Published in final edited form as:
Soc Dev Issues. 2014 May 1; 23(2): 250–266. doi:10.1111/sode.12049.

Emotional Reactivity and Regulation in Head Start Children: Links to Ecologically-Valid Behaviors and Internalizing Problems

Judith K. Morgan[1], **Carroll E. Izard**[2], and **Christopher Hyde**[3]

[1]University of Pittsburgh

[2]University of Delaware

[3]BioAssessments

Abstract

Children's emotional reactivity may interact with their regulatory behaviors to contribute to internalizing problems and social functioning even early in development. Ninety-one preschool children participated in a longitudinal project examining children's reactivity and regulatory behaviors as predictors of internalizing problems and positive and negative social behavior in the classroom. Children who paired negative emotion expression with disengagement during a laboratory task showed higher levels of internalizing problems and more negative social behavior in the classroom six months later. Positive emotion expression paired with engagement during a laboratory task predicted more positive social behavior in the classroom six months later. Physiological reactivity and regulation also predicted children's social behavior in the classroom. Findings suggest that preschool children with maladaptive reactivity and regulatory patterns may be at greater risk for internalizing problems even in early childhood.

Keywords

Emotion Regulation; Emotional Reactivity; Internalizing behavior

Understanding developmental risk factors for depression is important to clarify pathways to risk for depression and to identify mechanisms of change to target in early interventions for children at risk (Cole, Luby, & Sullivan, 2008; Izard, Fine, Mostow, Trentacosta, & Campbell, 2002). Whereas rates of clinical depression are low in early childhood (less than 1% of preschoolers, Zahn-Waxler, Klimes-Dougan, & Slattery, 2000), a considerable body of research has begun to evaluate early indicators of risk for depression (e.g., Durbin, Klein, Hayden, Buckley, & Moerk, 2005). Some studies suggest that traits that are related to depression are relatively stable, present early in development (Hasler, Drevets, Manji, & Charney, 2004), and observable both behaviorally and physiologically (Dougherty, Klein, Olino, Dyson, & Rose, 2009). In particular, trait-like differences in emotional reactivity may distinguish those who are at risk for depression (Dougherty, Klein, Durbin, Hayden, &

Correspondence should be addressed to Judith K. Morgan, Department of Psychiatry, 3811 O'Hara Street, University of Pittsburgh, Pittsburgh, Pennsylvania, 15232. morganjk@upmc.edu.
Author Note: Judith K. Morgan, University of Pittsburgh; Carroll E. Izard, University of Delaware; Christopher Hyde, BioAssessments

Olino, 2010). Additionally, emotion regulation may modulate the association between emotional reactivity and internalizing symptoms, and physiological regulatory differences may mirror these patterns (Dougherty et al., 2009). Thus, evaluation of both behavioral and physiological indices of reactivity and regulation as predictors of risk is warranted. The current study evaluated emotional and physiological reactivity and regulatory processes that may be associated with internalizing problems in early childhood. We suggest that emotional and physiological regulatory strategies may be involuntary, inherently associated with emotional reactivity, and may increase internalizing problems in early childhood, resulting in later risk for depression.

Internalizing problems comprise a broad category of affective symptoms (i.e., anxiety and depressive symptoms) associated with emotions and mood (Zahn-Waxler et al., 2000). In the preschool years, clinically significant internalizing problems have been understudied (Egger & Angold, 2006). However, subclinical internalizing problems (i.e., internalizing symptoms that are below the clinical threshold) such as difficulty separating from caregivers, high levels of sadness, and behavioral withdrawal have been observed in early childhood (Egger & Angold, 2006). Quite expectedly, subclinical internalizing problems in early childhood appear to be stable (Lavigne et al., 1998), reflect impairment in everyday settings (Egger & Angold, 2006), and may indicate risk for later clinical depression (Mesman & Koot, 2001). Evidence also suggests that internalizing problems in childhood are distinct from, albeit related to, temperamental traits of negative emotional reactivity or emotional dysregulation (Lengua, West, & Sandler, 1998). Knowing the long-term implications of early subclinical internalizing problems highlights an important research aim—the identification of early emotional behaviors that may predict the development of internalizing problems.

Emotional Reactivity

Emotional reactivity is defined as the propensity to intense and frequent emotion arousal (Rothbart & Derryberry, 1981) and may be one mechanism through which internalizing problems emerge in early childhood. Emotional reactivity is highly linked to temperament and associated with biological factors (Rothbart & Derryberry, 1981). Low levels of positive emotional reactivity reflects a tendency to experience low levels of positive emotion arousal across settings and has been connected to greater risk for depression via maternal history of depression (Durbin et al., 2005). Relatedly, low levels of positive emotional reactivity appear to be relatively stable and present prior to, during, and after the onset of depressive episodes in individuals at biological risk for depression (Hasler et al., 2004). Low positive emotionality may predict later risk for depression by contributing to rises in subclinical levels of internalizing problems (Dougherty et al., 2010). Children with low positive emotional reactivity may withdraw behaviorally in early childhood, due to less enjoyment of social activities (Rubin, Coplan, & Bowker, 2009, Spinrad et al., 2004). These early experiences of behavioral withdrawal from rewarding experiences may contribute to difficulty initiating and maintaining positive interpersonal relationships during early childhood, a sensitive period of development in which important cognitive growth and self-regulation is occurring (Rubin et al., 2009).

Likewise, greater negative emotional reactivity (i.e., high levels of sadness and irritability) in early childhood should predict internalizing problems during this time period, as experiencing these negative emotions represents important symptoms of internalizing problems (Zahn-Waxler et al., 2000). Research has found a positive link between high levels of negative emotional reactivity and later internalizing problems in children (Lonigan, Phillips, & Hooe, 2003). Combined with evidence that early temperament indices and subclinical internalizing problems may increase risk for later depression (Durbin et al., 2005; Mesman & Koot, 2001), these findings highlight the importance of evaluating negative emotional reactivity in challenging, but rewarding contexts early in development.

