Maternal Interactive Style across Contexts: Relations to Emotional, Behavioral and Physiological Regulation during Toddlerhood[1]

By: Susan D. Calkins, Cynthia L. Smith, Kathryn L. Gill, and Mary C. Johnson

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Abstract:
Sixty-five mothers and their 24-month-old toddlers were observed in a series of laboratory procedures designed to assess relations between maternal interactive style and emotional, behavioral and physiological regulation. Emotional regulation was assessed by examining the child's behaviors (aggression, distraction, object focus) when confronted by three emotion-eliciting tasks. Behavioral regulation was measured by examining children's ability to comply to maternal requests and to inhibit behavior during a delay task. Physiological regulation was derived from children's cardiac vagal tone responses to emotionally-arousing situations. Maternal interactive style was assessed by examining mothers' strategies for child behavior management (negative controlling, positive guidance) during three mother-child tasks. Maternal behavior was related to regulation in each of the three domains. Negative maternal behavior was related to poor physiological regulation, less adaptive emotion regulation, and noncompliant behavior. Positive maternal behavior was correlated with compliance, but not with any of the physiological or emotional measures. These findings are discussed in terms of the adaptive value of self-regulation in early development, and the importance of identifying the causal relations between maternal behavior and child regulation.
Keywords: Maternal behavior; regulation; temperament; heart rate

Article:
One of the critical tasks of the toddler period is the acquisition of skills and abilities that will support autonomous and self-regulated behavior (Sroufe, 1996). Although self-regulatory behavior becomes more salient during toddlerhood, its roots may be found much earlier in development. Moreover, the mastery of earlier regulatory tasks becomes part of later competencies (Kopp, 1982; Sroufe, 1996). In early infancy, for example, these regulatory tasks include neural regulation of autonomic arousal (Porges, 1996) and state regulation related to sleep–wake cycles and states of attention (Derryberry & Rothbart, 1985; Parmelee & Sigman, 1983). In later infancy, regulatory tasks include the acquisition of primitive emotion regulating

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behaviors (Stifter & Braungart, 1995) and the establishment of a secure bond with primary caregivers that will support a balance between interaction within the family and exploration in the larger social world (Ainsworth, Blehar, Waters & Wall, 1978). By toddlerhood, the tasks for the child include development of a self-system (Cicchetti, Ganiban & Barnett, 1991) and the adoption of standards of behavioral control and compliance (Kopp, 1982). By the time the child has reached the end of the toddler period, there is the expectation that he or she is capable of emotional, behavioral, and physiological regulation that support an emergent independent identity and self-sufficient behavior (Cicchetti, Ganiban & Barnett, 1991; Kopp, 1982).

The notion that self-regulation may occur on several levels, or within domains such as emotion, behavior and physiology, has been discussed by various theorists (Cicchetti, 1996; Porges, 1996). These domains are likely to be interdependent components of a larger self-regulatory system. While there is a clear developmental progression in the acquisition of self-regulatory skills and abilities within these domains, there are also individual differences in the extent to which a child demonstrates competent regulation. These individual differences have been shown to have important implications for psychosocial adaptation and the acquisition of important develop- mental achievements (Sroufe, 1996). For example, within the emotional domain, the construct of emotion regulation and its role in adaptation has been examined quite extensively, particularly in the infancy period. Emotion regulation refers to processes that serve to manage emotional arousal and support adaptive social and non-social responses (Calkins, 1994; Thompson, 1994). Emotion regulation strategies such as self-comforting, help-seeking, and distraction may assist the child in managing early temperament-driven frustration and fear responses in situations where the control of negative emotions may be necessary (Stifter & Braungart, 1995). Moreover, emotion regulation skills may be useful in situations of positive affective arousal such that they allow the child to keep such arousal within a manageable and pleasurable range (Grolnick, Cosgrove & Bridges, 1996; Stifter & Moyer, 1991). Because the lack of emotion regulation skills contributes to aggressive or withdrawn behavior (Calkins, 1994; Eisenberg et al., 1993, 1994; Cicchetti, Ackerman & Izard, 1995; Rubin, Coplan, Fox & Calkins, 1995), failure to acquire these skills may lead to difficulties in areas such as social competence. Thus, the acquisition of emotion regulation skills is considered an important achievement of early childhood.

A second domain where the acquisition of particular regulation skills may be observed during infancy and particularly toddlerhood refers to the control and management of behavior and behavioral reactivity. Examples of behavioral management or control include compliance to maternal directives and the ability to control impulsive responses (Kopp, 1982; Kuczynski & Kochanska, 1995). Increasingly, these kinds of demands are placed on children during toddlerhood; the task is for the toddler to overcome impulsive reactions or to suspend desired activity to meet exter nal demands. Self-control is demonstrated when a child is able to comply with demands, delay specific activities, and monitor his own behavior. As the balance of control shifts from external regulation to internal regulation, the different dimensions of self-control begin to be exhibited more frequently and in situations when caregivers are not present (Kopp, 1982).

A third level of self-regulation that has recently been investigated refers to the infant or child's ability to control levels of autonomic or physiological arousal. One approach to the study of

physiological arousal and its behavioral correlates in infants and young children has been to examine heart rate variability. Although there are multiple ways to measure this variability, Porges and colleagues (1985, 1996; Porges & Byrne, 1992) have developed a method that measures the amplitude and period of the oscillations associated with inhalation and exhalation. Thus, this measure refers to the variability in heart rate that occurs at the frequency of breathing (respiratory sinus arrythmia, RSA) and is thought to reflect the parasympathetic influence on heart rate variability via the vagus nerve. Porges has termed this measure of heart rate variability vagal tone (Vna) (Porges & Byrne, 1992; Porges, 1996). In characterizing the theoretical relation between RSA and behavior, Porges has speculated that the vagal tone measure reflects appropriate reactivity to, and awareness of, one's environment (Porges, 1991). In a number of studies, baseline measures of cardiac Vna have been linked to temperamental reactivity (Gunnar, Porter, Wolf, Rigatuso & Larsen, 1995; Stifter & Fox, 1990).

