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Parental Expressivity, Child Physiological and Behavioral Regulation, and Child Adjustment: Testing a Three-Path Mediation Model

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Parental Expressivity, Child Physiological and Behavioral Regulation, and Child Adjustment: Testing a Three-Path Mediation Model

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Research Findings: Parental expressivity, child physiological regulation (indexed by respiratory sinus arrhythmia suppression), child behavioral regulation, and child adjustment outcomes were examined in 45 children (M age = 4.32 years, SD = 1.30) and their parents. With the exception of child adjustment (i.e., internalizing and externalizing problems and adaptive skills), which were assessed with parents' ratings, all variables were observed behaviorally or physiologically. A 3-path mediation path model was tested with the relations between parental expressivity and child adjustment outcomes mediated through child physiological regulation and behavioral regulation. Despite low power to detect the mediated effect, there was evidence to suggest that physiological regulation and behavioral regulation were 2 mediating mechanisms by which parental high positive/low negative expressivity may influence adaptive skills. Thus, parental expressivity may shape children's physiological regulation. And physiological regulation may be 1 mechanism by which effortful control becomes manifested as behavioral regulation that becomes apparent to others who then make evaluations about individuals' adaptive skills. *Practice or Policy:* The results have

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implications for interventions aimed at parent training or parental coaching of emotion as well as interventions aimed at enhancing children's social-emotional or behavioral regulation to improve children's adaptive skills.

Self-regulation has been defined as "the internally-directed capacity to regulate affect, attention, and behavior to respond effectively to both internal and environmental demands" (Raffaelli, Crockett, & Shen, 2005, pp. 54–55). In early childhood research in particular, self-regulation has been conceptualized as being part of the temperament system (Eisenberg et al., 1995; Liew, McTigue, Barrois, & Hughes, 2008; Posner & Rothbart, 2000). *Temperament* refers to early and stable individual differences in emotional, attentional, and behavioral inclinations toward acting and reacting (Derryberry & Rothbart, 1997) and has been viewed as the basic emotional and behavioral building blocks that provide the developmental foundations for complex adaptive skills and social-emotional or behavioral adjustment (Lahey, 2004). Because temperament stems from constitutional or genetic endowment from biological parents (although temperament is continually shaped by children's experience in the environment), children's parents are expected to have an influence in shaping children's temperamental self-regulation. In the present study, a three-path mediation model is tested to understand the underlying mechanisms of children's self-regulation and social-emotional adjustment. Specifically, parental expressivity is expected to predict children's physiological and then behavioral regulation, which then predicts children's adaptive or maladaptive behaviors.

EFFORTFUL CONTROL

One important aspect of temperamental self-regulation is effortful control. *Effortful control* refers to the volitional aspect of self-regulation and is defined as the ability to voluntarily inhibit a dominant (physiological, attentional, or behavioral) response to activate a subdominant response (Rothbart & Bates, 2006). Effortful control is linked with executive attention and executive functioning (Sheese, Rothbart, Posner, White, & Fraundorf, 2008) and has been used to describe the volitional or voluntary aspect of self-regulatory processes. For example, children demonstrate effortful control by doing something they need to do over something they prefer to do. Parents' ratings of children's effortful control have been predictive of observed socially appropriate behavior as well as low behavior problems and high social competence (Liew, Eisenberg, & Reiser, 2004). Similar patterns of findings for a positive relation

between parent-rated effortful control and social competence or low problem behaviors have been found in other studies (e.g., Eisenberg, Zhou, et al., 2005; Zhou et al., 2007). Research with behavioral and questionnaire measures of effortful control often suggests that older children and girls tend to score higher on self-regulatory and effortful control skills in early childhood (Eisenberg, Zhou, et al., 2003; Kochanska, Murray, & Harlan, 2000; Liew et al., 2004; Stifter & Spinrad, 2002), with no strong gender or age differences found with physiological measures (Blair, 2003; Blair & Peters, 2003; Hastings et al., 2008).

Physiological Regulation and Adjustment

Physiological measures such as cardiac vagal suppression have been used to assess self-regulatory capacities (Porges, Doussard-Roosevelt, & Maiti, 1994). Vagal suppression is often measured with a cardiorespiratory measure called respiratory sinus arrhythmia (RSA; Grossman & Taylor, 2007). In response to challenging events, vagal or RSA suppression, as indicated by decreases in heart rate and reductions in RSA, is conceptualized as releasing the "vagal brake" (to reduce or withdraw vagal parasympathetic influence) so that a person can adaptively attend and respond to environmental challenges (Beauchaine, Gatzke-Kopp, & Mead, 2006; Porges, Doussard-Roosevelt, Portales, & Greenspan, 1996). Because RSA suppression taps primarily individuals' parasympathetic responding over their sympathetic responding (e.g., reactivity or emotionality), vagal or RSA suppression has been theorized to partly tap effortful control (Eisenberg, Morris, & Spinrad, 2005) and represents context-dependent emotion regulation or the readiness to cope with environmental demands (Calkins & Keane, 2004; Porges et al., 1996).

Consistent with the view that RSA suppression taps effortful control and facilitates readiness to adaptively attend and respond to environmental challenges, 2- and 3-year-olds' RSA suppression during mildly challenging tasks (e.g., inhibition or delay tasks) has been associated with self-regulatory behaviors such as visually and verbally engaging with an adult (Calkins, 1997). In 2-year-olds identified as at risk for behavioral problems, RSA suppression during a problem-solving task was associated with emotional and behavioral regulation (Calkins & Dedmon, 2000). Furthermore, Blair and Peters (2003) found evidence to suggest that physiological regulation is an important predictor of adaptive skills that children use in the classroom. Specifically, in a sample of preschoolers enrolled in Head Start programs, RSA suppression predicted teacher-reported on-task behavior above and beyond contributions from teacher-reported social competence, child age, and gender (Blair & Peters, 2003). In another study, Hastings and colleagues (2008) found that RSA suppression to a social challenge corresponded, albeit marginally, with

parent ratings of self-regulation. Furthermore, RSA suppression predicted low levels of externalizing problems (Hastings et al., 2008). In the present article, the term *RSA suppression* refers to individual differences in the ability to suppress RSA responding during a mildly challenging situation (i.e., completing a challenging puzzle) relative to RSA responding during a relatively neutral or mildly pleasant situation (i.e., viewing a pleasant film).

Behavioral (Fine Motor) Regulation and Adjustment

Behavioral regulation is an aspect of self-regulation and has been defined as the integration of cognitive processes including attention, working memory, and inhibitory control (McClelland, Cameron, Wanless, & Murray, 2007; Wanless et al., 2011). Because effortful control consists of executive attention (e.g., attention focusing and shifting) and inhibitory control abilities (Eisenberg et al., 1997; Rothbart & Bates, 2006), behavioral regulation may be a behavioral marker of effortful control.

Research findings indicate that observed behavioral regulation is associated with children's social-emotional and behavioral adjustment. For example, children's observed behavioral regulation has been positively linked to their socially appropriate or adaptive behavior (Eisenberg et al., 1997) as well as to low levels of internalizing and externalizing problems (Eisenberg, Cumberland, et al., 2001). A variety of tasks have been designed to measure behavioral regulation (see Ponitz et al., 2008). It is important to note that gross or fine motor skills may play different roles in children's developmental adjustment (Liew, Chen, & Hughes, 2009; Ponitz et al., 2008). Developmentally speaking, preschool-age children are increasingly expected to master or demonstrate behavioral regulation that requires fine motor skills such as drawing with crayons or markers and writing with pencils, which may be important for them as they prepare to enter formal schooling or transition from preschool to kindergarten or first grade. Thus, fine motor regulation may be a developmentally relevant aspect of behavioral regulation to focus upon and assess for preschoolers and their social-emotional and behavioral adjustment.