However, although evidence suggests that low positive and high negative emotional reactivity are both related to subsequent subclinical levels of internalizing problems in middle childhood and adolescence (Dougherty et al., 2010), the link between early childhood emotional reactivity and subclinical internalizing problems during early childhood is not as clear. We suggest that subclinical internalizing problems may develop during early childhood as a result of the combined effect of emotional reactivity and regulatory behaviors. Whereas we propose these subclinical symptoms likely will not shift to clinical levels of depression until adolescence, when developmental changes increase vulnerability to depression, we highlight the importance of detecting these early subclinical internalizing symptoms, particularly symptoms that are stable across time in early childhood, to allow for early identification for preventive intervention.

Engagement as a Regulatory Behavior

Emotional reactivity may contribute to child internalizing problems due to poor ability to regulate positive and negative emotions as emotion regulation is highly influenced by emotional reactivity (Cole, Martin, & Dennis, 2004). Children who have low levels of positive emotions may have greater difficulty initiating and maintaining positive emotions during rewarding experiences than do children with high levels of positive emotions. Children with a greater propensity to negative emotions or who experience intense negative emotions may have greater difficulty modulating those negative emotions during frustrating situations. Evaluating how the use of regulatory behaviors interacts with emotional reactivity may provide important information on how children with lower propensity to display positive emotions and greater propensity to show negative emotions may be at risk for developing internalizing problems.

Various regulatory behaviors and strategies have been evaluated as mechanisms of modulating emotion arousal in young children and as significant predictors of important outcomes in young children. Engagement during emotion-eliciting tasks is one important regulatory behavior that can sustain positive emotions in pleasant experiences and motivate action in frustrating tasks, as engagement appears to be closely linked to emotional states, particularly positive emotion (Izard et al., 2002). Evidence for engagement as a regulatory strategy for positive emotions is shown in studies evaluating persistence in young children. Greater persistence or engagement in pleasurable or challenging tasks has been associated with high levels of social competence and low levels of internalizing problems in young children (Eisenberg et al., 2001). In frustrating situations, greater engagement may

temporarily increase the intensity of negative emotions and highly reactive children may be unable to persist during those situations due to baseline levels of frustration that interfere with the task (Eisenberg et al., 2001). Thus, although engagement may be associated with distress, it may lead to adaptive outcomes as engagement in the task reflects motivation and assists children in achieving their desired goals in challenging (but possible) tasks.

Disengagement, on the other hand, is characterized as withdrawn behavior during an effortful task. Although low levels of disengagement may be associated with a neutral emotional profile and adaptive behavior (i.e., distraction) in some negative emotion-eliciting tasks (Grolnick Bridges, & Connell, 1996), high levels of disengagement during a challenging task may be associated with negative emotions such as sadness or frustration (Izard et al., 2002). Moreover high levels of disengagement may be maladaptive as they may interfere with social and cognitive growth (i.e., learning a new skill). In challenging (but possible) age-appropriate tasks that have a high potential for frustration but also for reward, disengagement may be maladaptive as it interferes with action that could result in a rewarding outcome (e.g., getting a prize). Despite the functional links between negative emotion and disengagement, high levels of disengagement have been linked to child internalizing problems (Compas, Connor-Smith, & Jaser, 2004).

Engagement may not be (and probably is not) voluntary or conscious in preschool children. Instead, regulatory behaviors may be unconsciously selected in part by the child's own characteristics—with children low on positive emotional reactivity less likely to be motivated to fully engage in an enjoyable task and children high on negative emotional reactivity less emotionally capable of engaging in a challenging task with the potential for reward (and thus disengaging). Dennis, Cole, Wiggins, Cohen, and Zalewski (2009) found that the propensity for emotions to motivate action in preschool children differed by discrete emotion (e.g., happiness motivating approach vs. sadness motivating withdrawal). Whereas emotional reactivity-regulatory patterns may be expected, their associations with problem behaviors in preschool children are unknown, and research is needed to evaluate how these emotional reactivity-regulatory sequences predict adaptive and maladaptive behaviors in children.

Physiological Reactivity and Regulation

Along with the pairing of behavioral regulatory strategies with emotional feelings, physiological regulation of emotions may be an important factor in the development of internalizing problems in young children and may mirror emotional reactivity and regulation. Although much of research evaluating regulation of the cardiovascular system has focused on parasympathetic measures of vagal tone (e.g., Gentzler, Santucci, Kovacs, & Fox, 2009), a considerable amount of research has also evaluated heart rate variability when children participate in challenging and provocative tasks as a means of understanding children's physiological reactivity and regulation of emotions (Calkins, Graziano, & Keane, 2007; Fabes, Eisenberg, Karbon, Troyer, & Switzer, 1994).

Across early development, heart rate variability during challenging tasks has been associated with adaptive outcomes in young children, such as greater sociability or adaptability (Fox,

1989; Zahn-Waxler, Cole, Welsh, & Fox, 1995) and lower levels of distress (Fabes et al. 1994). Evidence suggests that there may be an optimal level of heart rate reactivity to distressing tasks for adaptive emotion regulation in children, with too high or low levels of reactivity associated with problem behavior (Calkins, Graziano et al., 2007) These findings suggest that greater flexibility and modulation of heart rate may be adaptive for children in preventing emotional problems; however, over- or under-regulation of physiological reactivity may place children at risk. Additionally, physiological recovery from distress may be important for emotional regulation, although its link to physiological reactivity and behavioral outcomes is unclear (Gottman & Katz, 2002; Hessler & Katz, 2007). These findings indicate the need for careful examination of heart rate changes in response to emotion-eliciting tasks to evaluate both child physiological reactivity and recovery and connect them with ecologically-valid social behaviors and internalizing problems.

Overall, young children may possess trait-like emotional reactivity patterns that are reinforced by regulatory strategies that intensify or modulate these emotion feelings. The pairing of emotion feeling with certain regulatory strategies may contribute to the emergence of internalizing problems and increase risk for clinical depression later. Physiological reactivity and regulatory processes may mirror these emotional reactivity-regulatory pairings (e.g., children high on negative emotional reactivity may also show greater physiological reactivity to distress) and also influence social behaviors and internalizing problems. Understanding these emotional and physiological processes and how they are related to subclinical internalizing disorders during early development is important for informing future preventive interventions.