In contrast to the research examining resting measures of Vna, several studies have examined a second dimension or measure of cardiac Vna—the degree to which an individual displays decreases in, or suppression of, Vna during an attention- demanding, emotion-eliciting, or cognitively-challenging task. Suppression of Vna during demanding tasks may be a physiological strategy that allows the child to shift focus from internal homeostatic demands to demands that require internal processing or the generation of coping strategies to control affective, cognitive or behavioral arousal (Calkins, 1997; DeGangi, DiPietro, Greenspan & Porges, 1991; Fracasso, Porges, Lamb, & Rosenberg, 1994; Porges, 1996). This ability may foster the development of adaptive behavioral strategies that influence early self-regulated behavior. Several studies demonstrate that the ability to suppress Vna during such situations is related to better state regulation in infancy (DeGangi et al., 1991), better emotion regulation and fewer behavior problems in preschool (Calkins, 1977; Porges, Doussard-Roosevelt, Portales & Greenspan, 1996), and sustained attention in school-age children (Suess, Porges & Plude, 1994).

Porges has recently speculated on the two functional roles of vagal tone (Porges et al., 1996). The vagal system, he argues, is structured to deal with both internal and external demands. During periods of low external or environmental stress, vagal tone works to promote homeostasis and activities related to growth, while in situations of environmental challenge, the vagal system works to regulate metabolic output such that the external demands may be met. The first of these two functions, homeostasis, may be indexed by steady state, or baseline, measures of Vna. Baseline cardiac Vna may be a measure of the individual's characteristic physiological state or level of arousal, and by extension, may reflect temperament (Calkins, 1997). In characterizing the second function of Vna, management of metabolic output, Porges has invoked the notion of the 'vagal brake.' During periods of stress or challenge, the vagus functions as a brake to regulate cardiac output (Porges, et al., 1996). Control of the vagal brake may be measured in terms of suppression or decreases in Vna in response to various types of environmental challenge. Appropriate responses to environmental challenges (whether the are cognitive, emotional or behavioral) may be reflected in the ability of the individual to regulate, manage and coordinate more complex emotional or behavioral responses to external stimuli (Porges, 1991, 1996), and such responses may be supported by vagal suppression.

Research that has been conducted with infants and young children suggests that by the time a child has reached the third year of life, important milestones in the acquisition of skills that serve

to manage emotional, behavioral and physiological reactivity have been attained. These include regulation of state, control of affective expression and experience via particular self-generated and caregiver provided strategies, and behaviors that support compliant responses to adult demands (Kopp, 1982; Cicchetti et al., 1991). In addition, important individual differences among toddlers may be displayed in each of these domains. One important assumption of much of the research on the acquisition of self-regulation is that parental caregiving practices may support or undermine such development and thus contribute to observed differences among toddlers (Thompson, 1994). In infancy, there is an almost exclusive reliance on parents for the regulation of emotion, and over time, interactions with parents in emotion-laden contexts teach children that the use of particular strategies may be more useful for the reduction of emotional arousal than other strategies. There is also evidence that infants rely on parents for help in regulating physiological arousal related to behavioral organization (Spangler & Grossman, 1993; Spangler, Schiechle, Ilg, Maier & Ackerman, 1994). Given the toddler's continued reliance on parents for emotional and behavioral support, there is reason to believe that this support may be observed at the level of physiology beyond the infancy period. Furthermore, it is clear that particular maternal strategies related to inhibition of impulses and compliance to external demands are potent external regulators that eventually become internalized during toddlerhood (Kopp, 1982). Thus, parental practices are related to individual differences in regulatory behavior at all stages of development (Cicchetti et al., 1991). Absent from the literature on the role of parenting behaviors in the display of early self-regulatory behavior is a comprehensive examination of the relation between parental behavior and regulation across different domains (emotional, behavioral, and physiological).

One dimension of mother-child interaction that may be important in the development of self-regulation is the pattern of child management that the parent may use as the child makes the transition to toddlerhood. During this transition, many of the interactions between parent and child may be marked by efforts of the parent either to exert control over the child or to support competent self-management as the child seeks autonomy and independence. Such parental practices may be observed in everyday interactions where the parent has opportunities for modeling and reinforcing the child's behaviors (Thompson, 1991). Several studies have found a relation between negative control and harsh discipline practices and the development of behavior problems characterized by a lack of behavioral control (Crockenberg, 1987; Pettit & Bates, 1989; Weiss, Dodge, Bates & Pettit, 1992). Negative and controlling behavior on the part of the mother may inhibit the development of child behaviors that will support autonomy when the mother is unavailable (Crockenberg & Littman, 1990). In addition, there is a growing consensus that positive interactions with parents are important for the development of competent psychosocial behavior; a lack of positive maternal interactions may be harmful to the child and hinder attempts at self-management (Petit & Bates, 1989). Maternal positive guidance, characterized by efforts to reinforce and support the child's attempts at autonomy, may contribute to the development of appropriate self-regulatory behavior. Thus, the goal of this study was to examine whether a mother's style of interacting with her child, across a variety of contexts, would be related to the child's tendency to use adaptive versus nonadaptive emotion regulatory behaviors, to display compliant behavior and impulse control, and to evidence appropriate physiological regulation.

The first specific question addressed in this study was whether maternal behavior that was characterized by positive guidance or negative control, would be consistent across different contexts. We were primarily interested in contexts that would be indicative of typical mother-child interactions, as opposed to those with explicit regulatory demands. If maternal behavior across different contexts is to show a relation to regulatory behavior in children, it is important to determine how consistent mothers are in their use of negative versus positive behaviors. We hypothesized that there would be a high degree of consistency in that mothers would use similar positive or negative strategies across contexts that differed in terms of the degree of structure imposed on the dyad.

