child-rearing attitudes predict aggressive behaviors, but also for which levels of rejecting attitudes these associations were significant. All participants with complete or partial data were included in the analyses using full-information maximum likelihood (FIML; Enders & Bandalos, 2001), and both models were saturated. FIML is well recognized as an effective method for analyzing data with moderate to large amounts of missing data and has been demonstrated to provide less biased parameter estimates than other commonly used techniques, such as listwise deletion (Enders, 2013; Widaman, 2006). Total missingness for each measure is reported in Table 1. All analyses were conducted in Mplus 7.1 (Muthén & Muthén, 2017).

## Results

Table 1 provides the bivariate correlations, means, and standard deviations for the model covariates and variables of interest. There was a significant difference between RSA during baseline ( $M = 6.20$ ,  $SD = 1.18$ ) and during the anger-inducing film ( $M = 6.34$ ,  $SD = 1.09$ ),  $t(83) = -2.25$ ,  $p = .027$ ,  $d = .25$ . On average, children demonstrated some augmentation ( $M = -0.14$ , range = 0.83 to  $-2.19$ ), with 45.2% of the sample showing RSA suppression and 54.8% of the sample showing RSA augmentation in response to the anger-inducing video.

Children's aggressive behaviors were negatively correlated with children's sex (male = 0), positively correlated with children's attention problems, and positively correlated with rejecting child-rearing attitudes. Children's baseline RSA and RSA change were positively correlated, but neither variable was significantly correlated with children's aggressive behaviors.

Table 2 presents standardized and unstandardized model estimates and confidence intervals for Models one and two. Variables were centered to aid interpretation and hierarchical linear regression models tested direct and interactive associations. Significant main effects show that children had more aggression problems when they also had more attention problems,  $\beta = .24, p < .001$  and when mothers reported more rejecting child-rearing attitudes,  $\beta = .34, p < .001$ . Main effect predictors in Model 1 explained a significant amount of variance in the prediction of children's aggressive behaviors,  $R^2 = .38, F(7, 80) = 4.77, p < .001$ . Tests of moderation effects revealed a significant interaction between rejecting child-rearing attitudes and RSA change in the prediction of children's aggressive behaviors,  $\beta = -.29, p < .001$ . The inclusion of interaction terms in Model 2 also explained a significant amount of variance,  $R^2 = .06, p = .008$ , in the prediction of children's aggressive behaviors, final  $R^2 = .44, F(9, 78) = 4.37, p < .001$ . Simple slopes analyses (Figure 1) revealed that rejecting child-rearing attitudes predicted children's aggressive behaviors for children who demonstrated RSA augmentation (-1 SD),  $b = 4.33, p < .001$ , but that rejecting attitudes did not predict aggressive behaviors for children who showed RSA suppression (+1 SD),  $b = 0.33, p = .73$ . Specifically, the RoS analysis indicated that rejecting child-rearing attitudes predicted aggressive behaviors for individuals demonstrating weak RSA suppression or RSA augmentation (mean-centered RSA change scores of 0.24 or lower). Furthermore, consistent with a differential susceptibility model, RoS analyses identified a lower bound of -0.33 and an upper bound of 0.82 for rejecting child-rearing attitudes, suggesting that at average to low levels of rejecting child-rearing attitudes, children showing slight RSA suppression or RSA augmentation demonstrated fewer aggressive behaviors than children showing higher RSA suppression, whereas at higher levels of rejecting child-rearing attitudes (one SD above the mean and higher; i.e., the gray shading in Figure 1), children showing slight RSA suppression or RSA augmentation demonstrated more aggressive behaviors. The interaction between baseline RSA and rejecting child-rearing attitudes, the three-way interaction between baseline RSA, RSA change, and rejecting child-rearing attitudes, and interactions between children's RSA and gender were all non-significant.

## Discussion

The current study adds to the literature on the development of aggressive behavior problems by examining the relations between mothers' rejecting child-rearing attitudes and children's aggression, as well as the extent to which these links are moderated by children's baseline RSA and RSA suppression in response to anger-inducing films. Mothers' rejecting child-rearing attitudes predicted more aggression at age 4, and children's RSA reactivity in response to two anger-inducing video stimuli was found to moderate the effects of rejecting child-rearing attitudes on aggression. Average to low levels of rejecting attitudes predicted less aggression and highly rejecting attitudes predicted more aggression, but only for



children who demonstrated little to no RSA suppression or RSA augmentation in response to the anger-inducing films.