Hypotheses

We evaluated these emotional reactivity-regulatory sequences on affective and social behaviors in an important setting (child's classroom) in a sample of 3 to 5 year old low-income, African American children. Empirical research has indicated that studies that evaluate vulnerability factors associated with developing internalizing problems may be improved through the use of ecologically-valid methods (Murray, Woolgar, Cooper, & Hipwell, 2001). Epidemiological studies indicate that relative to the general child population, low-income preschool children show a higher incidence of emotional and behavioral problems (3–6% vs. 30% respectively; Qi & Kaiser, 2003), and these differences in rates hold for internalizing problems (7–31% in low socioeconomic samples). These prevalence rates speak to the greater likelihood of developing clinical disorders when experiencing multiple risk factors and traumatic events (e.g., poverty, exposure to violence) during early childhood, and low-income, minority children unfortunately experience these hardships at a disproportionate rate (Repetti, Taylor, & Seeman, 2002). Evaluating mechanisms of risk during early childhood in a sample of high socio-demographic risk children is important for targeting youth for preventive interventions.

Hypothesis 1 Greater positive emotional reactivity coupled with engagement during the exuberance task would relate to more positive social behavior in the classroom (i.e., happy expressions, positive social interactions). Greater negative emotional reactivity coupled with disengagement

during the distress task would relate to more negative social behavior (i.e., anger expressions, negative social interactions).

Hypothesis 2 More physiological reactivity to and less physiological recovery from the exuberance task (reflecting less ability to physiologically sustain positive emotion arousal) would relate to more positive social behavior. Likewise, more physiological reactivity to and less physiological recovery from the distress task would relate to more negative social behavior.

Hypothesis 3 Greater positive emotional reactivity coupled with engagement during the exuberance task would predict fewer internalizing problems across a 6 month period. Similarly, more physiological reactivity to and less physiological recovery from the exuberance task would be related to fewer internalizing problems.

Hypothesis 4 Greater negative emotional reactivity coupled with disengagement during the distress task would predict more internalizing problems. More physiological reactivity to and less physiological recovery from the distress task would relate to more internalizing problems across the 6 month period.

Method

Participants

Ninety-one 3- to 5-year-old African American participants were recruited from a Head Start program in the Mid-Atlantic region (M = 51.24 months, range of 39.93 to 63.13 months). Fifty-one % of the participants were female. In addition to living below the poverty line, children in our study had other socio-demographic risk factors. Mean parental education level was 11th grade and 65% of children came from single parent homes. Consistent with being at high socio-demographic risk for behavioral problems (Qi & Kaiser, 2003), children in our study had higher rates of elevated internalizing problems (17% with T-scores above 60) than would be expected of children within their age range based on epidemiological studies (Egger & Angold, 2006).

Participants were part of a larger longitudinal project on the effects of a teacher-implemented emotion-based preventive intervention for Head Start children (Izard et al., 2008). Due to the implementation of this intervention project across the school year, only participants within the control condition (N = 127) were eligible for this research study. Children enrolled in this Head Start project were predominately African American (59%) and Hispanic/Latino (40%). However, the majority of children in the control condition were non-Hispanic, African American children (79% of those reporting race/ethnicity). Due to language barriers, we chose to only recruit the African American children from this condition for this study. Participants were recruited when parents signed up for the intervention project's parent interview at time 1 (N = 95 participated in parent interviews for the intervention project) and 91 of those 95 parents enrolled in the study at that time. Of the 91 children in the study, only 82 participated in the laboratory tasks. The parents of the

remaining nine children either chose not to have their children participate in the child laboratory tasks or failed to bring them to the laboratory for participation. We collected only teacher ratings and classroom observations on the remaining nine children.

Sixty of the 82 children had usable heart rate data. Of the 22 children missing heart rate data, 77% (N=17) were missing because of data deletion due to more than 10% of data needing artifact editing (Calkins, Blandon, Williford, & Keane, 2007), 14% (N=3) were due to malfunction of the heart rate machine, and 9% (N=2) were due to parent or child refusal of heart rate measurement. Results from an ANOVA revealed no significant differences in parental educational level, marital status, child internalizing problems, or classroom behaviors between children with complete data and children with missing data on the heart rate variables.

Procedure

Time 1 data consisted of emotion and behavior coding and heart rate reactivity and recovery during an exuberance task and a distress task. At time 1, teachers rated their children's internalizing problems using the Caregiver Teacher Report Form (CTRF), and independent observers coded children's emotion expression and social interactions within the classroom.

For the emotion-eliciting tasks procedure, each child watched a four minute neutral video, "Spot" (Calkins, Blandon, et al., 2007) prior to and immediately following each of the two tasks. Data obtained during each of these three neutral videos were used to calculate a baseline measure of resting heart rate to calculate heart rate reactivity and recovery variables. The child procedure consisted of an exuberance task and a distress task from Goldsmith and Rothbart's (1993) Laboratory Temperament Assessment Battery (LAB-TAB). Participants were counterbalanced such that a randomly selected half of the children participated in the exuberance task first.

During the exuberance task, the experimenter taught the child how to blow bubbles using a bubble gun. The child and the experimenter then engaged in popping the bubbles before they reached the floor. The child was encouraged to remain standing in one spot during the procedure to minimize motor activity. This task lasted four minutes.

We adapted a distress task from the LAB-TAB to include a goal-directed puzzle task. During our distress task, the child chose an attractive toy from two possible options (toy guitar, leapfrog video game) and was told that he would have a chance to play with the toy. The toy was placed in a transparent box and locked with a padlock. The child was given a set of keys and told that if he is able to open the padlock he will be able to play with the toy. Each child was given a set of incorrect keys, none of which would open the lock. Similar to Eisenberg et al. (2001)'s puzzle task, the child was then left alone for two minutes before the experimenter returned to tell the child that if he is able to complete two age appropriate puzzles, the experimenter will open the box for him. The child was then given the two age appropriate puzzles to work on. The locked transparent box and keys were left in the room within eyesight of the child. The child was left alone with the puzzles for two minutes. After this procedure, the experimenter thanked the child for his hard work and was told that she

would go open the box for him so he could play with the attractive toy. This distress task lasted a total of four minutes.

Time 2 assessments occurred approximately six months later. Once again, teachers rated children's internalizing problems using the CTRF. Independent observers collected behavioral observations of child emotion and social behaviors in the classroom.