The second issue we addressed was whether maternal behavior would be related to the display of self-regulation in several domains. Specifically, we examined whether maternal positive versus negative interactive behaviors would be related to (1) emotional regulation, (2) behavioral regulation, and (3) physiological regulation. We hypothesized that maternal positive strategies would be significantly related to the adaptive (distraction) versus nonadaptive (aggression or acting-out) strategies that children use to manage emotion, to the ability to control impulsive behavior and engage in compliant behavior, and to physiological regulation in the form of vagal suppression during emotional challenge. In contrast, we hypothesized that maternal negative behavior would be related to poor regulation in each of these domains.

The third issue we addressed in this study was the relation between maternal positive and negative interactive style and emotional, behavioral, and physiological reactivity. Reactivity refers to the latency, frequency, and duration of a particular response (Rothbart & Derryberry, 1982), and may be measured in terms of affective expressiveness, impulsivity, or physiological measures indicative of temperamental reactivity, such as baseline Vna. Regulation is often thought of as management or control of reactivity. While reactivity and regulation are likely to be related to one another, it is possible to examine them as separate dimensions of functioning. While numerous studies have examined the relations between reactivity and regulation, especially in the emotional domain (Grolnick, Bridges & Connell, 1996; Stifter & Braungart, 1995), few studies have examined relations between maternal style and reactivity. We hypothesized that emotional, behavioral, and physiological reactivity might be less influenced by maternal interactive behavior than regulatory behavior, given that reactivity is considered to be a temperamental characteristic that is influenced by inborn, biological tendencies (Rothbart & Derryberry, 1981). Thus, our final goal of the study was to compare the strength of the relation between maternal behavior and regulation to that between maternal behavior and reactivity.

METHOD

Sample

Sixty-five 24-month-old toddlers (35 females, 30 males) and their mothers from a small southeastern city participating in a larger longitudinal study were the subjects in this study. Recruitment letters were sent to a large number of families whose names were obtained from local birth records. Families who returned the brief questionnaire were contacted by telephone and asked to come to the laboratory for an individual assessment within two weeks of the child's 24-month birthday. Families were excluded if there were any prenatal or perinatal complications, if gestational age was less than 38 weeks (pre-term) or if the child's birth weight was less than 5 lbs. The families were primarily caucasian (7 African American, 1 Hispanic) and middle class

(mean Hollingshead (1975) Four-Factor Index score 42.29, range 11 to 66, with the majority in the medium business/professional category or the skilled craftsmen/ clerical category).

Procedures

Subjects were assessed in these procedures in the following order:

Collection of Heart Period. A research assistant placed three disposable pediatric electrodes in an inverted triangle pattern on the toddler's chest while the child was seated at a table. The electrodes were connected to a preamplifier, the output of which was processed through a vagal tone monitor (VTM-I, Delta Biometrics, Inc, Bethesda, MD) for R-wave detection. A data file containing the interbeat intervals (IBIs) for the entire period of collection was transferred to a laptop computer for later artifact editing (resulting from child movement) and analysis. Mothers were asked to limit interaction with their children during data collection.

During physiological recording, the child was observed during a 3-episode sequence which was videotaped for later coding. The baseline episode consisted of a five-min segment of the videotape 'Spot,' a short story about a puppy that explores its neighborhood. While this condition was not a true baseline given that the child's attention was engaged in an external stimuli, it was sufficient to keep the child sitting quietly and showing little affect. Given the ages of the subjects in this study, such a stimulus was necessary in order to keep the child seated at the table and to limit movement artifact in the heart rate data. Following the baseline episode, one experimenter engaged the child in a two-minute positive emotion puppet play episode—a game of peek-a-boo with a puppet named Spot. Next, the experimenter gave the child an attractive electronic musical toy with which to play for one minute. Then the experimenter took the toy away, placed it in a clear plastic box that the child was unable to open, and put the box on the table in front of the child. This negative emotion barrier episode lasted for two-minutes. These two emotion tasks are considered appropriate for use with young children, and are typ ically used to elicit measures of temperament and regulation (c.f. Goldsmith & Rothbart, 1993; Grolnick et al. 1996; Vaughn, Kopp & Krakow, 1984). For each of the heart rate tasks, the mother sat nearby and was asked to respond normally to the child but not to initiate interaction. Videotaped behavior was examined across the three episodes and is described below.

Following the collection of heart period data, the electrodes were removed from the child's chest, and he or she was free to move about the room. The following procedures took place.

Freeplay. The child was observed for ten min while engaged in toy play with several age-appropriate toys. The experimenter asked the mother to sit nearby and respond to her child as she normally would, but not to direct play.

Compliance task with mother. At the experimenter's cue (a tap on the mirror), the mother asked her child to help her clean up the room by placing the toys in a toy box. Mothers were instructed to use whatever strategies they might use at home during the five min period.

Structured toy play with mother: Musical toy. The experimenter gave the mother a musical toy that played farm animal sounds and songs and asked her to show her child how the toy worked and to play with the child for a period of three min.

Impulsivity Task: Crayon delay. The experimenter asked the child if he would like to color, and provided the child with a box of large crayons and a sheet of paper. The experimenter told the child that she had to leave the room for a moment, and asked the child not to touch the crayons until she returned. The experimenter asked the mother to sit nearby and respond to her child as she normally would but not to initiate interaction. This episode lasted for two min.

Negative emotion task: High chair restraint. The experimenter placed the child in a high chair and told the child to wait for the experimenter to return to the room with a special toy. The mother sat nearby and was asked to respond normally to the child but not to initiate interaction. This episode lasted for 5 min, after which the child was removed from the high chair.