The ways in which parents influence children's aggressive behaviors are many (e.g., Cox, Mills-Koonce, Propper, & Gariépy, 2010), and the current study shows that rejecting child-rearing attitudes predict children's aggressive behavior problems. Explanations for this link include the possibility that parents who have rejecting child-rearing attitudes limit the ways in which they make themselves available to aid in the regulation of children's behaviors in emotional contexts. Additionally, parental emotional awareness, beliefs about emotions, and emotion socialization have all been shown to play an important role in the emergence of psychopathology (Gottman, Katz, & Hooven, 1996), and rejecting child-rearing attitudes may limit the extent to which parents adequately socialize emotion-related regulation and behaviors.

However, the current findings suggest that the impact of parents' rejecting child-rearing attitudes is not uniform across children. RSA modulation in response to external stimuli provides insight into how children perceive their experiences. For example, moderate withdrawal of vagal enervation (i.e., RSA suppression) in response to challenging or demanding tasks likely reflects an adaptive allocation of energy and focus of attention that could promote active coping. Experiences of threat or extreme challenge typically result in stronger RSA suppression which allows for sympathetic activation and the mobilization of resources to provide an adequate response (Calkins & Keane, 2004). Consistent with a differential susceptibility framework, in the current study, we found that rejecting child-rearing attitudes predicted children's aggression, but only for children who demonstrated very little RSA suppression or increases in RSA in response to the anger-inducing films, also known as RSA augmentation.

A lack of RSA suppression or RSA augmentation in response to external stimuli suggests that contextual cues are being perceived as not requiring allocation of resources and preparedness for active responses to threat (Porges, 2007, 2011). Rather, very little RSA suppression or RSA augmentation might suggest that the environment is perceived to be safe and engagement may be facilitated, as is typically the case with contextual cues that are positive, social, or benign, such as looking at a picture book or engaging with a caregiver. The current findings suggest that RSA augmentation in response to anger-inducing films represents a vulnerability factor in the context of mothers' highly rejecting child-rearing attitudes. Children who view anger-inducing stimuli as a safe context for social engagement may be particularly susceptible to the negative consequences of mothers' child-rearing attitudes which convey feelings of disappointment, devalue the importance of affectionate responses, and are rejecting or undermining of children's emotional experiences. Consistent with literature linking low RSA suppression or augmentation to children's aggressive behaviors, another potential interpretation for the current findings is that low suppression or augmentation might signify disengagement, or a failure to appropriately or fully orient to the social-emotional cues being presented (Porges, 1991; Porges, Doussard-roosevelt, & Maiti, 1994). Indeed, a failure to engage with socio-emotional cues in the environment may limit the extent to which aggressive behaviors are appropriately inhibited (e.g., Raine, 2002). This interpretation of the findings suggests that an inability to effectively interpret and engage

with emotionally-salient stimuli in the environment exacerbates the links between rejecting child-rearing attitudes and children's aggressive behaviors.

The findings also suggest that low rejecting child-rearing attitudes are associated with lower levels of aggression for children who demonstrated no RSA suppression or RSA augmentation to an anger-inducing film. The concept of *neuroception* suggests that low RSA suppression or augmentation indicates that the environment is being perceived as safe for calm engagement (Porges, 2011). Parents who have fewer rejecting child-rearing attitudes may provide a more supportive and validating environment for their children, particularly in emotionally arousing situations, than do parents with more rejecting attitudes (Fraley, et al., 2013; Wagner et al., 2015). When experiencing evocative situations while with their non-rejecting caregivers, preschoolers who are in a physiological state that is supportive of calm engagement could be more prepared to observe, internalize and emulate their parents' approach to social relationships than children who demonstrate RSA suppression thus resulting in lower levels of aggression (Grusec & Goodnow, 1994). Thus, in accord with the differential susceptibility model (Pluess & Belsky, 2010), the current findings suggest that children who demonstrate low RSA suppression or augmentation in the context of emotionally arousing situations are more likely to be influenced by their caregiving environment, for better (in the context of parents without rejecting attitudes) and for worse (in the context of parents with rejecting attitudes), compared to children who demonstrate the normatively expected parasympathetic response of moderate RSA suppression during emotionally salient experiences (Calkins & Dedmon, 2000; Calkins & Keane, 2004).

