# Children's dynamic RSA change during anger and its relations with parenting, temperament, and control of aggression☆

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## ABSTRACT

This study examined the moderating effects of child temperament on the association between maternal socialization and 4–6-year-old children's dynamic respiratory sinus arrhythmia (RSA) change in response to anger-themed emotional materials ($N = 180$). We used latent growth curve modeling to explore adaptive patterns of dynamic RSA change in response to anger. Greater change in RSA during anger-induction, characterized by more initial RSA suppression and a subsequent return to baseline, was related to children's better regulation of aggression. For anger-themed materials, low levels of authoritarian parenting predicted more RSA suppression and recovery for more anger-prone children, whereas more authoritative parenting predicted more RSA suppression and recovery for less anger-prone children. These findings suggest that children's adaptive patterns of dynamic RSA change can be characterized by latent growth curve modeling, and that these patterns may be differentially shaped by parent socialization experiences as a function of child temperament.

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## 1. Introduction

Variation in the functioning of physiological systems likely underlies individual differences in the development of emotion regulation (Porges, 2007). One such system is reflected in parasympathetic regulation of cardiovascular activity, which has been linked to young children's ability to regulate their emotions (Beauchaine, 2001; Porges, 2007). How best to model parasympathetic regulation as a dynamic phenomenon remains an issue (Brooker and Buss, 2010). In addition, parental socialization and child temperament have been identified as important contributors to children's emotion regulation (Eisenberg et al., 2001), but how these factors jointly contribute to parasympathetic regulation of emotion is unclear. Some research suggests that it is important to consider the moderating effects of child temperament on the relation between parenting and adjustment, including physiological regulation of different emotion states, although few studies have considered this approach to date. In addition, some researchers have argued for the need for methods that are more sensitive to the temporal aspects of physiological regulation. We investigated whether modeling parasympathetic change over the course of anger-induction was related to better behavioral regulation of anger in the form of control of aggression.

### 1.1. Respiratory sinus arrhythmia (RSA) and emotion

Parasympathetic functioning has been widely studied as a physiological substrate of emotional reactivity and regulation (Blandon et al., 2010; Calkins and Dedmon, 2000). The myelinated vagus nerve is the main mechanism of parasympathetic innervation of the heart, often referred to as vagal tone. Increased vagal tone dampens firing of the sino-atrial node of the heart, resulting in slower heart rate, less sympathetic arousal, and a calmer state. Conversely, suppression of vagal tone supports an increase of sympathetic arousal and mobilization of resources for behavioral coping and defensive responses. Respiratory sinus arrhythmia (RSA) refers to the heart rate variability that corresponds with the natural respiration cycle, and is mainly under the control of the vagus nerve, suggesting that RSA is an appropriate measure of activity in the parasympathetic nervous system (Porges, 2007).

Polyvagal theory provides a framework for understanding RSA functioning in relation to emotion (Porges, 2007, but see Grossman and Taylor, 2007 for critique of polyvagal theory), and proposes that suppression of RSA reflects adaptive orientation and regulatory

efforts in response to emotionally challenging events. Greater RSA suppression during emotionally challenging tasks has been associated with better emotion regulation in the form of less negative emotionality and fewer behavioral problems (Calkins and Dedmon, 2000; Calkins and Keane, 2004).

The dynamic nature of RSA activity coincides with theory suggesting that emotion regulation itself is a rapidly changing process that unfolds over time. Thus temporal changes in physiology should drive or correspond with temporal changes in emotion regulation. Some researchers have argued for the need for physiological measures that account for the dynamic nature of emotion (Brooker and Buss, 2010; Thompson et al., 2008). Traditional methods of quantifying RSA change observe the difference between RSA during baseline and task procedures either using arithmetic change scores or standardized residuals. These are static measures of RSA and might limit the ability to capture RSA change within an emotional event as it unfolds over time. In this study we attempted to address this limitation by observing RSA change during stimuli that progress from affectively neutral to emotionally valenced. Our approach differed from traditional methods in that we used latent growth curve analysis to model how children's RSA changed over the course of emotion and whether there were meaningful individual differences in this change (Brooker and Buss, 2010). This alternate method might better capture the temporal nature of dynamic RSA change associated with regulation in addition to the magnitude of RSA change.