Teaching task with mother. After asking the mother and child to sit on the floor, the experimenter gave the mother two puzzles and instructed the mother to teach the child to do the puzzles using whatever strategies she might at home. This episode lasted for a period of four min.

Pretend play with mother. While the mother and child were seated on the floor, the experimenter gave the mother a Sesame Street farm toy and asked the mother to play with her child as she might at home for a period of four min.

Compliance task: **Stop play**. At the experimenter's cue (a tap on the one-way mirror), the mother asked her child if s/he would stop playing with the farm and join her to read books on the sofa away from the toy. Mothers were instructed to use what- ever strategies during the two min compliance period that they might use at home to encourage their child to stop one activity and begin another.

Measures

Of particular interest from the eleven episodes were (1) maternal behavior during the mother-child tasks, (2) physiological reactivity during the baseline collection of heart rate and physiological regulation during the positive emotion puppet play and negative emotion barrier heart rate episodes, (3) behavioral regulation during the compliance and impulsivity episodes and behavioral reactivity during the impulsivity task, and (4) emotional reactivity and emotion regulatory behaviors during the positive (puppet play) and negative (barrier and restraint) emotion tasks.

Two coders were involved in the scoring of the maternal data, while two separate coders were involved in the scoring of the regulation data. The coders trained to reliability by working together on 10% of the videotaped sessions, and independently scoring an additional 10% of the videotapes for the purpose of calculating reliability. Reliability is reported below for each set of behavioral measures.

Maternal Interactive Style. Two broad categories of maternal behavior were scored during the mother-child tasks (structured play, teaching task, pretend play). Each maternal conversation turn and every instance of maternal physical activity directed toward the child was scored. Maternal negative control was a summary score reflecting (1) frequency of scolding, anger expressions,

derogatory remarks directed to child, threats, no's (negative control); (2) frequency of restricting child's movement, pulling, pushing, picking child up, hand slapping (physical control) and (3) frequency of directing the child's activity, telling the child what to do (verbal control).

Maternal positive guidance was a summary score reflecting (1) frequency of praise, affection, laughter (praise); (2) frequency of behaviors demonstrating an act for the child (show); and (3) frequency of positive feedback, encouragement, suggestions (guidance). Each of the summary scores from each individual mother-child task was then standardized for later use in cross-episode summary scores. Scoring reliability for the behaviors comprising the three styles of behavior were computed using Pearson correlations and ranged from .81 to .97. Descriptive statistics for these measures for each of the three episodes appear in Table 1.

Reactivity measures. Measures of physiological, emotional and behavioral reactivity were generated from the 11 episodes. To generate measures of physiological

Table 1. Descriptive Statistics (Frequencies) for Maternal Variables for Three Tasks and for Negative and Positive Summary Scores

Variable	*M*	*SD*	Minimum	Maximum	*n*
Structured Play					
Positive Guidance					
Praise	.48	.94	.0	5.0	65
Show	6.63	4.04	.0	18.0	65
Guidance	4.05	3.25	.0	16.0	65
Negative Control					
Physical control	1.46	2.11	.0	8.0	65
Negative control	.62	1.11	.0	6.0	65
Control	6.82	4.65	.0	20.0	65
Teaching Task					
Positive Guidance					
Praise	7.03	4.92	.0	20.0	65
Show	11.89	5.08	1.0	30.0	65
Guidance	14.26	5.21	.0	27.0	65
Negative Control					
Physical control	.71	1.25	.0	6.0	65
Negative control	1.03	1.95	.0	9.0	65
Control	10.12	7.51	.0	34.0	65
Pretend Play					
Positive Guidance					
Praise	.78	1.53	.0	8.0	64
Show	10.23	4.86	1.0	25.0	64
Guidance	6.23	3.72	.0	18.0	64
Negative Control					
Physical control	.30	.89	.0	5.0	64
Negative control	.28	.68	.0	3.0	64
Control	4.36	3.99	.0	21.0	64
Summary Variables for Maternal Measures					
Positive	−.01	2.24	−3.17	6.52	64
Negative	.02	2.34	−4.23	6.90	64

reactivity, the baseline heart rate IBI files were edited and analyzed using MXEDIT software (Delta Biometrics, Bethesda, MD). Analysis of the data consisted of applying the Porges (1985) method of calculating Vna. Heart period and Vna were calculated every 30 sec for the five min baseline period. These measures indexed physiological reactivity and were used in subsequent analyses. Three children were eliminated from analyses involving heart rate because they refused to allow the experimenter to place the electrodes.

Emotional reactivity was scored from the videotaped episodes using a computer- based coding system (Observational Coding System (OCS), Triangle Research Corporation, Chapel Hill, NC). This system allows the coder to specify behaviors that will be scored by assigning a key to each code. The videotape is viewed and the key onset and offset times for each behavior indicates the latency, frequency and duration of particular behaviors. To generate measures of emotional

reactivity, the tapes were scanned for the latency to smile or fuss and the duration of smiling, and fussing for the baseline, positive puppet play, and negative (barrier and high chair) tasks.

Measures of latency and duration of responding are hypothesized to capture differences among children across a variety of temperamental and emotional dimensions (Rothbart & Derryberry, 1981). The facial and vocal emotion displays were coded using a scheme appropriate for use with toddlers (Cole, Barret & Zahn- Waxler, 1992). Criteria for smiling included raised lip corners and cheeks and crinkling at eye corners. Criteria for fussing included sounds associated with either sadness or anger—low volume, soft moan or groan or high pitch, high volume sound with harsh quality. Fuss included non-word sounds, as well as words that were uttered in a fussy tone. Two coders trained to reliability by scoring five complete videotapes together, and then separately scoring five tapes. Questions were resolved by joint review and discussion. Reliability, using Pearson correlations, for the latency and duration of the affect measures were .90 (duration of smiling) and .97 (duration of fussing).