Strengths of the current study include the use of both baseline RSA and measures of changes in RSA in response to emotionally salient stimuli. The examination of RSA change in response to anger-inducing stimuli, rather than a general challenge task, allows greater specificity when attempting to elucidate links between rejecting child-rearing attitudes and children's behavior problems. There are also several important limitations that should be considered. First and foremost, this study is cross-sectional, and we are therefore unable to address the potential bidirectional associations between parents' attitudes and children's behaviors as they relate to the emergence of aggressive behaviors. While addressing the hypotheses cross-sectionally does provide some insight into how children's emotion-specific autonomic regulation moderates the links between parental attitudes and aggressive behaviors, it is only through the longitudinal investigation of these questions that we can begin to fully understand the dynamic relations between how parents socialize emotion and how children regulate during emotional experiences. It is our hope that the current study can provide some foundation for future longitudinal research on these topics.

Additionally, there is a substantial body of research describing the processes through which parental *beliefs* influence parenting *behaviors* and the consequences for child development (e.g., Mills & Rubin, 1990; Rubin & Mills, 1992); this study parallels this work by suggesting that mothers' rejecting attitudes towards parenting and socialization practices play an important role in understanding children's aggressive behaviors. However, the current study assesses only the absence or presence of negative parenting influences (e.g., low or high rejecting child-rearing attitudes) rather than the presence of positive parenting influences. In the future, researchers should explore how rejecting child-rearing attitudes are

behaviorally manifested across different types of parenting influences, an endeavor that could also extend the current findings by assessing parenting behaviors observationally rather than relying on forms of maternal-report for parents' attitudes and children's aggressive behaviors. For example, researchers have shown that context-specific parenting practices such as emotion language use (Meins, Centifanti, Fernyhough, & Fishburn, 2013) or sensitivity in response to distress (Leerkes et al., 2014; Mills-Koonce et al., 2007) contribute to children's aggression. It would be important to test whether context-specific parenting mediates links between rejecting attitudes and behavior problems. Finally, researchers should consider incorporating multiple reporters of children's aggressive behaviors (e.g., teachers) rather than relying on maternal report as the current study does. Also, researchers could broaden the impact of this work by incorporating measures of attention (e.g. eye-tracking) when investigating autonomic regulation during emotional experiences so that clearer conclusions can be drawn regarding the extent to which parasympathetic functioning truly reflects engagement versus disengagement.

Despite these limitations, the current study contributes to our understanding of the implications of rejecting child-rearing attitudes for the development of aggressive behavior, and for whom these experiences are most consequential. A parasympathetic response to stimuli portraying angry social interactions of slight RSA suppression to RSA augmentation emerged as a differential susceptibility factor for mothers' rejecting attitudes. This may suggest that biofeedback or other intervention procedures to modulate children's parasympathetic regulation in the context of strong emotions could serve to protect against their risk for developing aggression problems in contexts of environmental risk, or conversely, to promote their receptiveness to more positive socializing influences in less risky environments.

## Acknowledgments

The research reported in this manuscript was supported by a grant from the Social Sciences and Humanities Research Council of Canada to Kenneth H. Rubin. Preparation of the manuscript was supported by Grant R01 MH103253 from the National Institutes of Health to Rubin.

## References

- Achenbach TM. Manual for the child behavior checklist/4–18 and 1991 profile. Burlington VT: 1991.
- Achenbach TM, Dumenci L. Advances in empirically based assessment: Revised cross-informant syndromes and new DSM-oriented scales for the CBCL, YSR, and TRF: Comment on Lengua, Sadowski, Friedrich, and Fisher (2001). *Journal of Consulting and Clinical Psychology*. 2001; 69(4):699–702. DOI: 10.1037/0022-006X.69.4.699 [PubMed: 11550735]
- Beauchaine T. Vagal tone, development, and Gray's motivational theory: Toward an integrated model of autonomic nervous system functioning in psychopathology. *Development and Psychopathology*. 2001; 13(2):183–214. DOI: 10.1017/S0954579401002012 [PubMed: 11393643]
- Belsky J, Fearon RM, Bell B. Parenting, attention and externalizing problems: testing mediation longitudinally, repeatedly and reciprocally. *Journal of Child Psychology and Psychiatry*. 2007; 48(12):33–42. DOI: 10.1111/j.1469-7610.2007.01807.x
- Blair RJR. Psychopathic traits from an RDoC perspective. *Current Opinion in Neurobiology*. 2015; 30:79–84. DOI: 10.1016/j.conb.2014.09.011 [PubMed: 25464372]
- Block J. *The Q-Sort Method in Personality Assessment and Psychiatric Research*. Consulting Psychologists Press; 1961.