Measures

Heart rate reactivity—Following the method used by Calkins and colleagues, heart rate data were collected by placing electrodes on the child's chest during the emotion-eliciting tasks. The electrodes were connected to a preamplifier which provided output of the interbeat intervals (IBIs) for the period of heart rate collection. The output was then transferred to computer software for artifact editing which consisted of scanning each data file for outlier points due to movement artifact. Similar to Calkins, Blandon et al. (2007), IBI data in which more than 10 percent required editing were removed from the data set.

Heart rate reactivity for the exuberance task and distress task were calculated as the average IBI during the exuberance task minus the average IBI of the neutral video that immediately preceded it and as the average IBI during the distress task minus the average IBI of the neutral video that immediately preceded it, respectively. Heart rate recovery for the exuberance task and the distress task was scored as the average IBI during the exuberance task minus the average IBI of the neutral video that immediately followed it and as the average IBI during the distress task minus the average IBI during the neutral video that immediately followed it, respectively. A decrease in IBI from task (e.g., bubbles) to task (e.g., video) represented an acceleration in heart rate (Calkins, Blandon, et al., 2007).

Emotion and behavior coding—Children's emotion expressions were coded as happy, sad, angry, or noncodable during the exuberance and distress tasks using a coding system adapted from AFFEX emotional coding (Izard & Dougherty, 1980). Presence and intensity of emotion expression was coded during 5 second intervals for each of the four minute videos. Happy emotion expression was defined as the presence of happy facial expressions (smiles), vocal tones (giggles, excited tones), and movements (jumping up and down, clapping hands). An intensity of 1 indicated the presence of smiles or excited vocal tones. An intensity of 2 indicated the presence of happy facial expressions, paired with happy vocal tones or movements. Sadness emotion expression was defined as the presence of sad facial expressions (lowered lip corners, pouts), vocal tones (whines, whimpers), and movements (lowered head, slumped posture). An intensity of 1 indicated the presence of sad facial expressions. An intensity of 2 indicated the presence of sad facial expressions paired with sad vocal tones and movements. Anger emotion expression was defined as the presence of angry facial expressions (furrowed brow, lips pressed together), vocal tones (grunts, yells), and movements (stomping feet, tensing body). An intensity of 1 indicated the presence of angry facial expressions. An intensity of 2 indicated the presence of angry facial expressions paired with angry vocal tones and movements.

Child engagement/disengagement during the exuberance and distress tasks was coded in the final second of each 5 second epoch. Engagement/disengagement was coded only for this

final second but may have been present earlier in the epoch. Child engagement was coded as behavioral involvement in the task (i.e., blowing or popping bubbles during the exuberance task, actively working on the puzzles during the distress task). Child engagement was considered distinct from emotion coding as children were not coded as engaged if they simply showed emotion cues during the task (e.g., crying). Disengagement was scored as the absence of an engagement code during that epoch. This coding resulted in four scores: engagement during exuberance, engagement during distress, disengagement during exuberance, and disengagement during distress.

Undergraduate and graduate student coders were trained in emotion expression and engagement coding for each of the two tasks (exuberance, distress) on 10% of the data (ICC = .81 for happy expression; .99 for sadness expression, .84 for anger expression, and .80 for persistence). Random reliability checks were conducted after training to ensure that coders remained reliable (80% agreement) on the two tasks (an additional 10% of tapes were double-coded following reliability training).

Internalizing problems—Child internalizing problems were measured using the internalizing composite scale of Achenbach and Rescorla's (2000) CTRF at time 1 and time 2. This measure asks teachers to rate children's behavior on a 3 point Likert scale and is normed for 1.5 to 5 year old children. A sample item from the internalizing problems composite scale is "looks unhappy without good reason" The alpha for the internalizing behavior composite was .99 at time 1 and time 2. As internalizing problems at time 1 and time 2 were highly correlated ($r = .64$, $p < .01$) but did not significantly change over time ($F = .49$, n.s.), we aggregated these two measures to create a measure of internalizing problems that reflected their presentation over time.

Classroom behavior—We conducted two 8 minute live observations of each child during times when he was most likely to be involved in free play or structured activities in the classroom using the Behavior and Emotion Expression Observation System (Izard, King, & Finlon, 2007). Undergraduate-level research assistants coded the child's emotion and behavior every 15 seconds within the eight minute time period. Each child was coded for expressions of happiness, sadness, and anger and for positive social interactions (comprised of helping behaviors, comforting behaviors, and general positive behaviors) and negative social interactions (aggressive behaviors). Coders were trained using laboratory videos of free play behavior (N = 10–15 videotapes, 10–15% of sample) until they reached an inter-rater reliability of .80 (Cohen's kappa = .86). Random reliability checks were conducted after training using data from live classroom behavior to ensure that coders remained at 80 percent agreement (13% of observations). A positive social behavior aggregate was computed as proportion of epochs showing happiness expression in the classroom combined with proportion of epochs showing positive social interactions. A negative social behavior aggregate was computed as proportion of epochs showing anger expression in the classroom combined with proportion of epochs showing negative social interactions. As sadness expression was not significantly correlated with anger expression or negative interactions, it was not included in the aggregate.

Data analytic strategy—Emotional reactivity-regulatory sequences were computed as epochs that contained the presence of an emotion expression (e.g., happiness) and regulatory behavior (i.e., engagement). As these epochs were coded as peak intensity of the emotion expression within the 5 second epoch and regulatory behavior was coded as the presence of that action in the final second of the 5 second epoch, we were able to evaluate how the child's emotion (happiness, sadness, anger) was temporally followed by the regulatory behavior (engagement, disengagement). As sadness and anger expression were highly correlated during the distress task ($r = .73$, $p < .01$) and as the task is likely to elicit both of these emotions, we aggregated these two emotions. The two sequences of interest for this study were a positive emotion-engagement sequence and a negative emotion-disengagement sequence. Proportions of these two sequences across the 4 minute tasks (exuberance task for positive emotion-engagement sequence, distress task for negative emotion-disengagement sequence) were computed and the means of each of these proportions were used as predictor variables in our path models.

Results

We first ran preliminary analyses to examine the relation between our control, predictor, and outcome variables for each of our hypotheses. Tables 1 and 2 present the means, standard deviations, ranges, and intercorrelations among these variables. Older children were more engaged during the distress task ($r = .40$, $p < .01$). An ANOVA revealed that boys were more engaged during the exuberance task ($F = 2.33$, $p < .02$).