Mean duration of smiling for the four episodes (baseline, positive, negative barrier, negative high chair) was: 9.04, 35.11, 2.64, 12.69 sec. respectively. Mean duration of fussing for the four episodes (baseline, positive, negative barrier, negative high chair) was: 4.17, 3.62, 11.24, 47.38 sec. respectively. Comparison of the episodes in terms of the proportion of time the child spent displaying negative versus positive affect indicated that there was more smiling in the positive episode than in the base-line episode ($t(64) = -10.92$, $p < .001$), the negative barrier episode ($t(59) = -11.3\,1$, $p < .001$) and the negative high chair episode ($t(50) = 9.26$, $p < .001$). And more fussing occurred in the negative barrier and high chair episode than in the baseline episodes ($t(59) = 3.64$, $p < .001$ and $t(59) = 5.65$, $p < .001$, respectively), and the positive episode ($t(59) = 3.56$, $p < .001$ and $t(52) = 5.46$, $p < .001$, respectively). Thus, the baseline, positive and negative (barrier and high chair) episodes seemed to generate the appropriate differences in affect.

In subsequent analyses, emotional reactivity was indexed by (1) puppet play positive emotional reactivity—the duration of smiling measure for the positive episode; (2) barrier negative emotional reactivity—a summary score of the standardized reversed latency to fuss measure plus the standardized duration of fussing measure for the negative episode (these two measures were correlated $r = -.5\,1$, $p < .001$); and high chair restraint negative emotional reactivity—a summary score of the standardized reversed latency to fuss measure plus the standardized duration of fussing measure for the negative episode (these two measures were correlated $r = -.59$, $p < .001$). It should be noted that most children ($n = 44$ for barrier task, $n = 33$ for high chair task) did not become distressed to the negative emotion elicitors and that most children ($n = 61$) smiled to the puppet play task.

Behavioral reactivity was scored during the crayon delay task as impulsivity, or the latency to touch the crayons for the delay episode. Reliability on this measure was .98. Thirty of the 65 children did not touch the crayons during the two-min delay while six children touched the crayons immediately. Across the entire sample, the mean delay time was 69.77 sec (s.d. = 52.70).

Physiological regulation measures. To generate measures of physiological regutation we calculated measures of change or suppression in Vna by subtracting the positive and negative episode Vna from the baseline Vna. Thus, a positive difference score indicated that there was a

decrease in, or suppression of, Vna during the particular affect task. The negative task suppression score was also calculated by subtracting the episode measure from the baseline; although there may have been some contamination from the positive episode, it is important to calculate the child's response to the negative task from a resting state. Extensive artifact editing, due to excessive child movement, was required on the data files from 7 children during the positive affect elicitor and 10 children during the negative affect elicitor, and these data were eliminated from subsequent analyses. Descriptive statistics for the three episodes (baseline, positive puppet, negative barrier) and the two suppression scores (positive and negative) are presented in Table 2.

Table 2. Descriptive Statistics for Physiological Reactivity and Regulation: Vagal Tone across Baseline, Positive, and Negative tasks, and Suppression from Baseline to Positive and to Negative

Variable	*M*	*SD*	Minimum	Maximum	*n*
Baseline	5.36	1.22	2.13	8.27	62
Positive	4.98	1.19	2.39	7.22	56
Negative	4.60	1.13	1.14	6.87	52
Suppression (Positive)	.33	.77	–2.42	2.19	56
Suppression (Negative)	.72	.71	–.52	2.61	52

Emotional regulation measures. To generate measures of emotional regulation, the videotaped affect episodes (positive, negative barrier, negative high chair) were scored using the computer-based coding system. The tapes were coded for the dura- tion of time, during each of the three episodes, the child spent orienting toward task object (looking, touching puppet, box, high chair), distraction (orienting to mother, self or other objects in the room) and aggression/venting-banging, kicking, throwing, hitting the object of frustration (box, high chair). These types of regulatory strategies or behaviors are similar to those which are used in studies of infant and toddler emotion regulation (Stifter & Braungart, 1995). Moreover, the behaviors were used for these tasks because they are the kinds of behaviors that may alter the child's experience of affect in a given situation. For example, during a negative affect task such as the barrier task that is nearly impossible to solve, focusing on the denied object or aggressing/venting might be less adaptive strategies because they increase the level of frustration. Distraction was coded because these kinds of behaviors should serve to decrease the experience of negative affect. Coding reliability for these three categories of behavior across the three tasks ranged from .84 (orienting to focal object) to .96 (distraction).

Behavioral regulation measures. To generate measures of behavioral regulation, child behavior during the compliance tasks and the impulsivity task was scored. From the clean-up and stop play episodes, the frequency of the following behaviors was scored by viewing the videotape and scoring the child's behavior in response to maternal requests (1) active non-compliance—summary score of defiant responses (intensifying negative behavior, doing what mother asked child not to, expressing aggression) and anger in response to a maternal request or demand; (2) passive non- compliance—summary score of ignoring maternal requests and high amounts of off- task behavior (behaviors which indicated that the child was not cleaning up the toys, such as

playing or wandering around the room), and (3) compliance—summary score of compliant responses to maternal requests (doing what the mother asks or responding to the mother's requests within the 10 sec interval), number of toys placed in toybox and time to clean-up (reversed). Coding reliability for these measures across the two tasks ranged from .76 (defiance) to .95 (compliance).

The impulsivity task was scored, using the same computer program as for the emotion regulation tasks, for the duration of time the child focused on the crayons (looking, touching), engaged in distraction (orienting to mother, other objects, self), and displayed aggressive or venting behaviors. Scoring reliability for these three behaviors were: .84, .89 and .94.