- Boyce WT, Ellis BJ. Biological sensitivity to context: I. An evolutionary–developmental theory of the origins and functions of stress reactivity. *Development and Psychopathology*. 2005; 17(2):271–301. DOI: 10.1017/S0954579405050145 [PubMed: 16761546]
- Bretherton I, Munholland KA. *Handbook of attachment: Theory, research, and clinical applications*. Rough Guides, NY: 1999. Internal working models in attachment relationships: A construct revisited; 89–111.
- Calkins SD, Dedmon SE. Physiological and behavioral regulation in two- year-old children with aggressive/destructive behavior problems. *Journal of Abnormal Child Psychology*. 2000; 28:103–118. [PubMed: 10834764]
- Calkins SD, Graziano P, Keane SP. Cardiac vagal regulation differentiates among children at risk for behavior problems. *Biological Psychology*. 2007; 74(2):144–53. DOI: 10.1016/j.biopsycho.2006.09.005 [PubMed: 17055141]
- Calkins SD, Keane SP. Cardiac vagal regulation across the preschool period: Stability, continuity, and implications for childhood adjustment. *Developmental Psychobiology*. 2004; 45(3):101–112. DOI: 10.1002/dev.20020 [PubMed: 15505799]
- Calkins SD, Propper C, Mills-Koonce WR. A biopsychosocial perspective on parenting and developmental psychopathology. *Development and Psychopathology*. 2013; 25(4):139–414. DOI: 10.1017/S0954579413000680
- Cicchetti D, Natsuaki MN. Multilevel developmental perspectives toward understanding internalizing psychopathology: Current research and future directions. *Development and Psychopathology*. 2014; 26(4):1189–1190. DOI: 10.1017/S0954579414000959 [PubMed: 25422954]
- Cicchetti D, Rogosch FA. Equifinality and multifinality in developmental psychopathology. *Development and Psychopathology*. 1996; 8:597–600. DOI: 10.1017/S0954579400007318
- Cole PM, Teti LO, Zahn–Waxler C. Mutual emotion regulation and the stability of conduct problems between preschool and early school age. *Development and Psychopathology*. 2003; 15(1):1–18. DOI: 10.1017/S0954579403000014 [PubMed: 12848432]
- Côté SM, Vaillancourt T, LeBlanc JC, Nagin DS, Tremblay RE. The development of physical aggression from toddlerhood to pre-adolescence: a nation wide longitudinal study of Canadian children. *Journal of Abnormal Child Psychology*. 2006; 34(1):71–85. DOI: 10.1007/s10802-005-9001-z [PubMed: 16565888]
- Cox MJ, Mills-Koonce R, Propper C, Gariépy JL. Systems theory and cascades in developmental psychopathology. *Development and Psychopathology*. 2010; 22(3):497–506. DOI: 10.1017/S0954579410000234 [PubMed: 20576174]
- Davies PT, Sturge-Apple ML, Cicchetti D, Manning LG, Vonhold SE. Pathways and processes of risk in associations among maternal antisocial personality symptoms, interparental aggression, and preschooler’s psychopathology. *Development and Psychopathology*. 2012; 24(3):807–32. DOI: 10.1017/S0954579412000387 [PubMed: 22781856]
- Ellis BJ, Boyce WT. Biological sensitivity to context. *Current Directions in Psychological Science*. 2008; 17(3):183–187. DOI: 10.1111/j.1467-8721.2008.00571.x
- Enders CK. Dealing with missing data in developmental research. *Child Development Perspectives*. 2013; 7(1):27–31. DOI: 10.1111/cdep.12008
- Enders CK, Bandalos DL. The relative performance of full information maximum likelihood estimation for missing data in structural equation models. *Structural Equation Modeling*. 2001; 8(3):430–457. DOI: 10.1207/S15328007sem0803\_5
- Feldman R, Rosenthal Z, Eidelman AI. Maternal-preterm skin-to-skin contact enhances child physiologic organization and cognitive control across the first 10 years of life. *Biological Psychiatry*. 2014; 75(1):56–64. DOI: 10.1016/j.biopsycho.2013.08.012 [PubMed: 24094511]
- Fraley RC. Attachment stability from infancy to adulthood: Meta-analysis and dynamic Modeling of developmental mechanisms. *Personality and Social Psychology Review*. 2002; 6(2):123–151. DOI: 10.1207/S15327957PSPR0602\_03
- Fraley RC, Roisman GI, Haltigan JD. The legacy of early experiences in development: Formalizing alternative models of how early experiences are carried forward over time. *Developmental Psychology*. 2013; 49(1):109–126. DOI: 10.1037/a0027852 [PubMed: 22448982]

