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## Brief Report

## Physiology and functioning: Parents' vagal tone, emotion socialization, and children's emotion knowledge

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## ABSTRACT

This study examined relationships among parents' physiological regulation, their emotion socialization behaviors, and their children's emotion knowledge. Parents' resting cardiac vagal tone was measured, and parents provided information regarding their socialization behaviors and family emotional expressiveness. Their 4- or 5-year-old children ( $N = 42$ ) participated in a laboratory session in which their knowledge of emotional facial expressions and situations was tested and their own resting vagal tone was monitored. Results showed that parents' vagal tone was related to their socialization behaviors, and several parent socialization variables were related to their children's emotion knowledge. These findings suggest that parents' physiological regulation may affect the emotional development of their children by influencing their parenting behaviors.

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## Introduction

By preschool, children have arrived at the point where understanding of emotions becomes paramount. At this age, children begin to spend less time in their home environment and move to a setting in which their first nonfamilial social relationships are formed. They must rely less on the emotional coaching of their caregivers and begin to demonstrate affective competence in their independent social interactions. Emotion knowledge, or understanding the emotional reactions of others and the situations that likely cause them, is a key component of emotional competence and contributes to the development of the ability to engage in successful social

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interactions (Denham et al., 2003; Halberstadt, Denham, & Dunsmore, 2001). Children who are able to accurately read the emotional expressions of others and predict a likely emotional reaction in a given social situation can use this information to negotiate interpersonal interaction and successfully function in their new world of peer relationships. The current study employs a multimethod approach to investigate emotion situation knowledge and emotion expression knowledge in young children and probes the socialization and physiological concomitants of its development.

Parents must actively socialize their children to understand the norms of emotional behavior, a process often referred to as emotional socialization (Halberstadt, Fox, & Jones, 1993; Pollak & Thoits, 1989). Parents socialize their children through means such as emotional discourse, reaction to their children's emotions, and modeling. They can set the stage for their children's future emotion knowledge both directly through teaching of emotional information and indirectly through their own emotional actions and reactions.

Previous research findings are consistent with the premise that children's emotional competence develops, at least in part, within the context of parental emotion socialization. Studies have shown that parents who socialize their children by modeling positive expressive styles, showing high levels of emotional responsiveness, encouraging their children's own emotional expression, and discussing emotional events have more affectively competent children (Denham, Mitchell-Copeland, Strandberg, Auerbach, & Blair, 1997; Denham, Zoller, & Couchoud, 1994). Relating directly to emotion knowledge, studies have also shown that children better understand emotion when parents are emotionally expressive and responsive (Denham & Grout, 1992) and foster an atmosphere of positive emotional expressiveness within the home (Denham & Kochanoff, 2002). Previous studies also indicate that adequate balance of both positive and negative emotions in the family environment is indicative of children's adept emotional functioning (Eisenberg & Fabes, 1994; Valiente et al., 2006). Although the previous literature has established a link between parental socialization of emotion and children's emotional competence, the specific mechanisms underlying this relationship are still under investigation.

Emotional behaviors, whether in adults or in children, are believed to have an underlying physiological basis and to be influenced by people's physiological regulation. Cardiac vagal tone (VT), a measure of the variability in heart rate (Porges, 1995), is commonly used as an index of such regulation. Optimal resting VT is thought to underlie adaptive behavioral and emotional responses to environmental demands (Porges, Dousard-Roosevelt, & Maiti, 1994). Multiple studies of emotion during early childhood have found that high baseline VT is associated with several aspects of emotional competence, including but not limited to appropriate affective responding (Calkins, 1997), better emotion regulation (Fox, 1989), and fewer internalizing and externalizing behavior problems (El-Sheikh, Harger, & Whitson, 2001). However, it must be noted that a consistent relationship between VT and emotional competence is not always found (e.g., Eisenberg et al., 1995).