We conducted a path analysis in MPLUS 5 (Muthen & Muthen, 1998) using a maximum likelihood framework to evaluate the effects of reactivity and regulation on social behaviors and internalizing problems across the school year. Modeling path models within MPLUS is advantageous as it allows for testing of multiple dependent variables simultaneously. A maximum likelihood model was used to estimate the models and accommodate missing data ($N = 91$ for all of our models). Although children in our data set were nested within 15 classrooms, tests of interdependence indicated that interdependence among variables was low (ICC = .07 for internalizing problems, .07 for negative social behavior, .16 for positive social behavior). Thus, we did not account for clustering in our model.

Our model included positive social behaviors at time 2, negative social behaviors at time 2, and internalizing problems as dependent variables. Positive emotion-engagement, negative emotion-disengagement, physiological reactivity during the exuberance and distress tasks, and physiological recovery from the exuberance and distress tasks were entered as predictors (Table 3). Child age and sex were both originally included as covariates in the model, based on their relation to predictor and outcome variables. However, child sex and exuberance reactivity were both removed from the final model to create a more parsimonious model as neither were associated with any of our outcomes once entered into the path model. Model fit was good ($\chi^2 = 46.53$, $df = 21$, $p < .01$; CFI = 1.00, RMSEA = .00)

Hypothesis 1 Positive emotion-engagement during the exuberance task predicted more positive social behavior 6 months later. Negative emotion-disengagement during the distress task predicted more negative social

and approached significance in predicting less positive social behavior 6 months later.

Hypothesis 2 Greater physiological reactivity during the distress task was related to more negative social behavior. Greater physiological recovery from the distress task was related to more positive social behavior. Greater physiological recovery from the exuberance task predicted less positive social behavior.

Hypothesis 3 Positive emotion-engagement was unrelated to internalizing problems.

Hypothesis 4 Negative emotion-disengagement during the distress task predicted more teacher-reported internalizing problems.

Discussion

Early emotional reactivity and regulatory patterns may influence the development of internalizing problems in early childhood. These early childhood internalizing problems may increase risk for clinical depression later in development, potentially due to associated maladaptive social behaviors. We found evidence that emotional reactivity-regulatory patterns are associated with social behaviors that reflect social adjustment and maladjustment. In particular, happiness paired with engagement during a positive emotion-eliciting task predicted more positive social behavior in the classroom 6 months later. Negative emotion (anger and sadness) paired with disengagement during the distress task predicted more negative social behavior and approached significance in predicting less positive social behaviors six months later. These findings provide evidence that these reactivity-regulatory patterns represent relevant child behaviors that are stable across time and settings.

In addition, these reactivity-regulatory sequences predicted internalizing problems as reported across a six month period of early childhood. Similar to prior research linking negative emotional reactivity to later internalizing problems (Lonigan et al., 2003), negative emotion paired with disengagement during a distress task was associated with higher levels of teacher-reported internalizing problems. Children prone to more negative emotion who also show regulatory behaviors such as disengagement may be at elevated risk for internalizing problems during early childhood.

Children who pair high levels of negative emotions with disengagement may be more prone to give up in response to challenge and miss out on potentially rewarding outcomes, such as winning a prize or making a friend. Our negative emotion-eliciting task, albeit frustrating, included the potential for reward. Following the frustration and disappointment of not obtaining a desired toy, children were informed if they completed an age-appropriate puzzle that the experimenter would give them their desired toy. High levels of disengagement during this task might reflect lack of motivation to obtain a reward or an inability to regulate negative feelings in order to work towards a desired goal. As this pattern was associated with internalizing problems, this pattern may be indicative of risk for depression, a disorder of low motivation or engagement and dysregulated emotions.

Unexpectedly, positive emotional reactivity paired with engagement did not predict internalizing problems in our study. One possibility is that positive emotional reactivity and engagement may be specifically predictive of depressive but not anxious symptoms, given prior findings that positive emotionality distinguishes risk for depression from other affective disorders (Durbin et al., 2005), diminishing its ability to significantly relate to the broad composite of internalizing symptoms. Negative emotional reactivity and disengagement have been associated with both depressive and anxious symptoms (Compas et al., 2004), and may predict a broader composite of subclinical internalizing symptoms in early childhood as well.

We also found evidence that physiological reactivity to and recovery from positive and negative eliciting situations predicted social behavior in the classroom in an expected way. Children who are more physiologically reactive to frustrating tasks showed more negative social behavior in the classroom six months later. Children who were less able to maintain physiological arousal to positive experiences showed less positive social behavior in the classroom six months later. In contrast, children who were less able to modulate their physiological arousal after the distress task showed less positive social behavior.

These findings may indicate that, in terms of positive emotions, effective regulation may consist of maintenance of positive arousal; whereas in regard to negative emotions, effective regulation may be composed of decreasing negative arousal. Such adaptive modulation appears to be important for social behavior and these findings are similar to previous studies indicating that there may be optimal levels of physiological reactivity to emotion-eliciting situations (Calkins, Graziano et al., 2007) and that physiological recovery may be a distinct predictor of child outcomes (Hessler & Katz, 2007). It should be noted that these physiological measures were not associated with internalizing problems.

Our findings support our proposed model that negative emotional reactivity may interact with regulatory behaviors to predict internalizing problems in early childhood. We provide some evidence for why emotional reactivity may specifically relate to later risk for depression—through interplay with ineffective regulatory behaviors that may be associated with the development of subclinical internalizing problems in *early childhood*—putatively placing children at risk for subsequent clinical levels of depression. Rather than suggesting that these internalizing problems emerge later in development at the onset of clinical depression, we posit that subclinical internalizing symptoms develop early on and interfere with normative growth and development. More longitudinal research is needed to evaluate how subclinical internalizing problems in the preschool years directly relate to clinical levels of depression in adolescence and adulthood. Also, we only focused on the pairing of positive emotion-engagement and negative emotion-disengagement, based on emotion theory (Izard et al., 2002). Future research should evaluate how other pairings of emotional reactivity and regulation (e.g., negative emotion-engagement) may predict internalizing and other kinds of problems.