- Fury G, Carlson EA, Sroufe LA. Children's representations of attachment relationships in family drawings. *Child Development*. 1997; 68(6):1154–1164. DOI: 10.1111/j.1467-8624.1997.tb01991.x [PubMed: 9418231]
- Gao Y, Raine A, Venables PH, Dawson ME, Mednick S. Reduced electrodermal fear conditioning from ages 3 to 8 years is associated with aggressive behavior at age 8 years. *Journal of Child Psychology and Psychiatry*. 2010; 51(5):550–558. DOI: 10.1111/j.1469-7610.2009.02176.x [PubMed: 19788551]
- Gilliom M, Shaw DS. Codevelopment of externalizing and internalizing problems in early childhood. *Development and Psychopathology*. 2004; 16(2):313–333. DOI: 10.1017/S0954579404044530 [PubMed: 15487598]
- Gottman JM, Katz LF, Hooven C. Parental meta-emotion philosophy and the emotional life of families: Theoretical models and preliminary data. *Journal of Family Psychology*. 1996; 10(3): 243–268. DOI: 10.1037//0893-3200.10.3.243
- Grusec JE, Goodnow JJ. Impact of parental discipline methods on the child's internalization of values: A reconceptualization of current points of view. *Developmental psychology*. 1994; 30(1):4–13.
- Hastings PD, Nuselovici JN, Utendale WT, Coutya J, McShane KE, Sullivan C. Applying the polyvagal theory to children's emotion regulation: Social context, socialization, and adjustment. *Biological Psychology*. 2008; 79(3):299–306. DOI: 10.1016/j.biopsycho.2008.07.005 [PubMed: 18722499]
- Hastings PD, Kahle S, Han H-SG. Developmental affective psychophysiology: Using physiology to inform our understanding of emotional development. In: Lagatutta K, editor *Children and emotion: New insights into developmental affective science*. Basel, Switzerland: Karger; 2014. 13–28.
- Hastings PD, Rubin KH. Predicting mothers' beliefs about preschool-aged children's social behavior: Evidence for maternal attitudes moderating child effects. *Child Development*. 1999; 70(3):722–741. [PubMed: 10368918]
- Hastings PD, Rubin KH, DeRose L. Links among gender, inhibition, and parental socialization in the development of prosocial behavior. *Merrill-Palmer Quarterly*. 2005; 51(4):467–493. DOI: 10.1353/mpq.2005.0023
- Hooven C, Gottman JM, Katz LF. Parental meta-emotion structure predicts family and child outcomes. *Cognition & Emotion*. 1995; 9doi: 10.1080/02699939508409010
- Lahey BB, Van Hulle CA, Keenan K, Rathouz PJ, D'Onofrio BM, Rodgers JL, Waldman ID. Temperament and parenting during the first year of life predict future child conduct problems. *Journal of Abnormal Child Psychology*. 2008; 36(8):1139–58. DOI: 10.1007/s10802-008-9247-3 [PubMed: 18568397]
- Leerkes EM, Supple AJ, O'Brien M, Calkins SD, Haltigan JD, Wong MS, Fortuna K. Antecedents of maternal sensitivity during distressing tasks: Integrating attachment, social information processing, and psychobiological perspectives. *Child Development*. 2014; 0(0):1–18. DOI: 10.1111/cdev.12288
- Meins E, Centifanti LCM, Fernyhough C, Fishburn S. Maternal mind-mindedness and children's behavioral difficulties: Mitigating the impact of low socioeconomic status. *Journal of Abnormal Child Psychology*. 2013; 41(4):543–553. DOI: 10.1007/s10802-012-9699-3 [PubMed: 23299554]
- Mesman J, Bongers IL, Koot HM. Preschool developmental pathways to preadolescent internalizing and externalizing problems. *Journal of Child Psychology and Psychiatry*. 2001; 42(5):679–689. DOI: 10.1111/1469-7610.00763 [PubMed: 11464972]
- Miller JG, Choccol C, Nuselovici JN, Utendale WT, Simard M, Hastings PD. Children's dynamic RSA change during anger and its relations with parenting, temperament, and control of aggression. *Biological psychology*. 2013; 92(2):417–425. [PubMed: 23274169]
- Mills-Koonce WR, Gariépy JL, Propper C, Sutton K, Calkins S, Moore G, Cox M. Infant and parent factors associated with early maternal sensitivity: a caregiver-attachment systems approach. *Infant Behavior & Development*. 2007; 30(1):114–126. DOI: 10.1016/j.infbeh.2006.11.010 [PubMed: 17292784]
- Mills-Koonce WR, Willoughby MT, Garrett-Peters P, Wagner N, Vernon-Feagans L. The interplay among socioeconomic status, household chaos, and parenting in the prediction of child conduct