RESULTS

The approach to data analysis was to address the three questions posed earlier: the consistency of maternal behavior, and the relations of maternal behavior to toddler reactivity and regulation across the emotional, physiological, and behavioral domains. First, however, we conducted a series of t-test to examine possible sex differences in terms of maternal behavior, reactivity, and regulation. No such differences were found on any of these measures. In addition, we conducted each of the correlational analyses described below separately by sex to determine whether differing relations emerged for boys versus girls. Where significant differences between the magnitude of correlations for boys versus girls were apparent, they are reported. Otherwise, the analyses are reported for both sexes. Prior to addressing the main questions of the study, we examined the reactivity and regulation data for relations between and among these measures.

Preliminary analyses: Relations between reactivity and regulation.

Correlations between the physiological reactivity and regulation measures indicated significant relations between the two: baseline Vna was correlated with suppression during the positive puppet play task ($r = .37$, $p < .01$) and the negative barrier task ($r = .46$, $p < .001$). In comparing the reactivity measures (positive reactivity for puppet play, and negative reactivity for barrier and high chair) to the regulation measures, we observed several significant correlations. For the puppet task, focusing on the puppet was negatively related to smiling ($r = -.25$, $p < .05$). For the barrier episode, negative reactivity was negatively related to distraction ($r = -.28$, $p < .05$) and positively related to aggression/venting ($r = .35$, $p < .01$). For the high chair episode, negative reactivity was again positively related to aggression/venting ($r = .58$, $p < .001$ and negatively related to distraction ($r = -.33$, $p < .01$). Thus, consistent with previous research, emotional reactivity is related to the display of emotion regulation behaviors (Stifter & Braungart, 1995). In comparing the reactivity measure (latency to touch crayons) to the regulation measures, we observed that crayon focus strategy was the only measure significantly related ($r = -.29$, $p < .05$). The more the child focused on the crayon, the shorter was the latency to touch the crayons.

Preliminary analyses: Relations among types of regulation

To examine the relations among types of regulation, we examined the intercorrelations across emotional, behavioral and physiological regulation measures. These analyses indicated that there were modest relations between physiological regulation and emotional and behavioral regulation, but not between emotional and behavioral regulation. Vagal suppression during the negative barrier task was related to aggression/venting during both negative tasks ($r = -.29$, $p < .05$, $r = -.25$, $p < .10$ for the barrier and high chair respectively) and to distraction during the barrier task

(r = .26, p < .10). Vagal suppression during the negative barrier task was also correlated with compliance during the clean-up tasks (r = .26, p < .1 0) and during the stop play task (r = .23, p < .10). Given the modest relations across domains of regulation, we examined the relations between maternal behavior and regulation separately for each domain.

Consistency of Maternal Behaviors across structured play, teaching task and pretend play episodes

To examine the issue of consistency of maternal positive and negative behavior, we examined cross episode correlations among the three positive and three negative maternal measures. These correlations are presented in Table 3.

Table 3. Cross-episode correlations for maternal interactive style (positive guidance and negative control)

	Teaching task	Pretend play
Positive Guidance:		
Structured play	.41**	.43**
Teaching task		.39**
Pretend play		
Negative control:		
Structured Play	.48**	.30*
Teaching task		.25*
Pretend play		

** $p < .01$
* $p < .05$

As the table indicates, there was moderate consistency in terms of maternal positive behavior across the three maternal tasks; mothers who displayed high amounts of praise and guidance in one task tended to show high amounts in other tasks. There was also consistency in maternal negative behavior across the three tasks. Mothers who displayed a high amount of negative and controlling behavior in the structured toy task tended to show a high amount during the teaching task. Consistency in maternal negative behavior was more modest, though still significant, between the structured toy play and teaching and pretend play tasks.

Given the degree of cross-task consistency that was observed, we computed two summary scores (positive and negative) by standardizing and summing the episode scores. These episode scores also appear in Table 1. Cronbach's alphas were computed on the positive (.68) and negative summary scale scores (.64), and were deemed acceptable to warrant the use of the summary scores in subsequent analyses. The measures of maternal positive and maternal negative behavior were not significantly correlated (r = —.04).

Maternal Interactive Style and Emotional Regulation

To examine the relations between maternal interactive style and emotional regulation, correlational analyses were conducted between the emotion regulation measures (focal object, distraction, and venting) from the positive and negative (barrier and high chair) tasks and the two summary scores representing maternal positive guidance and negative control. These analyses indicated that maternal negative control was positively correlated with time spent orienting to the focal object (r = .28, p = .03) and negatively correlated with distraction during the negative

emotion barrier episode (r = —.26, p = .05). Maternal negative control was also negatively correlated with distraction during the high chair task (r = —.31, p = .03). There was no relation between any of the maternal measures and the emotion regulation measures from the positive affect episode.

Maternal Interactive Style and Behavioral Regulation

To examine the relations between maternal interactive style and behavioral regulation, correlational analyses were conducted between the regulation measures from the compliance (clean-up and stop play) tasks and the impulsivity (crayon delay) task and the two summary scores representing maternal positive guidance and negative control.

As Table 4 indicates, mothers who engaged in high amounts of positive guidance during structured and unstructured play had toddlers who were more compliant during the clean-up task and the stop play task. Mothers whose behavior was more negative during the play interactions with their toddlers also had children who were compliant, but these children also tended to engage in more passive non-compliance. In addition, children of mothers who used negative and controlling behavior tended to focus on the crayons during the delay task and were less likely to engage in distraction.

Sex differences in the association between maternal and child behavior were apparent for some of the behavioral regulation tasks, as can be seen in Table 4. While no sex differences in mother-child associations were found for the impulsivity task, sex differences did emerge in both compliance tasks (clean-up and stop play).