Children from our study were at elevated socio-demographic risk for developing internalizing disorders. Pairing negative emotion, in the face of challenging but potentially rewarding tasks, with disengagement may be particularly maladaptive for children of

disadvantaged backgrounds. Young children in disadvantaged settings may require greater engagement and persistence in challenging (but possible) tasks in order to succeed and achieve important social and cognitive growth in the face of hardship. In contrast, increasing engagement in socially rewarding tasks that elicit positive emotion feeling may be important for disadvantaged children to buffer the negative experiences of traumatic events and promote positive social development.

Strengths and Limitations

We utilized Cole et al.'s (2004) recommendations for measuring the interplay of emotional reactivity and regulatory behaviors in childhood. We assessed emotion expression separately from engagement/disengagement. We evaluated the temporal relations of these variables across each of the 4 minute emotion-eliciting tasks. We used multiple methods of measurement, including behavioral observations and heart rate measurement.

Another strength of our study is the linking of these emotional reactivity-regulatory patterns and physiological predictors to classroom social behaviors in high risk preschoolers. This link is important as we are able to provide evidence for the theoretical claim that these reactivity-regulatory patterns predict internalizing problems in early childhood due to their influence on normative growth and development.

Although our study included longitudinal data, we were unable to follow children for more than a six-month period, preventing us from examining whether emotional reactivity and regulation and subclinical internalizing problems predict the emergence of clinical depression later in development. Future research should examine how our behavioral and physiological predictors relate to development of clinical internalizing problems across childhood and adolescence.

Emotional reactivity as a trait variable is best captured by multiple measurements of emotion arousal in different settings across time. Other research has found that measurement of emotional reactivity using laboratory observations such as the LAB-TAB is moderately to highly stable (Hayden, Klein, & Durbin, 2005). Whereas we acknowledge the limitations of using only one measure of positive and negative emotional reactivity, the significant associations among our laboratory-based emotional reactivity-regulatory patterns to social behavior in a different setting (i.e. classroom) by independent observers 6 months later provides some assurance of the ecological validity of these laboratory measures as well as their ability to capture stable phenomena.

Implications for Intervention

Our findings suggest that as early as 3 to 5 years of age, children may show emotional reactivity and regulatory patterns that are predictive of subclinical internalizing problems that may increase risk for later depression. Research has highlighted the need for early identification of risk factors as a means of preventing clinical disorders, rather than intervening after their development (Cole et al., 2008). Targeting young children facing poverty is important as they may be at heightened risk for clinical disorders due to experiencing various hardships (Repetti et al., 2002). Altogether, our findings can help in identifying which children are at risk and should be targeted early in childhood for emotion-

based preventive interventions that promote adaptive and healthy development (Izard et al., 2008).

Acknowledgments

This research was funded in part by Grant 1R01MH080909-01A1 from the National Institute of Mental Health. We thank the staff of the Human Emotions Lab and the study families for making this research possible.

References

Achenbach, TM.; Rescorla, LA. Manual for the ASEBA preschool forms and profiles. Burlington, VT: University of Vermont. Department of Psychiatry; 2000.

Calkins SD, Blandon AY, Williford AP, Keane SP. Biological, behavioral, and relational levels of resilience in the context of risk for early childhood behavior problems. Development and Psychopathology. 2007; 19:675–700. [PubMed: 17705898]

Calkins SD, Graziano PA, Keane SP. Cardiac vagal regulation differentiates among children at risk for behavior problems. Biological Psychology. 2007; 74:144–153. [PubMed: 17055141]

Cole PM, Luby J, Sullivan MW. Emotions and the development of childhood depression: Bridging the gap. Child Development Perspectives. 2008; 2:141–148. [PubMed: 19956783]

Cole P, Martin SE, Dennis TA. Emotion regulation as a scientific construct: Methodological challenges and directions for child development research. Child Development. 2004; 75:317–333. [PubMed: 15056186]

Compas BE, Connor-Smith J, Jaser SS. Temperament, stress reactivity, and coping: Implications for depression in childhood and adolescence. Journal of Clinical Child and Adolescent Psychology. 2004; 33:21–31. [PubMed: 15028538]

Dennis TA, Cole PM, Wiggins PM, Cohen LH, Zalewski M. The functional organization of preschool-age children's emotion expression and actions in challenging situations. Emotion. 2009; 9:520–530. [PubMed: 19653775]

Dougherty LR, Klein DN, Durbin CE, Hayden EP, Olino TM. Temperamental positive and negative emotionality and children's depressive symptoms: A longitudinal prospective study from age three to age ten. Journal of Social and Clinical Psychology. 2010; 29:462–488.

Dougherty LR, Klein DN, Olino TM, Dyson M, Rose S. Increased waking salivary cortisol and depression risk in preschoolers: The role of maternal history of melancholic depression and early child temperament. Journal of Child Psychology and Psychiatry. 2009; 50:1495–1503. [PubMed: 19686335]

Durbin CE, Klein DN, Hayden EP, Buckley ME, Moerk KC. Temperamental emotionality in preschoolers and parental mood disorders. Journal of Abnormal Psychology. 2005; 114:28–37. [PubMed: 15709809]

Egger HL, Angold A. Common emotional and behavioral disorders in preschool children: Presentation, nosology, and epidemiology. Journal of Child Psychology and Psychiatry. 2006; 47:313–337. [PubMed: 16492262]

Eisenberg N, Gershoff ET, Fabes RA, Shepard SA, Cumberland AJ, Losoya SJ, Guthrie IK, Murphy BC. Mothers' emotional expressivity and children's behavior problems and social competence: Mediation through children's regulation. Developmental Psychology. 2001; 37:475–490. [PubMed: 11444484]

Fabes RA, Eisenberg N, Karbon M, Troyer D, Switzer G. The relations of children's emotion regulation to their vicarious emotional responses and comforting behaviors. Child Development. 1994; 65:1678–1693. [PubMed: 7859549]

Fox. Psychophysiological correlates of emotional reactivity during the first year of life. Developmental Psychology. 1989; 25:364–372.

Gentzler AL, Santucci AK, Kovacs M, Fox N. Respiratory sinus arrhythmia reactivity predicts emotion regulation and depressive symptoms in at-risk and control children. Biological Psychology. 2009; 82:156–163. [PubMed: 19596044]

Goldsmith, HH.; Rothbart, MK. The laboratory temperament assessment battery (LAB-TAB). Madison: University of Wisconsin; 1993.