PARENTAL EXPRESSIVITY

Although effortful control is considered to have a temperamental basis (Rothbart & Bates, 2006), effortful control does not become relatively coherent or stable until approximately 30 months (Kochanska et al., 2000), and parental socialization practices play an important role in shaping its development in early childhood (Eisenberg, Cumberland, & Spinrad, 1998). Many studies have documented relations between parenting

behaviors and children's effortful control (see Karreman, van Tuijl, van Aken, & Dekovic, 2006, for a review). Parental *emotional expressivity* has been identified as a parenting behavior that contributes to children's effortful control and their social-emotional or behavioral adjustment (Eisenberg, Gershoff, et al., 2001; Eisenberg, Zhou, et al., 2005; Valiente et al., 2006). *Parental expressivity* has been defined as the parent's pattern or style of nonverbal and verbal expressions within the family context (Halberstadt, Cassidy, Stifter, Parke, & Fox, 1995). One way to assess parental expressivity with children in stressful or challenging situations is to observe parents' expressions of positive and negative emotion when interacting with the child undergoing mild stress or challenge (Eisenberg, Gershoff, et al., 2001; Gottman, Katz, & Hooven, 1996; Halberstadt, Crisp, & Eaton, 1999).

Parental Expressivity and Child Regulation

A body of research indicates that parents who are supportive and responsive (e.g., express positive expressivity and warmth) to their children in stressful situations have children who are more likely to maintain an optimal level of arousal and less likely to become overaroused in those situations (Carson, Burks, & Parke, 1993; Carson & Parke, 1996; Eisenberg, Gershoff, et al., 2001; Parke & Buriel, 2006). With very young children, Calkins and Johnson (1998) did not find a relation between 18-month-olds' vagal or RSA measures and maternal positive or negative behavior. However, this lack of relation may be partly explained by the fact that effortful control (partly tapped by RSA suppression; Eisenberg, Morris, et al., 2005) is not very coherent or stable until 30 months (Kochanska et al., 2000). With preschoolers, children with high-quality parent–child relationships (including maternal positive expressivity and attachment security) were less physiologically reactive or better physiologically regulated (as indexed by skin conductance) to a fearful or stressful situation than children with low-quality parent–child relationships (Gilissen, Bakermans-Kranenburg, van IJzendoorn, & van der Veer, 2008; Gilissen, Koolstra, van Ijzendoorn, Bakermans-Kranenburg, & van der Veer, 2007). Furthermore, Hastings and colleagues (2008) observed parent–child interactions across three problem-solving tasks and found that negative and controlling maternal behavior was associated with children's low physiological regulation (as indexed by RSA suppression). Consistent with the view that parental expressivity contributes to children's ability to maintain an optimal level of arousal in stressful situations (Eisenberg, Gershoff, et al., 2001; Parke & Buriel, 2006), we hypothesize that observed parental high positive/low negative expressivity will contribute to child physiological regulation (i.e., RSA suppression) in the present study. Furthermore, consistent with the view that overarousal likely interferes with

children's ability to focus or shift attention and exert or demonstrate observed effortful control and adaptive behavior (Blair, 2002; Raver, 1996; Raver & Knitzer, 2002), we hypothesize that child physiological regulation will contribute to behavioral regulation.

Parental Expressivity and Child Adjustment

As for children's social-emotional or behavioral adjustment, studies have generally shown that parents' nonsupportive and nonresponsive expressivity tends to be associated with children's low social competence or high externalizing problems (Eisenberg et al., 1998). Parents' expressions of hostile or harsh negative emotions at their children's negative emotions have consistently been associated with child externalizing problems (Denham et al., 2000; Eisenberg, Cumberland, et al., 2001; Ramsden & Hubbard, 2002), whereas parents' expressions of sadness or distress have been mixed and sometimes associated with children's externalizing problems or low socially appropriate behavior (Eisenberg et al., 1999). Maternal negative and controlling behavior has also been associated with children's internalizing problems (Hastings et al., 2008).

Physiological and Behavioral Regulation as Mediating Mechanisms

Although the literature has consistently shown that parents' expressions of positive or supportive emotions toward their children are linked to children's social-emotional or behavioral adjustment and competence (e.g., Boyum & Parke, 1995; Eisenberg, Valiente, et al., 2003; Halberstadt et al., 1999), few studies have attempted to examine child physiological and behavioral regulation as two separate mediating mechanisms underlying the relation between parental expressivity and child adjustment. Distinguishing physiological from behavioral regulation is important for theoretical and applied reasons. If experts better understood whether child adjustment outcomes were directly related to physiological or behavioral regulation, interventions or treatment could be designed with, or aimed at, specific self-regulatory components or skills to enhance child adjustment. Conceptually speaking, the present study aims to replicate a series of studies conducted by Eisenberg and colleagues, who found that the relation between parental expressivity (e.g., positive expressivity and warmth) and child social-emotional or behavioral adjustment (e.g., behavior problems or social competence) is mediated through child effortful control (Eisenberg, Gershoff, et al., 2001; Eisenberg, Zhou, et al., 2005; Valiente et al., 2006). But the present study extends beyond this past research by separating out the physiological and behavioral aspects of effortful control to test the hypothesis that parental expressivity

contributes to children's physiological regulation, which then contributes to children's behavioral regulation. We further hypothesize that children's behavioral regulation is then observed by others (such as their parents), who then make evaluations regarding children's overall adaptive skills and internalizing or externalizing problems. Such a mediation chain, in which one mediator transmits the influence of an independent variable to a dependent variable, has been termed a *micromediational chain* (Cook & Campbell, 1979; see Taylor, MacKinnon, & Tein, 2008).

METHOD

Participants

Participants were 45 children (22 girls and 23 boys; M age = 4.32 years, $SD = 1.30$) and parents (42 mothers, 3 fathers) who were recruited from a university community in the southwestern United States. All participants were previously involved in a different study when the children were infants. Parents reported that 78% of children were Caucasian or non-Hispanic White, 13% were Hispanic American, and 9% were other. Among parents, 80% identified as Caucasian or non-Hispanic White, 13% identified as Hispanic American, and 7% identified as other. In regard to education, 43.2% of parents had a graduate (master's or doctoral) degree, 38.6% had bachelor's degree, and 18.2% had a 2-year college degree or high school education. Compared to data from the U.S. Census Bureau (2009) on statistics of the state, the sample was slightly overrepresented by non-Hispanic Whites and those with a graduate degree. In regard to annual household income, 32.6% earned $100,001 or more, 27.9% earned between $75,001 and $100,000, 23.3% earned between $50,001 and $75,000, and 16.3% earned between $25,001 and $50,000. As a point of comparison, the median household income was $55,742 for the state from which the participants were recruited (U.S. Census Bureau, 2007).

Procedures

Parents and children were invited to a university clinic for research that was approved by the institutional ethics and human research board, and parents were informed about the general study procedures before parental consent and child assent were obtained.