Although links between underlying physiological systems and overt emotional behaviors may develop during infancy and early childhood, they also are evident during adulthood (Butler, Wilhelm, & Gross, 2006; Gross, 2002). Thus, parents' emotion socialization behaviors might be expected to be influenced by their own physiological regulation. For example, parents with higher resting VT might be more likely to foster a positive emotional environment and encourage emotional expression by their children. As described above, these socialization behaviors have been associated with children's emotion competence and, in particular, the development of emotion knowledge. Furthermore, due to shared genes and environment, parents and children might possibly show similarity in the physiological systems that influence competent emotional functioning.

Thus, our study seeks to investigate the links between parental physiological regulation and their emotion socialization behaviors that, in turn, may affect children's developing emotion knowledge. Although previous research has examined relationships between children's physiological systems and overt emotional behavior, no study has addressed linkages among parents' VT, their emotion socialization behaviors, and the emotional development of their children.

## Method

### *Participants*

Participants were 44 4- or 5-year-olds (25 boys and 19 girls, mean age = 59.05 months,  $SD = 5.36$ ) and their primary caregivers recruited from the local community. Most children were tested with their mothers; however, 3 children were tested with their fathers and 1 was tested with a grandmother because these were their primary caregivers. The ethnic distribution of the sample reflected that of the mid-sized, southeastern U.S. town (68% Caucasian, 23% African American, 9% Hispanic/Asian/Middle Eastern). Of the 44 children, 2 were dropped from the data analyses, 1 who was not a native English speaker and 1 who was unable to complete the tasks, leaving a final sample of 42 children.

### *Questionnaire measures*

During the children's participation in the laboratory tasks, parents were asked to complete a series of short questionnaires. Those relevant to the current study, regarding family emotion socialization practices, are discussed below.

#### *Coping with children's negative emotions scale*

The Coping with Children's Negative Emotions Scale (CCNES) (Fabes, Eisenberg, & Bernzweig, 1990) is a self-report questionnaire that measures parents' reactions to their children's negative affect in situations that cause distress. Subscales (12 items per subscale) include Distress Reactions, Punitive Reactions, Expressive Encouragement, Emotion-Focused Reactions, Problem-Focused Reactions, and Minimization Reactions, with scores on each subscale ranging from 1 to 7. The mean Cronbach's alpha for subscales of the CCNES was .77 (ranging from .68 to .88).

#### *Self-expressiveness in the family questionnaire*

The Self-Expressiveness in the Family Questionnaire (SEFQ) (Halberstadt, Cassidy, Stifter, Parke, & Fox, 1995) measures family expressiveness of emotion by asking parents how often various emotional reactions occur in their home. Subscales (10 items per subscale) include Positive Dominant Expression, Positive Submissive Expression, Negative Dominant Expression, and Negative Submissive Expression, with scores on each subscale ranging from 1 to 9. The mean Cronbach's alpha for subscales of the SEFQ was .76 (ranging from .73 to .82).

### *Physiological measures*

Resting heart rate data were collected from both the parents and their children (MP150, Biopac Systems, Goleta, CA, USA). First, we placed heart rate sensors on the parents and collected 3.5 min of data while the parents sat silently in the testing room. Children were taken to a separate room and allowed to watch their parents' heart rate waveforms on a computer screen, which served to familiarize children to the nature of the heart rate collection procedure. Then children were asked whether they would like to wear the "heart stickers" and were shown how the sensors would be placed on their bodies by demonstration on a stuffed animal. After the children gave verbal consent, the three sensors were placed onto their chests in a triangular pattern. Children were then asked to watch a cartoon video while 7 min of baseline activity was recorded. This video was G rated and free of strong emotional content. Although this procedure does not provide a true baseline because the children's attention was engaged, it is considered necessary to ensure minimal movement or emotional expression from young child participants (Calkins, 1997). Heart rate data were later visually edited for artifact (Mindware Technologies, Gahanna, OH, USA), and the VT statistic was computed by a laboratory member certified in Porges's (1985) MXedit software. Any file containing more than 5% artifact was considered to be unusable and was treated as missing data.

### *Laboratory tasks*

Children completed a series of short emotional laboratory tasks. Those that are relevant to the current study are discussed below.