Gottman JM, Katz LF. Children's emotional reactions to stressful parent-child interactions: The link between emotion regulation and vagal tone. Marriage and Family Review. 2002; 34:265–283.

Grolnick WS, Bridges LJ, Connell JP. Emotion regulation in two year olds: Strategies and emotional expression in four contexts. Child Development. 1996; 67:928–941. [PubMed: 8706536]

Hasler G, Drevets WC, Manji HK, Charney DS. Discovering endophenotypes for major depression. Neuropsychopharmocology. 2004; 29:1765–1781.

Hayden EP, Klein D, Durbin CE. Parent reports and laboratory assessments of child temperament: A comparison of their associations with risk for depression and externalizing disorders. Journal of Psychopathology and Behavioral Assessment. 2005; 27:89–100.

Hessler DM, Katz LF. Children's emotion regulation: Self-report and physiological response to peer provocation. Developmental Psychology. 2007; 43:27–38. [PubMed: 17201506]

Izard, CE.; Dougherty, L. A system for identifying affect expressions by holistic judgments (AFFEX). Newark: University of Delaware, Instructional Resources Center; 1980.

Izard CE, Fine SE, Mostow AJ, Trentacosta CJ, Campbell J. Emotion processes in normal and abnormal development and preventive intervention. Development and Psychopathology. 2002; 14:761–787. [PubMed: 12549703]

Izard, CE.; King, KA.; Finlon, KJ. Unpublished manual. 2007. Behavior and Emotion Expression Observation System.

Izard CE, King KA, Trentacosta CJ, Morgan JK, Laureanceau JP, Krauthamer-Ewing ES, Finlon K. Accelerating the development of emotion competence in Head Start children: Effects on adaptive and maladaptive behavior. Development and Psychopathology. 2008; 20:369–397. [PubMed: 18211742]

Lavigne JV, Arend R, Rosenbaum D, Binns H, Kaufer Christoffel K, Gibbons RD. Psychiatric disorderes with onset in the preschool years: I. Stability of diagnoses. Journal of American Academy of Child and Adolescent Psychiatry. 1998; 37:1246–1254.

Lengua LJ, West SG, Sandler IN. Temperament as a predictor of symptomatology in children: Addressing contamination of measures. Child Development. 1998; 69:164–181. [PubMed: 9499565]

Lonigan CJ, Phillips BM, Hooe ES. Relations of positive and negative affectivity to anxiety and depression in children: Evidence from a latent variable longitudinal study. Journal of Consulting and Clinical Psychology. 2003; 71:465–481. [PubMed: 12795571]

Mesman J, Koot HM. Early preschool predictors of preadolescent internalizing and externalizing DSM-IV diagnoses. Journal of American Academy of Child and Adolescent Psychiatry. 2001; 40:1029–1036.

Murray L, Woolgar M, Cooper P, Hipwell A. Cognitive vulnerability to depression in 5-year-old children of depressed mothers. Journal of Child Psychology and Psychiatry. 2001; 42:891–899. [PubMed: 11693584]

Muthen, L.; Muthen, B. Mplus: User's guide 6.0. Los Angeles, CA: Muthen & Muthen; 1998–2010.

Qi CH, Kaiser AP. Behavior problems of preschool children from low-income families: Review of the literature. Topics in Early Childhood Special Education. 2003; 23:188–216.

Repetti RL, Taylor SE, Seeman TE. Risky families: Family social environments and the mental and physical health of offspring. Psychological Bulletin. 2002; 128:330–366. [PubMed: 11931522]

Rothbart, M.; Derryberry, D. Development of individual differences in temperament. In: Lamb, ME.; Brown, AL., editors. Advances in developmental psychology. Vol. 1. Hillsdale, NJ: Erlbaum; 1981. p. 37-86.

Rubin KH, Coplan RJ, Bowker JC. Social withdrawal in childhood. Annual Review of Psychology. 2009; 60:141–171.

Spinrad TL, Eisenberg N, Harris E, Hanish L, Fabes RA, Kupanoff K, Ringwald S, Holmes J. The relation of children's everyday nonsocial peer play behavior to their emotionality, regulation and social function. Developmental Psychology. 2004; 40:67–80. [PubMed: 14700465]

Zahn-Waxler C, Cole PM, Welsh JD, Fox NA. Psychophysiological correlates of empathy and prosocial behaviors in preschool children with behavior problems. Development and Psychopathology. 1995; 7:27–48.

Zahn-Waxler C, Klimes-Dougan B, Slattery MJ. Internalizing problems of childhood and adolescence: Prospects, pitfalls, and progress in understanding the development of anxiety and depression. Development and Psychopathology. 2000; 12:443–466. [PubMed: 11014747]

