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Profiles of disruptive behavior across early childhood: Contributions of frustration reactivity, physiological regulation, and maternal behavior

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Abstract

Disruptive behavior, including aggression, defiance, and temper tantrums, typically peaks in early toddlerhood and decreases by school entry; however, some children do not show this normative decline. The current study examined disruptive behavior in 318 boys and girls at 2, 4, and 5 years of age and frustration reactivity, physiological regulation, and maternal behavior in the laboratory at 2 years of age. A latent profile analysis (LPA) resulted in 4 longitudinal profiles of disruptive behavior, which were differentiated by interactions between reactivity, regulation, and maternal behavior. A high profile was associated with high reactivity combined with high maternal control or low regulation combined with low maternal control. Results are discussed from a developmental psychopathology perspective.

Disruptive behaviors, such as aggression, defiance, and temper tantrums, are some of the most common problems seen in children (Beauchaine et al., 2002). Furthermore, chronic disruptive behavior problems are resistant to treatment and result in significant costs to society over time (Shaw, Winslow, Owens, Vondra, Cohn, & Bell, 1998). Given the negative effects and stability of disruptive behavior, it is important to identify its antecedents in order to develop useful early intervention and prevention programs. Typically, children's early social development includes a moderate level of disruptive behavior, which normatively desists (declines) across early childhood as early exposure to conflict helps children attain prosocial strategies (Owens & Shaw, 2003; Tremblay, 2000). However, some children retain their disruptive behavior across childhood, which often leads to antisocial behavior in adolescence and adulthood (Broidy et al., 2003). Understanding the precursors of persistent problem behavior may inform prevention efforts by elucidating the skills important to developing prosocial behavior and the risk factors that thwart these positive trajectories.

Consistent with a developmental psychopathology framework, theories of externalizing behavior suggest individual differences in developmental patterns of disruptive behavior. For example, past work has suggested two patterns of externalizing behavior, a high persistent pattern and a normative pattern (Moffitt, 1993). Additional research has demonstrated more

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than two longitudinal patterns of aggressive and non-aggressive externalizing behavior problems (Maughan, Pickles, Rowe, Costello, & Angold, 2000). Although typically defined a priori, these patterns can be empirically estimated using new statistical techniques, such as semi-parametric mixture modeling (Nagin & Tremblay, 2005; Muthén, 2004). Studies using these techniques reveal empirical support for several patterns of disruptive behavior across early childhood (Hill, Degnan, Calkins, & Keane, 2006; NICHD, 2004; Shaw, Gilliom, Ingoldsby, & Nagin, 2003; Shaw, Lacourse, & Nagin, 2005). In addition, examining multiple longitudinal patterns of behavior, rather than a single pattern or behavior at a single time point, will better represent the complexity of developmental pathways compared with more traditional approaches (Sroufe & Rutter, 1984).

The existence of multiple patterns of disruptive behavior has been supported; however, the array of factors that might distinguish these early chronic trajectories from more normative trajectories is less clear. Child and maternal factors, such as temperamental reactivity, emotion regulation, and maternal control, have been posited to influence children's ability to effectively control their emotions and learn socially appropriate behavior (Calkins, 1994; Calkins & Degnan, 2006). Previous research examined a few of these factors as direct predictors (Hill et al., 2006; NICHD, 2004; Shaw et al., 2005) and one study examined interactions of these factors in relation to longitudinal patterns of disruptive behavior in early childhood (See Shaw et al., 2003). However, from a developmental psychopathological perspective, further exploration into the joint effects of temperament and maternal behavior on longitudinal patterns of externalizing behavior problems is essential to fully inform prevention efforts. The concepts of multifinality and equifinality imply that both child and maternal factors may relate to specific levels of disruptive behavior problems in multiple ways (Cicchetti & Rogosch, 1996). Thus, the present study examined frustration reactivity, physiological regulation, and maternal controlling behavior in toddlerhood as joint predictors of the probability of membership in longitudinal profiles of disruptive behavior across early childhood.