#### *Facial expression identification*

Through a computer game, a cartoon kangaroo narrator (“Skippy”) asked the child participants to help identify pictures of facial expressions corresponding to a specific emotion label (e.g., “Touch the happy face”). Using a touch screen computer, children selected the face (either happy, sad, angry, fearful, surprised, or disgusted) from a set of pictures of four child or adult models posing emotional expressions considered to be prototypes for these emotions (Ekman & Friesen, 1975). Each emotion was prompted four times for a total of 24 trials. These photographs have been used in multiple published studies (e.g., Camras & Allison, 1985; Wismer Fries & Pollak, 2004) and have been coded by a trained Facial Action Coding System (FACS) coder (Ekman & Friesen, 1978) to guarantee validity. To ensure understanding of the task, children were given two practice trials and were coached on the task until adequate understanding was achieved. Children received positive feedback throughout the task regardless of their performance.

#### *Emotion situation knowledge*

We created a computerized version of Denham’s (1986) widely used emotion situation knowledge task. During the computer task, Skippy reappeared to present 32 short vignettes about children and emotional events typical of their daily lives (i.e., going to an ice cream shop, experiencing a nightmare, having a favorite toy broken). The vignettes were depicted in simple line drawings, with the main story character displaying a neutral facial expression. The narrator of the story always spoke in a neutral tone; however, the exclamation of the child character contained emotion intonation to match the story. Children were asked to choose how the story character was feeling by touching one of four pictures of children posing emotional facial expressions (happy, sad, angry, or fearful).

## **Results**

### *Data reduction*

To form more comprehensive measures of parental emotion socialization, subscales from the CCNES and SEFQ were combined. Following the theoretical distinction and empirical findings of Eisenberg and Fabes (1994), we created aggregate CCNES scores of dismissing behaviors and coaching behaviors. This was accomplished by totaling those subscales hypothesized to indicate negative parental emotion socialization practices (i.e., the minimizing, punitive, and distress reaction subscales) and those subscales hypothesized to indicate positive parental emotion socialization practices (i.e., the expressive encouragement, emotion-focused coping, and problem-focused coping reaction subscales). Also, in following the cited study, the dismissing behaviors aggregate score was subtracted from the coaching behaviors aggregate score to provide a CCNES balance score. Similarly, following Valiente and colleagues (2006), we created a SEFQ balance score by subtracting the negative emotional behavior subscales of the SEFQ summed together (negative dominant emotion and negative submissive emotion) from the positive emotional behavior subscales summed together (positive dominant emotion and positive submissive emotion). Both balance scores have been used in previous studies as indicators of optimal socialization behaviors and expression in the home.

Finally, the total numbers of correct responses in both emotion knowledge tasks were summed to provide emotion expression and emotion situation knowledge scores (see Table 1).

### *Data analysis*

We used multiple imputation, as implemented in SAS Proc MI (SAS Institute, Cary, NC, USA), to address the relatively small amount of missing data in our study. Due to artifacts from participant

**Table 1**

Descriptive statistics for study variables

	Mean	SD	Range
Background variables			
1. Age (months)	59.05	5.36	48–68
Physiological variables			
2. Child baseline VT	6.38	1.30	3.23–8.32
3. Parent baseline VT	5.76	1.23	2.89–8.01
Emotion socialization variables			
4. CCNES coaching behaviors	16.85	1.75	12.92–20.50
5. CCNES dismissing behaviors	7.45	1.76	3.83–12.08
6. CCNES balance score	9.41	2.73	4.96–16.67
7. SEFQ balance score	5.87	1.99	1.48–9.10
Emotion knowledge variables			
8. Expression knowledge	17.0	2.59	9.0–21.0
9. Situation knowledge	23.5	3.46	16.0–29.0

movement and equipment malfunction, one child was missing VT data. There were no missing parent baseline VT, questionnaire, or child behavioral data.

To explore the effects of child age on our emotion knowledge variables, we computed bivariate correlations (see Table 2). Not surprisingly, age was related to both emotion expression knowledge,  $r = .33$ ,  $p < .05$ , and emotion situation knowledge,  $r = .32$ ,  $p < .05$ . On both measures, 5-year-olds scored higher than 4-year-olds: emotion expression knowledge,  $F(1, 40) = 5.74$ ,  $p < .05$ ; emotion situation knowledge,  $F(1, 40) = 8.13$ ,  $p < .01$ .