Table 4. Correlations between maternal positive and negative behavior and measures of behavioral regulation during compliance (reported separately by sex) and delay tasks

	Combined		Boys		Girls	
	Maternal positive	Maternal negative	Maternal positive	Maternal negative	Maternal positive	Maternal negative
Compliance 1: Clean-up						
Comply	.38**	.28*	.37**	.23	.23	.47**
Active non-compliance	.01	–.10	.03	.01	–.07	–.33*
Passive non-compliance	–.01	.30*	.04	.51**	–.02	–.21
Compliance 2: Stop play						
Comply	.08	.22	.10	–.19	.05	.46**
Active non-compliance	–.08	–.06	–.10	–.09	–.10	–.21
Passive non-compliance	–.16	.22	–.23	.39**	.06	.10
Impulsivity Task						
Focal object (crayons)	.08	.32*				
Distraction	.24	–.28*				
Vent	–.16	.21				

** $p < .01$
* $p < .05$

For boys, maternal positive behavior was significantly correlated with compliance in the clean-up task. Also, for both compliance tasks, boys' passive noncompliance was correlated with

maternal negative behavior. For girls, maternal negative behavior was significantly associated with compliance in both tasks and negatively correlated with active non-compliance in the clean-up task. Thus, maternal negative and controlling behavior was differentially related to compliant versus non-compliant behavior among girls and boys.

Maternal Interactive Style and Physiological Regulation

To examine the relations between maternal behavior and physiological regulation during the positive and negative (barrier) affect tasks, we examined correlations between maternal positive and negative behavior and vagal suppression during the positive and negative tasks. These analyses indicated that maternal positive guidance was not significantly correlated with physiological regulation during either the positive or negative emotion tasks. However, there was a significant correlation between maternal negative control and vagal suppression during the positive affect episode (r = —.32, p = .02). Higher amounts of maternal negative and controlling behavior was significantly related to lower suppression, or poorer regulation, during the puppet play positive emotion task.

Maternal Interactive Style and Physiological, Emotional and Behavioral Reactivity

The last issue we addressed in this study was whether maternal interactive style was related to the degree of emotional, physiological and behavioral reactivity displayed by the children during the regulation tasks. To answer this question, we computed correlations between maternal positive guidance and negative control and (1) base- line Vna, (2) positive emotionality during the puppet play task and negative emotionality during the barrier task and the high chair restraint tasks and (3) impulsivity during the crayon delay task. These analyses indicated that maternal behavior was not significantly correlated with any of the reactivity measures; thus, measures of the child's dispositional tendencies showed no significant relation to maternal interactive style.

DISCUSSION

The aim of this study was to explore the relation between maternal interactive style during the toddler period and the display of self-regulatory behaviors in three separate domains. Maternal interactive style was examined in situations that were separate and different from the contexts that elicited emotional, behavioral, and physiological regulation. The goal of the study was to characterize the way in which maternal interactive style is related to young children's display of the skills and strategies that underlie autonomous behavior during the transition from infancy to early childhood. Based on previous studies demonstrating relations between maternal behavior characterized by controlling and punitive behavior and child noncompliance and problem behavior (Crockenberg, 1987; Pettit & Bates, 1989; Weiss et al., 1992), we hypothesized that this pattern of maternal behavior would be related to maladaptive patterns of self-regulation (poor vagal suppression, problem-focused emotion regulation behaviors, and non-compliance). In addition, we examined the relations between maternal positive behavior and regulatory behavior. There has been less research on the influence of positive guidance techniques; however, we hypothesized that such behavior would be related to adaptive patterns of regulation. Finally, we also hypothesized that maternal behavior would be related to regulation in different domains, but not to reactivity to the stimuli that were designed to elicit regulatory efforts by the child.

The first issue we examined in this study was the consistency of maternal behavior, in terms of negative and positive strategies, across contexts that varied in terms of the degree of the structure of the task. The data indicated significant cross-context consistency in terms of both negative and controlling types of behaviors and in terms of behavior indicative of positive guidance. Thus, mothers appear to display styles of interacting with their children that are fairly consistent despite greater or lesser constraints on their interactions.

The next question we addressed was whether these styles were related to the display of self-regulation across several domains. Given the degree of stability of maternal behavior that was observed, we created summary scores to reflect maternal behavior and compared these negative and positive scores to emotional, physiological and behavioral regulation. The analyses with respect to emotion regulation strategies indicated that maternal negative behavior was related to the use of orienting to or manipulating the object of frustration (the barrier-box) and negatively related to the use of distraction techniques. The ability to control attention and engage in distraction (such that ruminating over the object of denial is minimized) has been related to the experience of less emotional arousal and reactivity (Calkins, 1997; Grolnick et al., 1996). These data support the notion that maternal behavior is related to the child's ability to engage in adaptive and functional emotion regulating strategies. Mothers demonstrating controlling behavior in contexts that do not explicitly require the regulation of emotions, but are nonetheless contexts for acquiring self-regulatory behavior, had children who employed nonadaptive strategies when in the situations where they had to regulate their emotions. Perhaps because their mothers typically exert significant control over the children's behavior, these children may not have a repertoire of optimal regulation strategies. The children may be used to depending on external regulation and, therefore, do not have adaptive internal regulation strategies to rely on in situations where the mother is not playing a strong role, such as the emotion regulation tasks in the present study.

A number of significant findings emerged in the analysis of the relations between maternal behavior and behavioral regulation. First, both maternal negative behavior and maternal positive behavior were related to compliant responses of the children. Given the fact that we have no way of knowing the direction of effects in this relationship, interpretation of these findings is complex. It is possible, though, that it is the case that both negative and positive styles of interaction lead to compliance in children—although whether the child complies out of fear of punishment or because he or she has developed particular coping skills is still unknown. Similar to other results within the compliance literature (e.g. Crockenberg & Littman, 1990), maternal negative behavior was also related to passive non-compliance—behavior that it characterized by simply ignoring the mother and being off-task. The results examining these relations separately by sex help to explain these findings. For boys, maternal positive behavior was related to compliance, and negative maternal behavior was related to passive non-compliance. However, for girls, negative maternal behavior was associated with compliance and negatively associated with active non- compliance. There are few data in the compliance literature that offer a clear explanation of these sex differences. In general, this literature finds that girls are easier to control than boys (Kuczynski & Kochanska, 1990). Girls may be acting out of fear of punishment, while boys may be motivated to ignore the demands of their mothers and elicit more negative and controlling behavior on the part of the mother. However, why they react this way to maternal behavior is a question that requires further study.