Physiological Regulation Assessment

In the presence of parents, a female experimenter placed two heart rate electrodes on the child's lower lateral ribs and a ground electrode on his or her

back to collect electrocardiograph (ECG) data. Children's respiration was measured by attaching a respiration cord around their abdominal area. After the heart rate electrodes and respiration cord were successfully placed on the children, the experimenter asked parents to go to a nearby room and complete questionnaires while their children participated in observational tasks. To measure children's physiological responses during a relatively neutral or mildly pleasant state, the experimenter asked children to watch a pleasant 90-s film[1] while the experimenter stepped behind a curtain in the room out of the children's sight. The ECG electrodes and respiration cord were fed into a five-channel Bioamp (James Long Company, 1999) that recorded the physiological data, and the ECG and respiration data were processed using interbeat interval (IBI) analysis software (James Long Company, 1999) that computed the difference between the maximum IBI during expiration and the minimum IBI during inspiration. The difference (measured in seconds) is considered a measure of RSA. Note that the IBI analysis software synchronizes the ECG with the respiration data so that the measure of RSA accounts for arrhythmia due to tonic shifts in heart rate.

After the film, the children were asked to complete a mildly challenging puzzle while their physiological responses were measured. The task was mildly challenging because the puzzle was placed inside a box with a cloth (with sleeves) covering the opened side that prevented children from seeing into the box and the puzzle (also see Eisenberg, Cumberland, et al., 2001; Eisenberg, Zhou, et al., 2005; Liew et al., 2003). The experimenter told the children that they would earn a sticker toward a prize if they did well on the puzzle completion task within 5 min without looking inside the box. Children were asked to place their hands and arms through the sleeves so that they could complete the task by feeling and maneuvering the puzzle pieces. Even though the experimenter emphasized to the children that they were supposed to complete the puzzle without looking inside the box, the children could lift up the sleeves and cloth and peek. If the children completed the puzzle before 5 min were up, they were told to ring a bell to signal the experimenter to come back to the room. Prior to leaving the children alone in the room to complete the puzzle, the experimenter set and started a programmable electronic time tracker.[2] The time tracker had green, yellow, and red lighted sections. The time tracker remained on a green light

[1]The 90-s film was an edited excerpt from a commercially available video recording produced by Team Baby Entertainment, LP. The film consists of young children engaged in pleasant and playful activities that are affiliated with the major university of the community from which participants were recruited.

[2]The time tracker was a commercially available visual timer and clock manufactured by Learning Resources®. This device is commonly used by parents or teachers to help children manage time.

until right before the 4-min mark, when the green light flashed three times (as a warning) and then turned to the yellow light at 4 min and made a ticking sound for 5 s. Thus, the children could notice the ticking sound even if they were not looking at the lights on the timer. Similarly, the time tracker remained on the yellow light until right before the 5-min mark, when the yellow light flashed 3 times (as a warning) and then turned to the red light, which flashed at 5 min and also provided an audio-recorded cue that announced that "time's up!"

Parental Expressivity Assessment

After the children completed the first puzzle, the parents were asked to come into the room and assist their children on a second puzzle that was more challenging than the first. The parents sat across from the children facing the side of the box that was clear acrylic so that the parents could see the puzzle and the children's hands. Thus, the parents could provide verbal and gestural directions to assist their children with the puzzle. Similar to the first puzzle, the experimenter told the children that they would earn a sticker toward a prize if they did well on the puzzle within 5 min and reminded the children to complete the puzzle without looking inside the box. If the children completed the puzzle before 5 min were up, the children could ring a bell to signal the experimenter to return to the room. In the same manner as the first puzzle, the experimenter set and started the programmable time tracker and then left the room to allow the parents and children to complete the puzzle. Recall that the time tracker provided visual cues (i.e., changed from a green to a yellow and then to a red light) and auditory cues (i.e., ticking sounds and the announcement that "time's up!") about the time remaining to complete the puzzle. After completing the second puzzle task, the parents returned to another room to complete questionnaires while the experimenter removed the heart rate electrodes and respiration cord from the children.

Behavioral Regulation Assessment

Next, children's behavioral (fine motor) regulation was assessed. The children were asked to demonstrate behavioral (fine motor) regulation by using a pencil to trace a geometric figure (a star) while staying on the lines of the figure with and then without instructions to go as slowly as possible.

Child Adjustment Assessment

As part of the questionnaires that parents completed, parents provided information on children's internalizing and externalizing problems and adaptive skills. At the end of the sessions, parents were debriefed and

parents and children received complementary t-shirts for their participation in the study.

Measures

Parental expressivity in response to their children undergoing a mild challenge was recorded and observed through a one-way mirror during the parent–child puzzle task. Child physiological regulation was indexed by children's physiological reactions (RSA suppression) when they were completing a challenging puzzle task by themselves. Child behavioral regulation was observed when the children were asked to complete a fine motor, effortful control task. And children's adjustment was assessed using parents' reports of children's internalizing and externalizing problems and adaptive skills.

Physiological Regulation

Physiological regulation was indexed by *RSA suppression*,[3] which was the reversed score of the standardized residualized RSA change score. RSA suppression was calculated by computing a regression with the mean level of RSA during the 90-s mildly pleasant film as the predictor and the mean level of RSA during the mildly challenging child puzzle as the outcome and multiplying that value by -1 (Calkins & Keane, 2004) because standardized residualized RSA change scores correspond to the inverse of vagal suppression (Hastings et al., 2008). Approximately 40% of children exhibited RSA suppression ($n = 18$). Note that prior to the calculations of RSA suppression scores, heart rate and respiratory data were inspected and corrected for artifacts when needed (physiological data could not be collected or data files were corrupted and could not be analyzed for 9 participants), and RSA scores (in the metric of ''peak-to-valley'' RSA) were calculated using procedures and software (James Long Company, 1999) described earlier for the physiological regulation assessment.

Behavioral Regulation

Behavioral regulation (tapping primarily inhibitory or effortful control) was observed using a task (trace a star) from a behavioral battery designed to assess effortful and inhibitory control (Kochanska, Murray, & Coy, 1997; Murray & Kochanska, 2002). Children were asked to use their dominant

[3]During the measurement of RSA suppression, the duration of on-task behavior, the number of times the child peeked inside the puzzle box or at the puzzle pieces, and the latency to first peek were observed during the child-alone puzzle task. Correlational analyses indicated no significant associations between these observed behaviors during the child-alone puzzle task and resting RSA or RSA suppression.

or writing hand to trace a geometric figure (a star) using a pencil without going outside the lines of the figure. The children participated in three trials. In Trial 1, the children's baseline responses were observed without any instructions to slow or inhibit their behaviors. In Trial 2, the children were asked to complete the task as quickly as possible (but scores from Trial 2 were not used in the present study, as they were not relevant for inhibitory control, which indexes behavioral regulation). In Trial 3, the children were asked to complete the task as slowly as possible. Children's *behavioral regulation*[4] was calculated as the difference between the time (measured in seconds) it took the children to complete Trial 3 (slow trial) and the time it took the children to complete Trial 1 (baseline trial). The experimenter and a research assistant observing behind a one-way mirror timed and recorded all trials. Interrater reliabilities were calculated with correlations between timings from the experimenter and research assistant for Trials 1 and 3 and were rs(37) = .98 and .93, ps < .01, respectively.