The first focus of our study was to probe the relationship between parents' physiological regulation and their socialization practices. Therefore, we conducted a series of correlations between parent baseline VT and CCNES and SEFQ scores. First, parent baseline VT was significantly correlated with both the CCNES balance score,  $r = .33$ ,  $p < .05$ , and the SEFQ balance score,  $r = .34$ ,  $p < .05$ , indicating that parents with better physiological regulation reported home environments that included a favorable balance of emotional interaction. In addition, the relationship between parent baseline VT and the CCNES coaching behaviors aggregate score was nearly significant,  $r = .29$ ,  $p = .06$ , indicating that parents with superior physiological profiles may be prone to more optimal socialization behaviors.

The second focus of our study was to examine the contribution of parents' socialization practices to their children's emotion knowledge. Therefore, we examined a series of correlations between parents' reports of their emotion socialization behaviors and children's performance on the emotion

**Table 2**

Intercorrelations among study variables

	2	3	4	5	6	7	8	9
Background variable								
Child age	.27	.22	.12	.01	.07	-.10	.33*	.32*
Physiological variables								
Child baseline VT		.04	.18	.07	.07	.15	.03	.04
Parent baseline VT			.29#	-.21	.33*	.34*	-.06	.30*
Emotion socialization variables								
CCNES coaching behaviors				-.21	.78**	.17	-.06	.15
CCNES dismissing behaviors					-.78**	-.18	-.31*	-.29#
CCNES balance score						.22	.17	.28#
SEFQ balance score							-.08	.07
Emotion knowledge variables								
Expression knowledge								.59**
Situation knowledge								—

Note.  $N = 42$ , # $p < .07$ , \* $p < .05$ , \*\* $p < .01$ .

knowledge tasks. The CCNES dismissing behaviors aggregate score correlated negatively with emotion expression knowledge,  $r = -.31$ ,  $p < .05$ , and its negative relationship with emotion situation knowledge approached significance,  $r = -.29$ ,  $p = .06$ . Specifically, parents who reported themselves as using negative emotion socialization behaviors had children who demonstrated less emotion knowledge. When entered into linear regression models (at the second step), CCNES dismissing behavior scores contributed 9% of the variance in emotion situation knowledge,  $\Delta R^2 = .087$ ,  $F = 4.16$ ,  $p < .05$ , and 10% of the variance in emotion expression knowledge,  $\Delta R^2 = .099$ ,  $F = 4.88$ ,  $p < .05$ , beyond that of age (entered at the first step). Also, the correlation between the CCNES balance score and emotion situation knowledge was nearly significant,  $r = .28$ ,  $p = .07$ , suggesting that parents who described more balance in their socialization behaviors had children who were more knowledgeable about emotion situations.

We conducted further correlational analyses to better understand the relationship between parent and child physiological regulation and child emotion knowledge. No significant relationships were found between child VT and either emotion knowledge measure. Parent baseline VT, however, was related to emotion situation knowledge,  $r = .30$ ,  $p = .05$ . Finally, parent baseline VT did not correlate with child baseline VT,  $r = .04$ ,  $p = .82$ .

## Discussion

The current study is the first to demonstrate links between parents' physiological regulation and their emotion socialization practices. Parents with higher resting VT reported more desirable emotion socialization behaviors. We also found that parents with high resting VT, indicative of better regulation abilities, had children who were more knowledgeable about emotional situations. In addition, replicating previous studies, we found relationships between parental emotion socialization and children's emotion knowledge. Parents who encouraged emotional expression in their children had children who were more knowledgeable about emotional situations.

The first focus of our study was to examine the link between parents' physiological regulation and their reported socialization behaviors. Parents who had higher resting VT, which is considered to be indicative of better regulatory abilities (Porges, 1995), scored higher on several measures of optimal socialization. Although these results are novel, they are consistent with theories hypothesizing a relationship between the vagal system and modulation of emotional reactivity and expression and with previous research showing a relationship between VT and other forms of behavioral regulation (for an example, see Porges et al., 1994). According to this research, when one is met with a physical, cognitive, or emotional challenge, high basal VT helps to minimize emotional reactivity, allowing attention toward environmental demands (Porges, 1995). Therefore, parents who themselves are better at regulating emotion may also be better able to focus their attention away from their own affective arousal and, thus, may more effectively socialize their children's emotional reactions under distressing circumstances and highly arousing positive events. Certain controversy does exist, however, regarding the underlying construct of VT and its measurement (Grossman & Kollai, 1993), preventing us from absolute understanding of the nature in which this physiological variable directly influences emotional behaviors.