With respect to our examination of the relation between maternal behavior and physiological regulation, one significant finding emerged. Maternal negative and controlling behavior was related to physiological regulation during the positive emotion eliciting task (puppet play with the experimenter). Mothers who used more negative and controlling behavior had toddlers who showed less suppression, indicative of poorer physiological regulation, during the puppet task. Maternal positive behavior was not related to suppression in either the positive or negative task. In a previous study with preschoolers, physiological regulation was associated with more interaction with the puppet during a similar task (Calkins, 1997). Such physiological regulation is thought to reflect attentional control; attention to particular aspects of the task (the puppet versus other objects in the room) is likely used in the service of increasing or decreasing particular felt affects (Calkins, 1997). The observation that maternal behavior is related to physiological regulation is consistent with other research on young children indicating that maternal behavior is related to biobehavioral regulation (Spangler et al., 1994). Again, children demonstrating poor regulation may be used to having more external regulation from mothers and do not demonstrate adaptive physiological regulation when mothers are not playing a strong role in helping their children's regulation. Physiological regulation during the negative emotion eliciting task (barrier) was not related to maternal behavior. It should be noted that the derivation and use of the vagal suppression measure as an index of regulation during emotion-eliciting situations is still somewhat exploratory. Consequently, it may not be correlated with maternal behavior in the same way that more traditional measures of behavioral and emotional regulation are.

Within the domains of both emotion regulation and physiological regulation, we expected that positive maternal behaviors would be associated with adaptive child regulation strategies. For the most part, this association was not found. A certain level of positive, guiding and reinforcing behavior may be necessary to provide benefits to child regulation. The mothers in this sample, the majority of whom are middle class, showed a high level of the kinds of positive behaviors hypothesized to be important to the development of adaptive regulation. In fact, the mothers showed more positive behavior than negative behavior in every task, so the effects of negative maternal behavior may be more potent than the effects of positive behavior. It should be noted, as well, that the maternal negative variable was likely driven more by maternal directive behavior, which may not be viewed as entirely negative, than by the other types of negative behavior. The nature of the influence of maternal positive behavior needs to be more fully examined in future investigations with samples where frequencies of positive maternal behaviors are low as well as high.

The third issue we examined in this study was whether there would be a relation between maternal behavior and reactivity across the domains of emotional, behavioral, and physiological reactivity. Our hypothesis was that, in contrast to the significant relations between maternal behavior and regulation, there would be little relation between reactivity and maternal behavior. This hypothesis was supported in that the data indicate that there was no relation between maternal behavior and negative reactivity during the barrier and high chair task or between maternal behavior and positive emotional reactivity during the puppet play. Similarly, there was no relation between maternal behavior and baseline measures of vagal tone or between maternal behavior and the measure of impulsivity during the crayon delay task. Each of these measures in

the three domains may be thought of as reflecting temperament; thus the null findings may reflect the fact that maternal behavior does not influence the display of particular temperamental dimensions, but rather, affects the way the child manages, or regulates, that reactivity. It should be noted, however, that there was little variability in the emotional reactivity measures, which may be another explanation for the lack of observed relations.

This study is a first step toward a better understanding of the complex ways that maternal behavior may affect child functioning. While most studies of the relations between maternal behavior and regulation have focused on emotion regulation during the infancy period, this study has emphasized that important accomplishments are displayed during the toddler period. In addition, it is important to recognize that emotion regulation may be only one type of regulation, or one domain where regulation is emerging, that is important at this age. Studies relating physiological regulation to both social and non-social functioning (Porges et al., 1996) suggest that this may be an important dimension to explore. Critical developments in behavior control and regulation that occur during this period should be observed as well. As children enter preschool and kindergarten, the ability to manage one's responses to external demands will likely be an important predictor of successful adaptation.

The second important contribution of this study is the effort made to examinematernal behavior in contexts separate from that which elicits regulation. First, it is important to understand the independent contribution of maternal behavior to childregulation. Second, it must be recognized that mothers interact with their children insituations with not-so-explicit regulatory demands. Clearly these kinds of structuredand non-structured interactions, occurring as they do quite frequently during toddlerhood, are influential in children's development. Yet, there have been few efforts to examine them.

There are a number of issues that need to be addressed to understand better the factors that affect the use of adaptive versus nonadaptive regulation behaviors during toddlerhood. This study has a number of limitations that make the conclusions we have drawn somewhat tentative. First, the associations we observed between maternal behavior and self-regulation were modest. In all likelihood, there are multiple factors that influence the display of adaptive or maladaptive regulatory behaviors. In this study, we examined only one such factor: maternal behavior. And, while maternal behavior accounts for a significant portion of the variance in regulatory behavior, other factors (temperamental or emotional reactivity, for example) are also involved in the acquisition and display of regulatory skills. Second, the study is limited in that the data are generated in a single laboratory visit. Multiple assessments, multiple sources of information (parent report of coping, for example), and naturalistic observations of everyday behaviors with no constraints on maternal behavior would clearly strengthen this study. Another major issue that should be addressed further is the question of how maternal behavior affects the development of regulation skills. In this study, we can only speculate on the direction of effects between mother and child behavior. Future studies should be both longitudinal and multi-component in order to address questions of development.

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