Predictors of longitudinal profiles of disruptive behavior

One constellation of factors suggested to contribute to the maintenance of disruptive behavior is temperament, which includes reactivity to the environment and regulation of that reactivity (Cole, Martin, & Dennis, 2004). The stable and enduring aspect of temperament is thought to be an individual's level of emotional and motor reactivity during an emotionally challenging context, which is influenced by regulatory systems over time (Rothbart & Bates, 2006; Rothbart, Derryberry, & Hershey, 2000). In fact, observed measures of emotional reactivity during emotion-eliciting situations are moderately stable (Calkins, 2002; Stifter & Fox 1990; Rothbart, Derryberry et al., 2000) and related to important behavioral outcomes (for a detailed review, see Rothbart & Bates, 2006). Whereas reactivity to novelty has been linked to internalizing behaviors (Fox, Henderson, Rubin, Calkins, & Schmidt, 2001), frustration reactivity has been linked to externalizing behaviors in toddlerhood and early childhood (Calkins, 2002; Hubbard et al., 2002). For instance, children who are highly reactive to frustration may act aggressively when provoked or aggravated because of their tendency to perceive these provocations as hostile (Vitaro, Brendgen, & Tremblay, 2002). In general, negative, difficult temperamental components are associated with externalizing behavior problems (Rothbart & Bates, 2006). However, research exploring the effects of frustration reactivity on longitudinal patterns of problem behavior across early childhood is limited (See Shaw et al., 2005 for an exception).

Children's frustration reactivity is thought to be stable, but it also is influenced by regulatory systems over time (Rothbart & Bates, 2006; Rothbart, Derryberry, & Hershey, 2000). Thus, in addition to frustration reactivity, emotion regulation also is suggested to influence disruptive behavior. Whereas frustration reactivity is the emotional excitation of an individual, emotion

regulation is the biological or behavioral processes that alter that reactivity (Rothbart, Ahadi, & Evans, 2000). Through both physiological and behavioral factors, children first develop strategies to regulate arousal, which later develop into a formal repertoire of skills used to actively regulate emotions and behavior in a variety of contexts (Calkins, 1994; Calkins & Degnan, 2006). These skills lead to positive social skills and a decline in disruptive behavior over time (Denham & Burton, 1996). Emotion regulation is typically measured as behavior or physiology during situations that have presumed regulatory demands and elicit specific regulatory behaviors (Cole et al., 2004). A physiological construct frequently linked to emotion regulation is vagal tone (VT). When there are external demands the autonomic nervous system supports the arousal of the sympathetic system by withdrawing the parasympathetic (vagal) input to the heart and other organs in order to promote fight/flight behaviors (Porges, 1991; Porges, Doussard-Roosevelt, & Maiti, 1994). Thus, under stress or challenge, RSA (Respiratory Sinus Arrhythmia; an estimate of VT) is expected to decrease from baseline (vagal withdrawal; Porges et al., 1994) and this decrease is related to lower frustration reactivity, the use of emotion regulation skills (Calkins, 1997; Calkins et al., 2002), and fewer behavior problems (Calkins & Dedmon, 2000; Eisenberg, Fabes, & Murphy, 1996).

Children's levels of frustration reactivity and physiological regulation have been directly related to externalizing behavior problems at specific time periods throughout childhood, but the longitudinal implications of early reactivity-regulation profiles are unknown. In addition, temperamental reactivity and emotion regulation are hypothesized to interact in relation to children's social adjustment (Calkins & Degnan, 2006; Rothbart & Bates, 2006; Sanson, Hemphill, & Smart, 2004). Undoubtedly, when children are able to regulate their frustration reactivity they are better able to interact in a positive, social manner. However, if children have limited regulatory skills and are prone to frustration, they are likely to develop maladaptive social behavior. Studies examining these types of interactive effects found that a combination of higher frustration reactivity and lower regulation skills predicts greater defiance (Stifter, Spinrad, & Braungart-Rieker, 1999), lower social competence (Calkins, Gill, Johnson, & Smith, 1999; Belsky, Friedman, & Hsieh, 2001), and greater externalizing behavior problems (Diener & Kim, 2004; Eisenberg, Guthrie et al., 2000). Also, an examination of observed and physiological measures of reactivity and regulation found that observed distress at 2-years of age was negatively related to 4-year positive social adjustment, but only for those children with lower physiological regulation (Calkins & Degnan, 2005). This work suggests that children's frustration reactivity and emotion regulation interact to predict disruptive behavior problems; however, few studies have explored these interactions in relation to longitudinal patterns of behavior. From a developmental psychopathology viewpoint, examining measures of reactivity and regulation from multiple levels of analysis as joint influences on longitudinal pathways of behavior problems would support the value of these skills for the development of positive social behavior (Kuperminc & Brookmeyer, 2006). Therefore, the current study examined the joint effects of observed frustration reactivity and physiological regulation in toddlerhood in relation to longitudinal patterns of disruptive behavior in early childhood.