Parental Expressivity

Parental expressivity was measured as parents' affective reactions in response to their children undergoing a mild challenge and was coded during four brief periods of the parent–child puzzle task: (a) 3 s during the flashing of the green light (as a warning) right before it switched to the yellow light, (b) 3 s after the yellow light turned on, (c) 3 s during the flashing of the yellow light (as a warning) before it switched to the red light, and (d) 3 s after the red light turned on. These four brief periods were selected to represent the most stressful periods of the puzzle task for children. Parents' positive and negative affective reactions were recorded through a one-way mirror and then coded by two trained research assistants. Based on the work of Ekman and Friesen (1969), Izard (1977, 1978), and other researchers (also see Liew et al., 2004), parents' facial, vocal, or verbal cues that indicated negative, neutral, and positive affect were rated on a 7-point Likert-type scale (ranging from −3 to +3, with negative values representing negative affect, 0 representing neutral, and positive values representing positive affect; values of 1 represented vague signal, 2 represented clear but moderate signal, and 3 represented clear and strong or

[4]The duration of on-task behavior, the number of times the child peeked inside the puzzle box, and the latency to first peek were observed during the child-alone puzzle task. Correlational analyses indicated that children who worked longer on the child-alone puzzle exhibited poorer behavioral (fine motor) regulation (on the trace-a-star task), but no relations were found between peeking behaviors and behavioral regulation. To avoid issues associated with shared method variance when delineating relations between physiological and behavioral regulation, we did not include behaviors during the child-alone puzzle as measures of behavioral regulation in this study.

intense signal). Thus, a highly positive score on parental expressivity represented high positive affect/low negative affect, whereas a highly negative score on parental expressivity represented low positive/high negative affect. Interrater reliabilities were calculated with correlations between ratings from a research assistant (who coded all participants) and the researcher (who coded 24 randomly selected participants) for the four periods that were described previously, $rs(22) = .90$, .75, .91, and .79, $ps < .01$, respectively.

Child adjustment. Parents reported on their children's internalizing and externalizing behavior problems as well as adaptive skills using the Behavior Assessment System for Children–2 (BASC-2; Reynolds & Kamphaus, 2004). The BASC-2 is frequently used in social-emotional assessments and has been adopted for use by school psychologists in school systems in a number of major cities in the United States (Merydith, 2001). The scale consists of 134 items, scored on a Likert scale from 1 (*never*) to 4 (*almost always*). The BASC-2 measures nine clinical scales and five adaptive behavior scales. Internal consistency ranges from .60 to .90 for the general and clinical norms, the composite range is from .80 to .90, and the scales range from .60 to .90. Test–retest was .80 s to .90 s. The present study used age-appropriate versions of the BASC-2 for each child (32 completed the preschool version and 13 completed the child version). The internalizing, externalizing, and adaptive T-scores were used in the present study.

RESULTS

Descriptive and preliminary analyses were conducted first, and differences in participants' demographic characteristics (i.e., children's age, gender, and ethnicity as well as family's annual income) on the major variables (i.e., parental expressivity, physiological regulation, behavioral regulation, internalizing problems, externalizing problems, and adaptive skills) were examined. Correlational analyses were conducted to examine relations among the major variables. Following the descriptive statistics, a path model was tested to examine the hypothesized three-path mediated effects. Issues of statistical power are discussed.

Descriptive Statistics

The means and standard deviations for the major variables are presented in Table 1. Note that, because of equipment or procedural problems, there were nine participants with missing data on physiological regulation, eight participants with missing data on parental expressivity, and six participants with

TABLE 1
Means (*SD*) for the Major Variables

Measure	*Total Sample*	*Boys*	*Girls*
Parental expressivity	0.51 (0.84)	0.39 (0.86)	0.65 (0.82)
Physiological regulation	0.00 (0.99)	0.21 (0.79)	−0.21 (1.14)
Behavioral regulation	11.89 (28.34)	11.80 (32.20)	11.99 (24.53)
Internalizing problems	53.90 (9.03)	51.45 (8.94)	56.60 (8.54)
Externalizing problems	51.40 (7.67)	51.77 (8.25)	51.00 (7.17)
Adaptive skills	52.10 (8.17)	52.50 (8.71)	51.65 (7.74)

missing data on behavioral regulation. Major variables were first screened for normality and outliers. None of the major continuous variables were skewed according to the cutoff values of 2 for skewness and 7 for kurtosis (West, Finch, & Curran, 1995) except for the measure of behavioral regulation, which was moderately positively skewed. Upon examination of the frequencies and distribution of scores (Barnett & Lewis, 1994) on behavioral regulation, one outlier was detected, a score that was more than 4 *SD* above the mean. Examination of the video from the outlier's responses on the behavioral regulation (trace-a-star) task indicated that the score was properly recorded. Thus, all scores were included in the analyses.

Relationships Among Family Background Variables and Major Variables

Relationships between demographic variables and major variables were examined to screen for potential influences of these background variables. Because demographic variables were not the focus of the present study, we summarize significant relationships that were found between demographic and major variables rather than providing all of the statistical findings. Child age was the only demographic variable that was significantly associated with the major variables.

Age and major variables. To examine whether child age was associated with major variables, we conducted zero-order correlations. Age was positively associated with behavioral regulation, $r(37) = .40$, $p < .05$.

Gender and major variables. To examine whether boys and girls differed on the major variables, we conducted single-factor (gender) multivariate analysis of variance (MANOVA) on the major variables. No significant gender differences were found on the major variables, Wilks's Fs$(6, 20) = 1.24$, *ns*.

Ethnicity and major variables. Child ethnicity was reported by parents and coded as Caucasian or non-Hispanic White and Hispanic American or

other. Single-factor (ethnicity) MANOVA was conducted on the major variables, and results indicated no differences across ethnic groups, Wilks's $Fs(12, 38) = 0.57$, *ns*.

Income/education and major variables. Parents reported family income (coded as $25,001–$50,000, $50,001–$75,000, $75,001–$100,000, and $100,001 or higher) and single-factor (family income) MANOVA was conducted on the major variables. No significant differences were found across income groups, Wilks's $Fs(18,49) = 1.36$, *ns*. In addition, parents provided information on maternal and paternal level of education (high school education, 2-year college, bachelor's degree, and graduate degree), and maternal and paternal level of education was correlated with the major variables. Besides a marginally positive association between maternal education and parental expressivity, $r(34) = .30$, $p < .10$, no other relations were found between parental education and the major variables.

Correlational Analyses on the Major Variables

Zero-order correlations were conducted to examine relations among the major variables. Because correlations are presented in Table 2, we highlight the general patterns of results.

Parental expressivity was positively correlated with both physiological regulation and behavioral regulation (with the latter approaching statistical significance). Physiological regulation and behavioral regulation were positively associated with each other. In regard to the child adjustment measures, internalizing and externalizing problems were positively correlated with each other. But adaptive skills was not significantly related to either internalizing or externalizing problems. Neither parental expressivity nor physiological regulation was directly related with any of the child adjustment measures,

TABLE 2
Zero-Order Correlations Between Major Variables

Measure	*1*	*2*	*3*	*4*	*5*	*6*
1. Parental expressivity	—					
2. Physiological regulation	.37*	—				
3. Behavioral regulation	.30†	.47**	—			
4. Internalizing problems	.24	.10	−.15	—		
5. Externalizing problems	.01	.11	−.06	.46**	—	
6. Adaptive skills	.09	.09	.42*	−.04	−.23	—

†$p < .10$. *$p < .05$. **$p < .01$.

but behavioral regulation and adaptive skills were positively associated with each other.

Power Analysis for the Three-Path Mediation Path Model

Before the actual model fitting, we conducted a power analysis to determine the power for each of the paths of the hypothesized three-path mediation path model as well as the power to detect the mediated effects. We defined the mediated effect as the product of the paths from parental expressivity to physiological regulation; physiological regulation to behavioral regulation; and behavioral regulation to internalizing problems, externalizing problems, or adaptive skills. As mentioned earlier, this type of mediation with multiple paths in a chain has been described by Taylor et al. (2008).