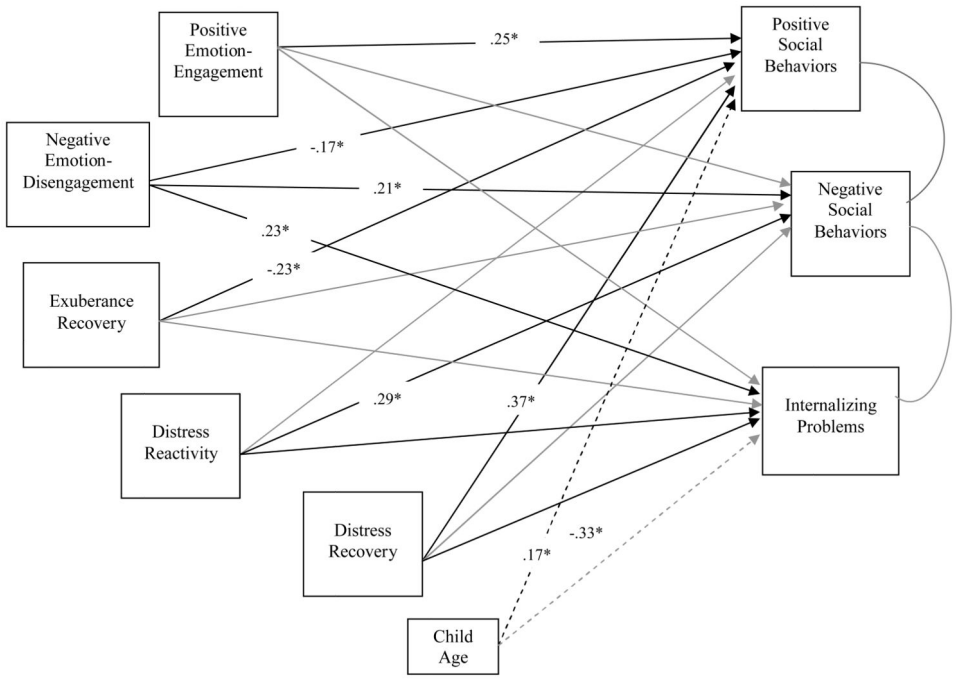

Figure 1. Final Path Model of Reactivity and Regulation on Positive and Negative Social Behavior and Internalizing Problems

Note. $^{**}p < .01$. $^{*}p < .05$. $^{+}p < .10$. Only significant estimates are reported from the standardized model. Faded lines represent non-significant paths. Dashed lines represent paths from covariates (age). $\chi^2 = 46.53$, $df = 21$, $p < .01$; CFI = 1.00, RMSEA = .00

Table 1

Means, Standard Deviations, and Ranges of Predictor and Outcome Variables

Variable	*M*	*SD*	*Range*
1. Age	50.54	6.70	39.39–62.27
2. Happy-Exub	.76	.32	.08–1.44
3. Sad-Dist	.06	.20	.00–1.33
4. Angry-Dist	.04	.10	.00–.83
5. Engagement-Exub	.69	.12	.40–.96
6. Disengagment-Dist	.77	.19	.17–.98
7. Happy-Classroom	25.14	16.73	.00–75.00
8. Sad-Classroom	.95	2.90	.00–20.31
9. Angry-Classroom	1.43	2.14	.00–10.94
10. Positive Social	38.32	19.05	3.13–84.21
11. Negative Social	1.16	2.06	.00–10.94
12. T1 Internalizing	6.13	7.04	.00–28.00
13. T2 Intern	6.85	6.71	.00–28.00
14. Exub Reactivity	−24.61	25.26	−95.00–19.00
15. Exub Recovery	−15.76	21.93	−67.00–38.00
16. Dist Reactivity	−24.19	21.96	−69.00–31.50
17. Dist Recovery	−18.83	19.47	−58.50–48.50

Note:

** $p < .01$.

* $p < .05$.

+ $p < .10$.

Table 2

Intercorrelations of Predictor and Outcome Variables

Variable	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*
1. Age	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2. Happy-Exub	.01	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
3. Sad-Dist	−.22^{+}	−.01	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4. Angry-Dist	−.13	.01	.73**	--	--	--	--	--	--	--	--	--	--	--	--	--
5. Engagement-Exub	.12	08	.07	.27*	--	--	--	--	--	--	--	--	--	--	--	--
6. Disengagement-Dist	.40**	−.21	−.47**	−.37**	.03	--	--	--	--	--	--	--	--	--	--	--
7. Happy-Classroom	.01	.15	−.08	−.07	.12	.19	--	--	--	--	--	--	--	--	--	--
8. Sad-Classroom	.00	.11	.04	−.05	−.21^{+}	−.06	.03	--	--	--	--	--	--	--	--	--
9. Angry-Classroom	−.08	.10	.09	.22^{+}	.06	−.27*	−.18*	.03	--	--	--	--	--	--	--	--
10. Positive Social	.04	.24*	.11	.15	.11	.05	.50**	−.13	.04	--	--	--	--	--	--	--
11. Negative Social	−.11	−.02	.28*	.31*	−.02	.02	−.01	.00	.37**	.12	--	--	--	--	--	--
12. Time 1 Internalizing	−.06	−.13	.24*	.41**	.05	−.03	−.01	.05	.18	−.06	.04	--	--	--	--	--
13. Time 2 Internalizing	.05	−.12	.07	.12	.10	−.01	−.10	.03	.05	−.27*	−.15	.64**	--	--	--	--
14. Exub Reactivity	−.04	.22	.02	.02	−.12	−.22	.08	−.24	.02	−.08	.01	−.14	−.01	--	--	--
15. Exub Recovery	−.05	.33*	.00	−.01	−.07	−.34*	−.12	.04	.01	−.28	−.07	−.21	.06	.74**	--	--
16. Dist Reactivity	−.05	.14	−.22	−.18	.12	.05	.27^{+}	−.02	.11	.22	.15	−.03	−.25^{+}	−.19	−.15	--
17. Dist Recovery	−.25^{+}	.18	.10	−.18	.18	−.32*	.38*	.07	.03	.22	−.02	.09	−.11	.01	.17	.45**

Note:

** $p < .01$.

* $p < .05$.

$^{+}$ $p < .10$.

Table 3

Path Model of Reactivity and Regulation on Teacher-Rated Internalizing Problems, Positive Social Behavior, and Negative Social Behavior (N = 91)

Fixed Effect	*B*	*t*	*p*
Teacher-rated Internalizing			
Age	−.10	−.96	.34
Positive Emotion-Engagement	−.06	−.54	.59
Negative Emotion-Disengagement	.23*	2.29*	.02
Distress Reactivity	−.14	−1.05	.29
Exuberance Recovery	−.07	−.70	.48
Distress Recovery	.04	.14	.78
Positive Social Behavior			
Age	.17	1.72+	.09
Positive Emotion-Engagement	.25*	2.24*	.03
Negative Emotion-Disengagement	−.17	−1.77+	.08
Distress Reactivity	−.04	−.31	.76
Exuberance Recovery	−.23*	−2.36*	.02
Distress Recovery	.37*	2.69*	.01
Negative Social Behavior			
Age	−.33	−3.43	.00
Positive Emotion-Engagement	.07	.59	.56
Negative Emotion-Disengagement	.21*	2.17*	.03
Distress Reactivity	.29	2.10*	.04
Exuberance Recovery	.02	.17	.87
Distress Recovery	−.20	−1.41	.16

Note. The values in the table come from the standardized model.

** $p < .01$.

* $p < .05$.

+ $p < .10$.