Another factor that influences children's levels of frustration reactivity, emotion regulation, and socially appropriate behavior is maternal behavior. From birth, caregivers assist infants with general state regulation by providing basic necessities (e.g., food and clothing); however, during the transition to toddlerhood this assistance evolves into more complex social interactions in which children learn to manage their own distress and behavior. The development of these self-management abilities is expected to occur with the support of a positive mother-child relationship (Calkins, 1994). In contrast, children's aggression, noncompliance, or broader externalizing problems are associated with controlling, rejecting, or harsh parenting behavior (Campbell, Pierce, Moore, Marakovitz, & Newby, 1996; Rubin, Hastings, Chen, Stewart, & McNichol, 1998; Shaw et al., 1998).

Maternal behaviors, such as control or rejection, also may interact with children's frustration reactivity and emotion regulation in relation to disruptive behavior problems (Calkins & Degnan, 2006; Rothbart & Bates, 2006). For instance, maternal behavior may enhance or undermine the development of important regulatory skills, which reactive children would have difficulty acquiring otherwise (Braungart & Stifter, 1991; Calkins et al., 1998; Calkins, 2002). Specifically, mothers who are sensitive and responsive may help children, who have high frustration reactivity and regulatory difficulties, develop appropriate social behavior. In contrast, mothers who are intrusive or hostile may exacerbate their children's frustration reactivity and poor regulatory skills, leading to greater disruptive behavior problems (Gilliom, Shaw, Beck, Schonberg, & Lukon, 2002; Rubin, Burgess, Dwyer, & Hastings, 2003). Supporting this notion, research examining the joint effects of maternal behavior and temperament reveals that children's frustration reactivity typically predicts externalizing outcomes when mother are high on control or low on positivity (Calkins, 2002; Paterson & Sanson, 1999; Rubin et al., 2003). However, one study found that maternal control had a positive impact on children's frustration reactivity (Bates, Pettit, Dodge, & Ridge, 1998), suggesting that the same level of maternal control may not operate the same way in all contexts or with all children. In some instances (e.g., when danger is present; Bates et al., 1998), maternal control may help dampen children's frustration reactivity and limit the display of disruptive behavior. However, in other situations (e.g., freeplay; Calkins, 2002), maternal control may exacerbate a negative temperament and increase disruptive behavior. In addition, maternal control may lead to disruptive behavior when children are not prone to frustration, but have strong approach tendencies. Parents, of this type of child, may attempt to inhibit the approach behavior, frustrate the child, and increase the likelihood of disruptive behavior (Derryberry & Reed, 1994). Overall, maternal controlling behavior may have different implications for child externalizing outcomes depending on the child's individual level of frustration reactivity and regulatory capabilities. Therefore, the current study examined the joint effects of maternal control, child observed frustration reactivity, and child physiological regulation in toddlerhood in relation to longitudinal patterns of disruptive behavior in early childhood.

Goals and Hypotheses

Consistent with the goal of developmental psychopathology, this study aimed to examine multiple longitudinal patterns of disruptive behavior while investigating the joint effects of both child and maternal factors on these multiple patterns of development. The primary goal of this study was to use a semi-parametric group-based approach to examine latent profiles of disruptive behavior from 2 to 5 years of age. Multiple longitudinal patterns of disruptive behavior across childhood were expected due to individual differences in the initial propensity for externalizing behavior problems and the development of socially appropriate behavior over time (Moffitt, 1993; Owens & Shaw, 2003). Similar to those found in previous research on early childhood (e.g., Hill et al., 2006; Shaw et al., 2003), four profiles of disruptive behavior were hypothesized to emerge: a high profile; a high, declining profile; a moderate, declining profile; and a low profile.