- problems and callous–unemotional behaviors. *Development and Psychopathology*. 2016; 28(3): 757–771. DOI: 10.1017/S0954579416000298 [PubMed: 27427804]
- Mills RSL, Rubin KH. Parental beliefs about problematic social behaviors in early childhood. *Child Development*. 1990; 61(1):138–151.
- Muthén LK, Muthén BO. *Mplus Users Guide*. 2017.
- Oliver BR, Barker ED, Mandy WPL, Skuse DH, Maughan B. Social cognition and conduct problems: A developmental approach. *Journal of the American Academy of Child and Adolescent Psychiatry*. 2011; 50(4):385–394. DOI: 10.1016/j.jaac.2011.01.006 [PubMed: 21421178]
- Patriquin MA, Lorenzi J, Scarpa A, Calkins SD, Bell MA. Broad implications for respiratory sinus arrhythmia development: Associations with childhood symptoms of psychopathology in a community sample. *Developmental Psychobiology*. 2015; 57(1):120–130. [PubMed: 25503815]
- Perry NB, Nelson J, Calkins SD, Leerkes EM, O’Brien M, Marcovitch S. Early physiological regulation predicts the trajectory of externalizing behaviors across the preschool period. *Developmental Psychobiology*. 2014; 56(7):1482–1491. DOI: 10.1002/dev.21228 [PubMed: 24909987]
- Pluess M. Individual differences in environmental sensitivity. *Child Development Perspectives*. 2015; 9(3):138–143.
- Pluess M, Belsky J. Differential susceptibility to parenting and quality child care. *Developmental Psychology*. 2010; 46(2):379–390. DOI: 10.1037/a0015203 [PubMed: 20210497]
- Porges SW. Vagal tone: An autonomic mediator of affect. *The Development of Emotion Regulation and Dysregulation*. 1991:111–28.
- Porges SW. Social engagement and attachment. *Annals of the New York Academy of Sciences*. 2003; 1008(1):31–47. [PubMed: 14998870]
- Porges SW. The polyvagal theory: phylogenetic substrates of a social nervous system. *International Journal of Psychophysiology*. 2001; 42(2):123–146. [PubMed: 11587772]
- Porges SW. The polyvagal perspective. *Biological Psychology*. 2007; 74(2):116–143. DOI: 10.1016/j.biopsycho.2006.06.009 [PubMed: 17049418]
- Porges SW, Doussard–Roosevelt JA, Maiti AK. Vagal tone and the physiological regulation of emotion. *Monographs of the Society for Research in Child Development*. 1994; 59(2–3):167–186.
- Propper CB, Holochwost SJ. The influence of proximal risk on the early development of the autonomic nervous system. *Developmental Review*. 2013; 33(3):151–167. DOI: 10.1016/j.dr.2013.05.001
- Raine A. Biosocial studies of antisocial and violent behavior in children and adults: A review. *Journal of Abnormal Child Psychology*. 2002; 30(4):311–326. [PubMed: 12108763]
- Raine A, Reynolds C, Venables PH, Mednick SA, Farrington DP. Fearlessness, stimulation-seeking, and large body size at age 3 years as early predispositions to childhood aggression at age 11 years. *Archives of General Psychiatry*. 1998; 55(8):745–751. DOI: 10.1001/archpsyc.55.8.745 [PubMed: 9707386]
- Roisman GI, Newman D, Fraley RC, Haltigan JD, Groh AM, Haydon KC. Distinguishing differential susceptibility from diathesis-stress: Recommendations for evaluating interaction effects. *Development and Psychopathology*. 2012; 24(2):389–409. DOI: 10.1017/S0954579412000065 [PubMed: 22559121]
- Rubin KH, Burgess KB, Dwyer KM, Hastings PD. Predicting preschoolers’ externalizing behaviors from toddler temperament, conflict, and maternal negativity. *Developmental Psychology*. 2003; 39(1):164–176. DOI: 10.1037/0012-1649.39.1.164 [PubMed: 12518817]
- Rubin KH, Mills RSL. Maternal beliefs about adaptive and maladaptive social behaviors in normal, aggressive, and withdrawn preschoolers. *Journal of Abnormal Child Psychology*. 1990; 18(4):419–435. DOI: 10.1007/BF00917644 [PubMed: 2246433]
- Rubin KH, Mills RSL. Parents’ thoughts about children’s socially adaptive and maladaptive behaviors: Stability, change, and individual differences. In: Sigel I, Goodnow J, McGillicuddy-de Lisi A, editors *Parental Belief Systems: The Psychological Consequences for Children*. Hillsdale, N.J: Erlbaum; 1992. 41–68.