We also sought to replicate previous literature and examine the effects of parental emotion socialization behaviors on children's development of emotion understanding. We found that parents' CCNES dismissing behavior scores were negatively related to their children's emotion expression and emotion situation knowledge, whereas the CCNES balance score was positively related to emotion situation knowledge. These results are generally consistent with the previous literature showing that parental socialization of emotion is linked to the development of emotional competence. For example, Denham and Kochanoff (2002) found that parental socialization behaviors, as measured by the CCNES, contribute to children's understanding of emotional expressions and situations. Similarly, Eisenberg, Fabes, and Murphy (1996) found that the CCNES predicted children's positive social functioning.

With respect to parents' emotional expressivity, some previous studies have reported a link between emotion expression in the family and child emotional competence. For example, Eisenberg and colleagues (1992) found that mothers' reports of emotional expression in their homes,

as indicated by the SEFQ, predicted appropriate emotional expression in their children. However, other studies (e.g., Garner & Power, 1996) have failed to find a significant link between the SEFQ and children's emotion knowledge. Our study also found no relationship between the SEFQ and children's emotion understanding. Thus, the findings of our study are generally in harmony with some of the literature on emotion socialization, although the literature itself is not entirely consistent.

We also found that parent VT was positively related to children's emotion situation knowledge. Our hypothesis is that this relationship is mediated by parents' socialization behaviors, as reflected most strongly in their CCNES balance scores. Nonetheless, the relationship between CCNES balance score and situation knowledge was not strong enough in our study to justify our formally testing a mediation model. However, we believe that the general pattern of our findings suggests that one might profitably proceed to further investigate these relationships, perhaps using larger sample sizes and a variety of other measures of emotion knowledge and parent socialization.

Consistent with previous studies (e.g., Bornstein & Suess, 2000), we found no relationship between parent and child VT. Therefore, our data do not suggest that parents' VT influences children's emotion knowledge through its effect on children's VT. Instead, as we suggested above, parents' regulation may affect the emotional competence of their children through their own emotional socialization behaviors. These positive socialization behaviors may lead children to develop better knowledge of emotion and, subsequently, better social and emotional competence.

The results of our study contribute to a growing body of literature examining the relationship between parental socialization and children's emotional development. However, some important limitations must be acknowledged. First, our relatively small sample size precluded using more sophisticated analytical techniques to probe relationships among our study variables. Second, only one primary caregiver was tested with each child participant, and the gender of that parent was not always constant. Possibly, a relationship between parent and child VT does exist but is more difficult to detect with limited data from a single family member. Also, given that slight differences have been found in the relationship between VT and temperament based on gender of the child (Eisenberg, Fabes 1996), there may also be similar differences between mothers and fathers. A final limitation involves the correlational nature of the bivariate relationships we found. Because correlations cannot specify the direction of causality, one might argue that emotion socialization behaviors or child emotion knowledge determines parent VT. This latter possibility is unlikely, however, given previous research showing that parent resting VT remains stable from 2 months to 5 years after the birth of the child (Bornstein & Suess, 2000). If parents' VT has stabilized before their child's birth, it seems reasonable to propose that parent VT later influences their child's development through its effect on the parents' own socialization behaviors. Nonetheless, future studies may further examine the genetic, physiological, and behavioral pathways through which parents affect their children's emotional development.

In conclusion, our study has suggested that parents' physiological regulation influences their emotion socialization behaviors and the emotion understanding of their children. By influencing children's emotion knowledge, parent socialization may indirectly—as well as directly—affect children's interaction with their teachers and peers during the preschool years. Thus, the current study highlighted the multiple pathways through which parents can affect the early social relationships formed by their children.

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