We estimated power using a Monte Carlo approach described by Muthén and Muthén (2002) and by Thoemmes, MacKinnon, and Reiser (2010). The main question was how much power there was to detect effects of a certain size given the fixed sample size. Based on estimates from previous studies that were conducted in similar domains of research (see Eisenberg, Gershoff, et al., 2001; Eisenberg, Zhou, et al., 2005; Valiente et al., 2006), we generated the best estimate for correlations among all of the observed measures (see Table 3). These ranged from .05 (correlation between parental expressivity and adaptive skills) to .50 (correlation between physiological regulation and behavioral regulation). Although these previous studies did not match the present experimental design precisely, we felt that observed effects from these studies would provide the best possible estimate for effect sizes that we could reasonably expect to find in the present sample. Given the effect size assumptions and the sample size of 45 children, the power was sufficient (equal or greater than .80) to detect the path from parental expressivity to physiological regulation, physiological regulation to behavioral regulation, and behavioral regulation to adaptive skills. However, the

TABLE 3
Power Analysis: Estimated Correlations Between Major Variables Based on Previous Research

Measure	*1*	*2*	*3*	*4*	*5*	*6*
1. Parental expressivity	—					
2. Physiological regulation	.40	—				
3. Behavioral regulation	.30	.50	—			
4. Internalizing problems	.20	.10	−.10	—		
5. Externalizing problems	−.10	.10	−.10	.45	—	
6. Adaptive skills	.05	.10	.40	.30	−.30	—

power to detect relations between behavioral regulation and internalizing or externalizing problems was generally low (both around .12). Finally, the power to detect the mediated effect from parental expressivity to adaptive skills was low (.25), and the power to detect the mediated effect from parental expressivity and internalizing and externalizing problems was low as well (both below .05).

Testing the Three-Path Mediation Path Model

To test the hypothesized three-path mediation model, we fitted a path model on the raw data using Mplus software (Version 5.2, Muthén & Muthén, 2008). Missing data (average of 8% missing data across all major variables) was addressed by using full information maximum likelihood. The initial model provided a good fit to the data as indicated by the nonsignificant chi-square test, $\chi^2(7,\ N=45)=4.67,\ p=.70$. For completeness, we also report traditionally reported fit statistics. The root mean square error of approximation of the model was .00, and the comparative fit index was 1.00, both as expected in the case of a chi-square value that is smaller than the degrees of freedom. The standardized root-mean-square residual was .065, also indicating acceptable model fit.

Joint significance test of mediation. We tested the three-path mediational model using the *joint significance test* (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). "In a three-path mediational model, the joint significance test finds evidence for mediation if each of the three paths in the mediated effect is significantly nonzero" (Taylor et al., 2008, p. 244). As seen in Figure 1, parental expressivity significantly predicted child physiological

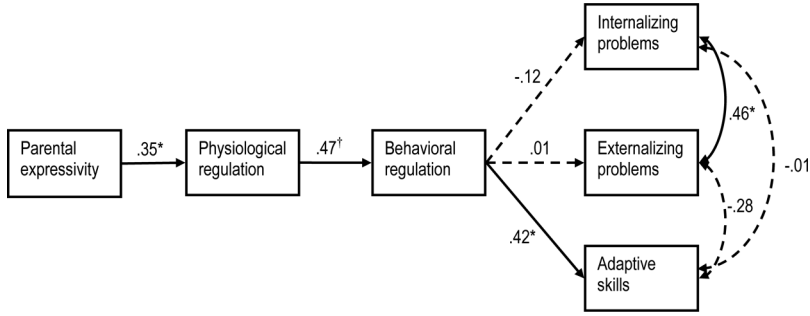

FIGURE 1 Joint significance test of the hypothesized three-path mediated path model. $\chi^2(7,\ N=45)=4.67,\ p=.70$, comparative fit index = 1.00, root mean square error of approximation = .00, standardized root-mean-square residual = .07. Standardized path coefficients are presented in the figure. $^{\dagger}p=.07$. $^{*}p<.05$.

regulation. Parental high positive/low negative expressivity explained 12% of the variance in child physiological regulation. The path between physiological regulation and behavioral regulation approached significance, with a p value equal to .069. The explained variance in behavioral regulation was 22%. The relation between behavioral regulation and adaptive skills was significant, explaining 18% of the variance in adaptive skills. However, the relations between behavioral regulation and internalizing and externalizing problems were both not significant and explained virtually none of the variance (R^2 for internalizing problems = .02, R^2 for externalizing problems $<$.01).

DISCUSSION

The present findings demonstrate that it is important to examine physiological and behavioral components of effortful control, because specific modalities or components of effortful control may be more directly related to parenting behaviors or child adjustment outcomes. There is some evidence to suggest that child physiological and behavioral regulation are two mediating mechanisms by which parental high positive/low negative expressivity may transmit influence upon children's adaptive skills.

Physiological and Behavioral Regulation

A major goal of the present study was to delineate the physiological component from the behavioral component of effortful control in order to clarify how each aspect relates to parental expressivity and to child adjustment outcomes. Consistent with the overall pattern of results from previous research (e.g., Blair, 2003; Eisenberg, Zhou, et al., 2003; Hastings et al., 2008; Kochanska et al., 2000), we found that older children exhibited greater behavioral regulation but that age was unrelated to physiological regulation. In regard to relations between the two modalities of self-regulatory responding, the results indicate that physiological regulation (as indexed by RSA suppression to a mildly challenging puzzle task) was positively correlated with behavioral regulation. This finding lends support to the conceptualization of self-regulation as consisting of neurophysiological and behavioral components of effortful control (Blair & Peters, 2003; Raffaelli et al., 2005).

The finding that physiological regulation shares common variance with behavioral regulation supports the notion that behavioral regulation (i.e., observed effortful control) has a physiological and temperamental basis (Beauchaine et al., 2006; Calkins & Keane, 2004). As noted by Hastings and colleagues (2008, p. 300), "Dynamic indices of physiology measured

in ecologically meaningful contexts are likely to be more robust indicators of individual differences in children's self-regulation.'' Thus, physiological components of effortful control may be one underlying mechanism by which self-regulatory capacities become manifested and observable as behavioral regulation (i.e., observed effortful control) by others, such as the experimenter in the laboratory or parents during their daily observations of their children in the home (see Hastings et al., 2008).

Relations Between Behavioral Regulation and Adjustment Outcomes

Although physiological regulation and behavioral regulation are both components of effortful control, it appears that behavioral regulation may be directly related to child adjustment outcomes. Consistent with past research (Oland & Shaw, 2005), there was substantial comorbidity between internalizing and externalizing problems in the present sample (see Table 2). Furthermore, the findings indicate that behavioral regulation was associated with adaptive skills but not pathological symptoms (internalizing or externalizing problems). This finding is consistent with the literature demonstrating that behavioral regulation is an important indicator or correlate of adaptive skills (e.g., McClelland, Cameron, Connor, et al., 2007). The measure of behavioral regulation used here tapped inhibitory control, fine motor skills and eye–hand coordination, working memory (e.g., remembering task instructions), and executive attention (e.g., paying attention to accomplish a task or goal). Thus, these capacities or skills likely enable children to easily adapt to their environment. For preschoolers, adaptive skills may be important for school readiness as well as for successful management of their experiences during entry into formal schooling or transition from preschool to kindergarten. The present finding of a lack of relation between behavioral regulation and pathological symptoms needs to be interpreted in light of the fact that the present sample was normative or nonclinical. Thus, an overwhelming majority of the sample did not reach a level of diagnosable problem for either internalizing or externalizing symptoms (i.e., scoring above $T = 70$ on the internalizing or externalizing subscales of the BASC-2). In fact, only two children (both girls) reached a diagnosable level for internalizing problems, even though the distribution was not significantly skewed in any direction.