- Shortt JW, Stoolmiller M, Smith-Shine JN, Eddy J, Sheeber L. Maternal emotion coaching, adolescent anger regulation, and siblings' externalizing symptoms. *Journal of Child Psychology and Psychiatry*. 2010; 51(7):799–808. DOI: 10.1111/j.1469-7610.2009.02207.x [PubMed: 20059622]
- Sroufe LA, Coffino B, Carlson E. Conceptualizing the role of early experience: Lessons from the Minnesota Longitudinal Study. *Developmental Review*. 2010; 30(1):36–51. DOI: 10.1016/j.dr.2009.12.002 [PubMed: 20419077]
- Suess PE, Porges SW, Dana P. Cardiac vagal tone in sustained attention in school-aged children. *Psychophysiology*. 1994; 31:17–22. [PubMed: 8146250]
- Wagner NJ, Hastings PD, Rubin KH. Callous-unemotional traits and autonomic functioning in toddlerhood interact to predict externalizing behaviors in preschool. *Journal of Abnormal Child Psychology*. 2017; 0(0):1–12. DOI: 10.1007/s10802-017-0374-6
- Wagner NJ, Mills-Koonce WR, Willoughby MT, Cox MJ. Parenting and cortisol in infancy interactively predict conduct problems and callous-unemotional behaviors in childhood. *Child Development*. 2017; 0(0):1–19. DOI: 10.1111/cdev.12900
- Wagner NJ, Mills-Koonce WR, Willoughby MT, Zvara B, Cox MJ. Parenting and children's representations of family predict disruptive and callous-unemotional behaviors. *Developmental Psychology*. 2015; 51(7):935–947. DOI: 10.1037/a0039353 [PubMed: 26010385]
- Wagner N, Mills-Koonce R, Willoughby M, Propper C, Rehder P, Gueron-Sela N. Respiratory sinus arrhythmia and heart period in infancy as correlates of later oppositional defiant and callous-unemotional behaviors. *International Journal of Behavioral Development*. 2017; 41(1):127–135. [PubMed: 28042190]
- Widaman KF. Missing data: What to do with or without them. *Monographs of the Society for Research in Child Development*. 2006; 71:42–64. DOI: 10.1111/j.1540-5834.2006.00404.x