### 1.2. Socialization, temperament and RSA

Parenting practices play a significant role in shaping children's development of emotion regulation. Authoritative parenting that is warm and involved, responsive, and democratic has been associated with children's development of adaptive emotion regulation and fewer externalizing and internalizing behaviors (Hart et al., 2003; Hastings et al., 2008b). Conversely, an authoritarian parenting style, including such behaviors and attitudes as hostility, high control, punitiveness and low responsiveness, is generally associated with poorer emotion regulation in children (Eisenberg et al., 2001; Mills et al., 2011).

Authoritative parents, through their provision of structure and appropriate support, may facilitate their child's management of challenges without interfering with the child's autonomy. Attaining experiences of mastery in this way might provide children with greater opportunity to practice effective emotion regulation and develop healthy physiological regulation. Children's RSA change during emotionally evocative events might be one mechanism by which parent behaviors help shape development of emotion regulation and associated behavioral outcomes. For example, critical and overcontrolling parenting has been found to be associated with lower RSA in a social context, which in turn mediated the association between parenting and behavioral self-regulation (Hastings et al., 2008a). However, a number of studies have failed to find significant associations between parenting and RSA (Kennedy et al., 2004; Rubin et al., 1997). These inconsistent findings suggest that other factors, such as child temperament, might also influence how socialization is related to children's RSA during emotion.

Temperament can be defined as biologically based individual differences in the probability of experiencing different emotions and arousal states (Goldsmith et al., 1987). As such, children's temperament has been found to be associated with characteristic patterns of emotional responsiveness. Difficult, negatively reactive, or anger-prone children have a lower threshold for anger arousal and are slower to calm or soothe (Rubin et al., 1998). Some research has shown that children with different temperaments vary in their patterns of RSA response to emotional stimuli (Blandon et al., 2010; Calkins, 1997; Huffman et al., 1998). For example,

RSA suppression during challenging situations has been associated with greater temperamental soothabilty in infancy (Huffman et al., 1998), and greater emotion regulation and fewer behavioral problems in preschool children (Calkins, 1997; Calkins and Keane, 2004). However, other studies have failed to find significant associations between RSA suppression and difficult temperament (Blandon et al., 2010). These inconsistent findings again suggest that simple, direct associations between temperament and RSA might be quite modest, strengthening the argument that both temperament and parenting factors should be considered when studying physiological aspects of children's emotion regulation.

### 1.3. Biopsychosocial approaches to emotion regulation

Biopsychosocial models provide a conceptual framework for integrating temperament and parenting contributions to emotion regulation. Current models of the interaction between parenting and child temperament differ with regard to their predicted outcomes for children's emotional development. The differential susceptibility to environment hypothesis posits that children with difficult temperaments, or who are highly physiologically reactive, are more susceptible to environmental influences such as parenting, for better or worse (Ellis et al., 2011). By this model, difficult children are likely to have higher rates of problems related to poor emotion regulation when raised in adverse environments, but lower rates when raised in supportive ones. A number of studies have found significant interaction effects between parenting and difficult temperament in support of these hypotheses (Klein Velderman et al., 2006; Pluess and Belsky, 2010). Conversely, diathesis-stress perspectives propose that some individuals have an inherent vulnerability to be adversely affected by stressful environments, but are not more susceptible to the benefits of positive environments (Zuckerman, 1999). A third perspective, goodness-of-fit, proposes that child outcomes depend on the interplay of various combinations of parenting characteristics and temperament qualities (Chess and Thomas, 1999).

While a number of investigators have applied such biopsychosocial models to the development of reported or observed measures of children's emotion regulation, fewer studies have considered their relevance for understanding children's emotional physiology. Gilissen et al. (2007) found that temperamentally inhibited children had stronger sympathetic reactions to fear inducing stimuli if they had insecure, compared to secure, attachments to their mother. Conversely, Burgess et al. (2003) did not find that temperament moderated associations between children's attachment security and their RSA or heart rate. It is still unclear which factors might influence the development of individual differences in RSA change during other emotions, specifically anger. Poorly regulated anger is linked to increased aggression (Berkowitz, 1990; Denson et al., 2012). More research is needed that considers the temporal aspects of RSA change as well as magnitude to determine whether there might be joint contributions of parenting and temperament to children's dynamic RSA change during anger, and whether this dynamic RSA change is related to behavioral regulation of anger as reflected in control of aggressive behaviors.

### 1.4. Current study

In this study we used latent growth curve modeling to quantify children's dynamic RSA change during an anger-induction film clip. This method provides more information about the temporal variation of RSA, and magnitude of RSA change at different points in time (in relation to children's starting or intercept RSA value), than traditional methods of capturing RSA change (i.e., arithmetic change scores and standardized residual scores). We predicted that this dynamic measure of RSA change in response