It is interesting that physiological regulation was not significantly associated with children's adaptive skills or pathological symptoms. We believe that the measure of physiological regulation (i.e., RSA suppression to a mildly challenging puzzle task) partly taps context-dependent emotion regulation or the readiness to cope with environmental demands (Calkins & Keane, 2004; Porges et al., 1996). The context-dependent nature of the measure of physiological regulation may partly explain why it was not

directly related to children's adaptive skills. Other researchers have noted similar difficulties and mixed results with the use of context-dependent measures of physiological regulation (e.g., Grossman & Taylor, 2007; Hastings et al., 2008). It is important to note that physiological regulation was positively correlated with behavioral regulation. Because people cannot easily observe another's internal processes, such as physiological regulation, the influence of physiological regulation on adaptive skills is likely through processes at the behavioral level. Thus, behavioral regulation may be directly related to adaptive skills, but there is also a correspondence between behavioral and physiological regulation. Such relations are consistent with our hypothesis that the influence of physiological regulation children's adjustment is transmitted or mediated through behavioral regulation.

Relations Between Parental Expressivity and Child Variables

Consistent with past research and theoretical expectations (e.g., Eisenberg et al., 1998, 1999), parental high positive/low negative expressivity was significantly positively correlated with child physiological regulation (and approaching significance for behavioral regulation). Recall that parental positive expressivity was observed during what was believed to be the most stressful periods of the puzzle task for children (i.e., immediately before and during the flashing of the yellow and red warning lights to indicate that time was running out to complete the puzzle task). Thus, observed parental high positive/low negative expressivity (believed to indicate warm, supportive, and nurturing parental behavior) when the child was undergoing frustrating, challenging, or stressful events corresponded to child physiological regulation (when the child had to complete a challenging puzzle alone). The present findings are somewhat consistent with those from Hastings and colleagues (2008), who found that maternal negative control predicted poor physiological regulation (low levels of RSA suppression). Furthermore, the current results appear to be consistent with the work of Gottman et al. (1996), who found that emotion-related parenting behavior (i.e., emotion coaching) was related to child physiological regulation. Note that we did not assess emotion coaching, consisting of dimensions such as scaffolding-praising parenting and derogatory parenting. Rather, the measure of parental expressivity consisted of high positive/low negative affect. Even though "scaffolding-praising is not merely a dimension of global positivity" (Gottman et al., 1996, p. 254) the current measure of parental expressivity may have captured some aspects of parental emotion coaching, given that parental expressivity was observed in the context of a teaching (puzzle) task across four brief periods selected to represent the most stressful periods of the puzzle task for children (see Ramsden & Hubbard, 2002).

Physiological and Behavioral Regulation as Mediating Mechanisms

Despite relatively low power (.25) to detect the hypothesized mediated effect as indicated by the power analyses, the results from the joint significance test indicate that physiological regulation and behavioral regulation are two mediating mechanisms by which parental expressivity may influence adaptive skills. These findings are consistent with results from a series of studies conducted by Eisenberg and colleagues showing that the relation between parental expressivity and child behavior problems or social competence is mediated through child effortful control (Eisenberg, Gershoff, et al., 2001; Eisenberg, Zhou, et al., 2005; Valiente et al., 2006).[5] Extending past studies, the present study results contribute to the existing literature by separating out the physiological and behavioral aspects of effortful control to show that parental high positive/low negative expressivity contributes to children's physiological regulation, which then contributes to children's behavioral regulation. And the study results indicate that it is behavioral regulation that is directly related to children's adaptive skills.

Study Limitations and Conclusion

A strength of the present study is the use of distinct modes or methods (i.e., physiological, behavioral, and questionnaire) of measurement for all major variables. Specifically, each major variable was assessed with a distinct methodology and/or assessed in a distinct context. Such a methodology gave us confidence that any relations found between parental expressivity, physiological regulation, behavioral regulation, and adaptive skills were not due to shared method variance. It is important to note that the study results indicate that parental expressivity and child physiological regulation are linked, and future studies could further explore whether responsive and supportive parenting serves as a mechanism in the development of children's effortful control (e.g., Eisenberg, Zhou, et al., 2005). Despite the small sample size in the present study, several significant findings were revealed, and there was some evidence to support the hypothesis that the relation between parental expressivity and child adaptive skills is mediated through child physiological regulation and behavioral regulation. Although this study was grounded in theory and previous research, we acknowledge that it was not designed to confirm the direction of influences between measures of parental expressivity, effortful control, and adjustment. Thus, further research with

[5]In a previous study (Valiente et al., 2006), correlations between observed effortful control and mothers' reports of externalizing and internalizing behaviors were .09 and −.21, *ns* and $p = .01$, respectively. In the present study, corresponding correlations were −.06 and −.15, respectively.

experimental or longitudinal designs and adequate power to detect mediated effects is needed to replicate the study results and gain a deeper understanding of the pathways by which parental expressivity may transmit influence on child adjustment. In addition, this sample consisted of primarily upper middle-class non-Hispanic Caucasian families. Therefore, caution needs to be taken when applying findings to families from other ethnic/racial or socioeconomic groups. Nonetheless, the overall pattern of results suggests that behavioral regulation may have a neurophysiological or temperamental basis in effortful control. It is important to note that it was behavioral regulation, and not physiological regulation, that directly contributed to adaptive skills. However, parental high positive/low negative expressivity contributed to physiological regulation. The results have implications for interventions aimed at enhancing children's self-regulatory and adaptive skills through parental coaching of emotion and behavioral management techniques (Gottman et al., 1996). In conjunction with parent training, evidence-based social-emotional or educational curricula aimed at enhancing preschoolers' behavioral regulation may improve their adaptive or school readiness skills at a time when they are entering formal schooling or transitioning from preschool to kindergarten and first grade.

REFERENCES

Barnett, V., & Lewis, T. (1994). *Outliers in statistical data* (3rd ed.). New York, NY: Wiley.

Beauchaine, T. P., Gatzke-Kopp, L., & Mead, H. K. (2006). Polyvagal theory and developmental psychopathology: Emotion dysregulation and conduct problems from preschool to adolescence. *Biological Psychology*, *74*, 174–184.

Blair, C. (2002). School readiness: Integrating cognition and emotion in a neurobiological conceptualization of children's functioning at school entry. *American Psychologist*, *57*, 111–127.

Blair, C. (2003). Behavioral inhibition and behavioral activation in young children: Relations with self-regulation and adaptation to preschool in children attending Head Start. *Developmental Psychobiology*, *42*, 301–311.

Blair, C., & Peters, R. (2003). Physiological and neurocognitive correlates of adaptive behavior in preschool among children in Head Start. *Developmental Neuropsychology*, *24*, 479–497.

Boyum, L. A., & Parke, R. D. (1995). The role of family emotional expressiveness in the development of children's social competence. *Journal of Marriage and Family*, *36*, 193–199.

Calkins, S. D. (1997). Cardiac vagal tone indices of temperamental reactivity and behavioral regulation in young children. *Developmental Psychobiology*, *31*, 125–135.