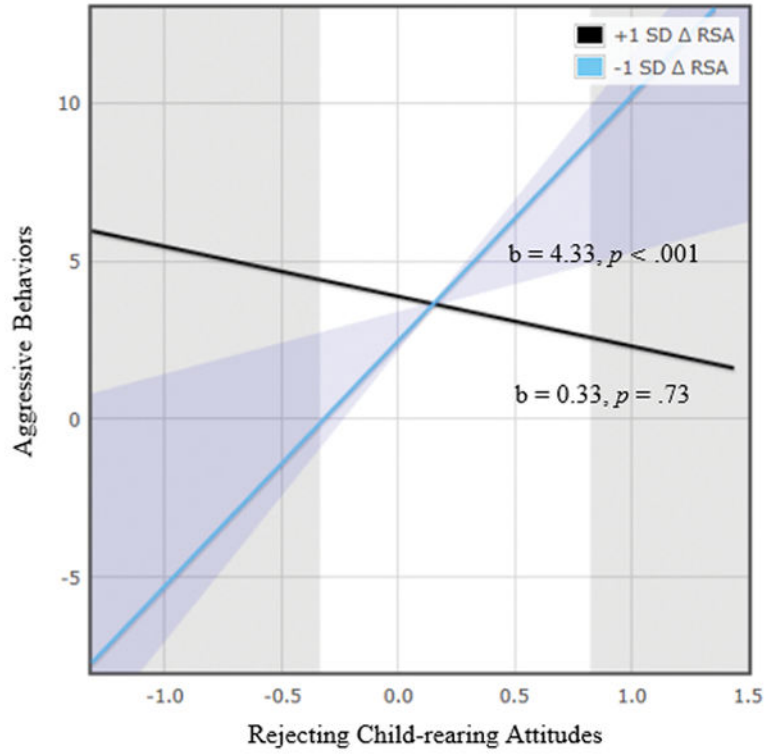


Figure 1.



**Table 1**

**Zero-order Bivariate Correlations Between Model Predictors**

	1	2	3	4	5	6	7	8
1. Sex (male = 0)	-							
2. Maternal Education	-.14	-						
3. Child Age in Months	.02	.05	-					
4. Attention Problems	-.35**	-.05	-.02	-				
5. Rejecting Child-rearing Attitudes	-.23	-.06	.01	.29*	-			
6. Child's Baseline RSA	.10	-.26*	.18	-.04	.05	-		
7. Child's RSA	.01	-.16	.02	-.03	-.14	.38**	-	
8. Aggressive Behaviors	-.39**	.10	-.10	.41**	.45**	.03	-.04	-
N	88	88	88	74	70	84	84	74
Mean	-	3.1	50.9	2.7	2.5	6.2	-0.1	8.9
Standard Deviation	-	1.1	1.3	2.2	0.6	1.1	0.6	5.1
Min. -Max.	-	1-6	49-54	0-9	1-4	3-9	-2-2	1-22

Notes: *p* .05\*, *p* .01\*\*

**Table 2**

**Hierarchical Regression Models predicting Children's Aggressive Behaviors**

Parameter	Model 1		Model 2	
	B (β)	CI	B (β)	CI
Sex (male = 0)	-2.39 (-.23)*	-.42 to -.35	-2.45 (-.23)*	-.41 to -.05
Maternal Education	0.74 (.16)^	-.02 to .34	0.87 (.19)*	.12 to .37
Child Age in Months	-0.37 (-.09)	-.27 to .08	-0.40 (-.10)	.27 to .07
Attention Problems	0.55 (.24)**	.03 to .43	0.47 (.20)*	.02 to .39
Rejecting Child-rearing Attitudes	3.09 (.34)**	.14 to .53	3.09 (.34)**	.15 to .53
Child's Baseline RSA	0.35 (.08)	-.12 to .27	-0.13 (-.03)	-.23 to .17
Child's RSA	0.07 (.01)	-.18 to .19	0.71 (.07)	-.23 to .28
Child's Baseline RSA X Rejecting Child-rearing Attitudes	-	-	0.27 (.04)	-.17 to .24
Child's RSA X Rejecting Child-rearing Attitudes	-	-	-4.67 (-.29)**	-.49 to -.09
Total R <sup>2</sup> ( R <sup>2</sup> )	.38 (-)	.44 (.06)		

Notes:  $p < .10$ ,  $p < .05$ ,  $p < .01$ ,  $p < .001$ ; continuous predictors centered; higher order interactions non-significant; CI = confidence interval; RSA = Respiratory Sinus Arrhythmia