Calkins, S. D., & Dedmon, S. E. (2000). Physiological and behavioral regulation in two-year-old children with aggressive/destructive behavior problems. *Journal of Abnormal Child Psychology*, *28*, 103–118.

Calkins, S. D., & Johnson, M. C. (1998). Toddler regulation of distress to frustrating events: Temperamental and maternal correlates. *Infant Behavior and Development*, *21*, 379–395.

Calkins, S. D., & Keane, S. P. (2004). Cardiac vagal regulation across the preschool period: Stability, continuity, and implications for childhood adjustment. *Developmental Psychobiology*, *45*, 101–112.

Carson, J. L., Burks, V. M., & Parke, R. D. (1993). Parent-child physical play: Determinants and consequences. In K. B. MacDonald (Ed.), *Parent-child play*, (pp. 197–220). Albany: State University of New York Press.

Carson, J. L., & Parke, R. D. (1996). Reciprocal negative affect in parent-child interactions and children's peer competency. *Child Development*, *67*, 2217–2226.

Cook, T. D., & Campbell, D. T. (1979). *Quasi-experimentation: Design and analysis issues for field settings*. Chicago, IL: Rand McNally.

Denham, S. A., Workman, E., Cole, P. M., Weissbrod, C., Kendziora, K. T., & Zahn-Waxler, C. (2000). Prediction of externalizing behavior problems from early to middle childhood: The role of parental socialization and emotion expression. *Development and Psychopathology*, *12*, 23–45.

Derryberry, D., & Rothbart, M. K. (1997). Reactive and effortful processes in the organization of temperament. *Development & Psychopathology*, *9*, 633–652.

Eisenberg, N., Cumberland, A., & Spinrad, T. L. (1998). Parental socialization of emotion. *Psychological Inquiry*, *9*, 241–273.

Eisenberg, N., Cumberland, A., Spinrad, T. L., Fabes, R. A., Shepard, S. A., Reiser, M., … Guthrie, I. K. (2001). The relations of regulation and emotionality to children's externalizing and internalizing problem behavior. *Child Development*, *72*, 1112–1134.

Eisenberg, N., Fabes, R. A., Murphy, B. C., Maszk, P., Smith, M., & Karbon, M. (1995). The role of emotionality and regulation in children's social functioning: A longitudinal study. *Child Development*, *66*, 1360–1384.

Eisenberg, N., Fabes, R. A., Shepard, S. A., Guthrie, I. K., Murphy, B. C., & Reiser, M. (1999). Parental reactions to children's negative emotions: Longitudinal relations to quality of children's social functioning. *Child Development*, *70*, 513–534.

Eisenberg, N., Gershoff, E. T., Fabes, R. A., Shepard, S. A., Cumberland, A. J., Losoya, S. H., … Murphy, B. C. (2001). Mothers' emotional expressivity and children's behavior problems and social competence: Mediation through children's regulation. *Developmental Psychology*, *37*, 475–490.

Eisenberg, N., Guthrie, I. K., Fabes, R. A., Reiser, M., Murphy, B. C., Holgren, R., … Losoya, S. (1997). The relations of regulation and emotionality to resiliency and competent social functioning in elementary school children. *Child Development*, *68*, 295–311.

Eisenberg, N., Morris, A. S., & Spinrad, T. L. (2005). Emotion-related regulation: The construct and its measurement. In D. Teti (Ed.), *Handbook of research methods in developmental science*, (pp. 423–442). Oxford, England: Blackwell.

Eisenberg, N., Valiente, C., Morris, A. S., Fabes, R. A., Cumberland, A., Reiser, M., … Losoya, S. (2003). Longitudinal relations among parental emotional expressivity, children's regulation, and quality of socioemotional functioning. *Developmental Psychology*, *39*, 3–19.

Eisenberg, N., Zhou, Q., Losoya, S., Fabes, R. A., Shepard, S. A., Murphy, B. C., … Cumberland, A. (2003). The relations of parenting, effortful control, and ego control to children's unregulated expression of emotion. *Child Development*, *74*, 875–895.

Eisenberg, N., Zhou, Q., Spinrad, T. L., Valiente, C., Fabes, R. A., & Liew, J. (2005). Relations among positive parenting, children's effortful control, and externalizing problems: A three-way longitudinal study. *Child Development*, *76*, 1055–1071.

Ekman, P., & Friesen, W. (1969). The repertoire of nonverbal behavior: Categories, origins, usage, and coding. *Semiotica*, *1*, 49–98.

Gilissen, R., Bakermans-Kranenburg, M. J., van IJzendoorn, M. H., & van der Veer, R. (2008). Parent-child relationships, temperament, and physiological reactions to fear-inducing film clips: Further evidence for differential susceptibility. *Journal of Experimental Child Psychology*, *99*, 182–195.

Gilissen, R., Koolstra, C. M., van Ijzendoorn, M. H., Bakermans-Kranenburg, M. J., & van der Veer, R. (2007). Physiological reactions of preschoolers to fear-inducing film clips: Effects of temperamental fearfulness and quality of the parent-child relationship. *Developmental Psychobiology*, *49*, 187–195.

Gottman, J. M., Katz, L. F., & Hooven, C. (1996). Parental meta-emotion philosophy and the emotional life of families: Theoretical models and preliminary data. *Journal of Family Psychology*, *10*, 243–268.

Grossman, P., & Taylor, E. W. (2007). Toward understanding respiratory sinus arrhythmia: Relations to cardiac vagal tone, evolution and biobehavioral functions. *Biological Psychology*, *74*, 263–285.

Halberstadt, A. G., Cassidy, J., Stifter, C. A., Parke, R. D., & Fox, N. A. (1995). Self-expressiveness within the family context: Psychometric support for a new measure. *Psychological Assessment*, *7*, 93–103.

Halberstadt, A. G., Crisp, V. W., & Eaton, K. L. (1999). Family expressiveness: A retrospective and new directions for research. In P. Philippot, R. S. Feldman, & E. Coats (Eds.), *The social context of nonverbal behavior*, (pp. 109–155). New York, NY: Cambridge University Press.

Hastings, P. D., Nuselovici, J. N., Utendale, W. T., Coutya, J., McShane, K. E., & Sullivan, C. (2008). Applying the polyvagal theory to children's emotion regulation: Social context, socialization, and adjustment. *Biological Psychology*, *70*, 299–306.

Izard, C. E. (1977). *Human emotions*. New York, NY: Plenum.

Izard, C. E. (1978). On the ontogenesis of emotions and emotion-cognition relationships in infancy. In M. Lewis, & L. A. Rosenblum (Eds.), *The development of affect*, (pp. 389–413). New York, NY: Plenum.

James Long Company. (1999). *IBI analysis system*. Retrieved from http://www.jameslong.net/#IBI%20Analysis%20System

Karreman, A., van Tuijl, C., van Aken, M. A. G., & Dekovic, M. (2006). Parenting and self-regulation in preschoolers: A meta-analysis. *Infant and Child Development*, *15*, 561–579.

Kochanska, G., Murray, K., & Coy, K. C. (1997). Inhibitory control as a contributor to conscience in childhood: From toddler to early school age. *Child Development*, *68*, 263–277.

Kochanska, G., Murray, K., & Harlan, E. T. (2000). Effortful control in early childhood: Continuity and change, antecedents, and implications for social development. *Developmental Psychology*, *36*, 220–232.

Lahey, B. B. (2004). Commentary: Role of temperament in developmental models of psychopathology. *Journal of Clinical Child and Adolescent Psychology*, *33*, 88–93.

Liew, J., Chen, Q., & Hughes, J. N. (2009). Child effortful control, teacher-student relationships, and achievement in academically at-risk children: Additive and interactive effects. *Early Childhood Research Quarterly*, *23*, 51–64.

Liew, J., Eisenberg, N., Losoya, S. H., Fabes, R. A., Guthrie, I. K., & Murphy, B. C. (2003). Children's physiological indices of empathy and their socioemotional adjustment: Does caregivers' expressivity matter?. *Journal of Family Psychology*, *17*, 584–597.

Liew, J., Eisenberg, N., & Reiser, M. (2004). Preschoolers' effortful control and negative emotionality, immediate reactions to disappointment, and quality of social functioning. *Journal of Experimental Child Psychology*, *89*, 298–319.

Liew, J., McTigue, E., Barrois, L., & Hughes, J. N. (2008). Adaptive and effortful control and academic self-efficacy beliefs on literacy and math achievement: A longitudinal study on 1st through 3rd graders. *Early Childhood Research Quarterly*, *23*, 515–526.

MacKinnon, D. P., Lockwood, C. M., Hoffman, J. M., West, S. G., & Sheets, V. (2002). A comparison of methods to test mediation and other intervening variable effects. *Psychological Methods*, *7*, 83–104.

McClelland, M. M., Cameron, C. E., Connor, C. M., Farris, C. L., Jewkes, A. M., & Morrison, F. J. (2007). Links between behavioral regulation and preschoolers' literacy, vocabulary, and math skills. *Developmental Psychology*, *43*, 947–959.

McClelland, M. M., Cameron, C. E., Wanless, S., & Murray, A. (2007). Executive function, behavioral self-regulation, and social-emotional competence: Links to school readiness. In O. N. Saracho, & B. Spodek (Eds.), *Contemporary perspectives in social learning in early childhood education*, (pp. 113–137). Charlotte, NC: Information Age.

Merydith, S. P. (2001). Temporal stability and convergent validity of the Behavior Assessment System for Children. *Journal of School Psychology*, *39*, 253–265.

Murray, K. T., & Kochanska, G. (2002). Effortful control: Factor structure and relation to externalizing and internalizing behaviors. *Journal of Abnormal Child Psychology*, *30*, 503–514.

Muthén, L. K., & Muthén, B. O. (2002). How to use a Monte Carlo study to decide on sample size and determine power. *Structural Equation Modeling*, *4*, 599–620.

Muthén, L. K., & Muthén, B. O. (2008). *Mplus (Version 5.2)*. Los Angeles, CA: Author.

Oland, A. A., & Shaw, D. S. (2005). Pure versus co-occurring externalizing and internalizing symptoms in children: The potential role of socio-developmental milestones. *Clinical Child and Family Psychology Review*, *8*, 247–270.

Parke, R. D., & Buriel, R. (2006). Socialization in the family. Ethnic and ecological perspectives. In N. Eisenberg, W. Damon, & R. M. Lerner (Eds.), *Handbook of child psychology: Vol. 3. Social, emotional, and personality development*, 6th ed., (pp. 429–504). Hoboken, NJ: Wiley.

Ponitz, C. C., McClelland, M. M., Jewkes, A. M., Connor, C. M., Farris, C. L., & Morrison, F. J. (2008). Touch your toes! Developing a direct measure of behavioral regulation in early childhood. *Early Childhood Research Quarterly*, *23*, 141–158.

Porges, S. W., Doussard-Roosevelt, J. A., & Maiti, A. K. (1994). Vagal tone and the physiological regulation of emotion. *Monographs of the Society for Research in Child Development*, *59*, 167–186.

Porges, S. W., Doussard-Roosevelt, J. A., Portales, A. L., & Greenspan, S. I. (1996). Infant regulation of the vagal "brake" predicts child behavior problems: A psychobiological model of social behavior. *Developmental Psychobiology*, *29*, 697–712.

Posner, M. I., & Rothbart, M. K. (2000). Developing mechanisms of self-regulation. *Development & Psychopathology*, *12*, 427–441.

Raffaelli, M., Crockett, L. J., & Shen, Y. (2005). Developmental stability and change in self-regulation from childhood to adolescence. *Journal of Genetic Psychology*, *166*, 54–75.

Ramsden, S. R., & Hubbard, J. A. (2002). Family expressiveness and parental emotion coaching: Their role in children's emotion regulation and aggression. *Journal of Abnormal Child Psychology*, *30*, 657–667.

Raver, C. (1996). Success at catching and keeping toddlers' attention: An examination of joint attention among low-income mothers and their 2-year-olds. *Early Development and Parenting*, *5*, 225–236.

Raver, C. C., & Knitzer, J. (2002). *Ready to enter: What research tells policymakers about strategies to promote social and emotional school readiness among three- and four-year-olds*. New York, NY: National Center for Children in Poverty.

Reynolds, C. R., & Kamphaus, R. W. (2004). *Behavior assessment system for children* (2nd ed.). Circle Pines, MN: American Guidance Service.

Rothbart, M. K., & Bates, J. E. (2006). Temperament. In N. Eisenberg, W. Damon, & R. M. Lerner (Eds.), *Handbook of child psychology: Vol. 3. Social, emotional, and personality development*, 6th ed., (pp. 99–166). Hoboken, NJ: Wiley.

Sheese, B., Rothbart, M., Posner, M., White, L. K., & Fraundorf, S. H. (2008). Executive attention and self-regulation in infancy. *Infant Behavior & Development*, *31*, 501–510.

Stifter, C. A., & Spinrad, T. L. (2002). The effect of excessive crying on the development of emotion regulation. *Infancy*, *3*, 133–152.

Taylor, A. B., MacKinnon, D. P., & Tein, J. (2008). Tests of the three-path mediated effect. *Organizational Research Methods*, *11*, 241–269.

Thoemmes, F., MacKinnon, D. P., & Reiser, M. R. (2010). Power analysis for complex mediational designs using Monte Carlo Methods. *Structural Equation Modeling*, *17*, 510–534.

U.S. Census Bureau. (2007). *2007 State median income*. Retrieved from http://www.census.gov/hhes/www/income/statemedfaminc.html

U.S. Census Bureau. (2009). *Census 2009 population, demographic, and housing information*. Retrieved from http://quickfacts.census.gov/qfd/states/48000lk.html

Valiente, C., Eisenberg, N., Spinrad, T. L., Reiser, M., Cumberland, A., Losoya, S. H., & Liew, J. (2006). Relations among mothers' expressivity, children's effortful control, and their problem behaviors: A four-year longitudinal study. *Emotion*, *6*, 459–472.

Wanless, S. B., McClelland, M. M., Acock, A. C., Ponitz, C. C., Son, S.-H., Lan, X., … Li, S. (2011). Measuring behavioral regulation in four societies. *Psychological Assessment*, *23*, 364–378.

West, S. G., Finch, J. F., & Curran, P. J. (1995). Structural equation models with non-normal variables: Problems and remedies. In R. H. Hoyle (Ed.), *Structural equation modeling: Concepts, issues and applications*, (pp. 56–75). Thousand Oaks, CA: Sage.

Zhou, Q., Hofer, C., Eisenberg, N., Reiser, M., Spinrad, T. L., & Fabes, R. A. (2007). The developmental trajectories of attention focusing, attentional and behavioral persistence, and externalizing problems during school-age years. *Developmental Psychology*, *43*, 369–385.