The second goal of this study was to examine the joint effects of observed child frustration reactivity, physiological emotion regulation, and observed maternal controlling behavior in toddlerhood on the probability of membership in the profiles. Toddlers prone to high frustration reactivity were hypothesized to exhibit high levels of disruptive behavior; however, physiological emotion regulation was posited to protect children from maintaining these behavior problems across early childhood. In addition, the level of maternal control was expected to be positively related to profiles with greater disruptive behavior problems in general, but especially when children displayed higher rates of frustration reactivity and lower physiological regulation. While these factors (frustration reactivity, physiological regulation, and maternal control) have been directly related to disruptive behavior problems in previous

work, the present study examined how they might interact to differentiate multiple profiles of disruptive behavior over early childhood. While this approach was somewhat exploratory, specific interaction effects were expected to emerge. Specifically, high levels of frustration reactivity, lower levels of physiological regulation, and higher maternal control were hypothesized to increase the likelihood of membership in the high disruptive behavior profile. In contrast, the probability of membership in the high, declining profile was expected to be related to a combination of higher levels of both frustration reactivity and physiological regulation supported by lower levels of maternal control. The probability of membership in the moderate, declining and low profiles was expected to be related to lower levels of frustration reactivity, higher levels of physiological emotion regulation, and lower levels of maternal control. However, a higher probability of membership in the moderate, declining profile was expected to be related to slightly more frustration reactivity than the probability of membership in the low profile. In summary, child frustration reactivity, physiological emotion regulation, and maternal control were expected to collectively differentiate the probability of membership in the disruptive behavior profiles.

Method

Participants

Participants for the current study were part of a longitudinal study of 447 2-year old children (215 male, 232 female) obtained from three cohorts. Sixty-seven percent were European American, 27% were African American, 4% were biracial, and 2% were Hispanic. At age 2, the children were primarily from intact families (77 %) that were economically diverse with Hollingshead (1975) scores ranging from 14 (unskilled laborers/menial service workers) to 66 (major business professionals), with an average score of 39.56 (medium business professionals). Parental education levels ranged from some high school (3% mothers, 6% fathers) to advanced degrees (12% mothers, 11% fathers) and over 30% of mothers and fathers had completed college.

Recruitment

The goal for recruitment was to obtain a representative community sample of children, some of whom were at risk for developing future externalizing behavior problems. Thus, all cohorts were recruited through child day care centers, the County Health Department, and the local Women, Infants, and Children (WIC) program. The sample was screened by gender to obtain equal numbers of males and females. In addition, recruitment was targeted to all areas of the county to obtain a sample representative of the surrounding area in terms of race and socioeconomic status (SES).

Potential participants for cohorts 1 and 2 ($n = 307$) were recruited at 2 years of age (cohort 1: 1994–1996 and cohort 2: 2000–2001) and screened using mother-report on the Child Behavior Checklist (CBCL 2–3; Achenbach, 1992). Children with an externalizing T-score of 60 or above were selected to be in the *Externalizing Risk* group ($n = 143$). Those with both externalizing and internalizing T-scores below 60 were selected to be in the *Low Risk* group. Cohort 3 was initially recruited when infants were 6 months of age (in 1998) for their level of frustration based on laboratory observation and parent report (See Calkins et al., 2002, for more information). This cohort was followed from 6 months of age through the infancy and toddler period, and children whose mothers completed the CBCL at 2 years of age were included in the current study ($n = 140$). Based upon the criteria described above, 21 children from this cohort were placed in the *Externalizing Risk* group. Cohort 3 had a significantly lower average 2-year externalizing T-score ($M = 50.36$) compared to cohorts 1 and 2 ($M = 54.49$), $t(445) = -4.32$, $p = .00$. Of the entire sample ($N = 447$), 164 children met criteria for the *Externalizing Risk* group. There were no significant differences between any cohorts with regard to gender,

$\chi^2 (2, N = 447) = .63, p = .73$, race, $\chi^2 (2, N = 447) = 1.13, p = .57$, or 2-year SES, $F (2, 444) = .53, p = .59$.

Missing Data

Of the 447 participants originally selected at 2 years of age from maternal report on the CBCL, 6 were dropped because they did not participate in any 2-year laboratory data collection. At 4 years of age, 399 families participated. Families missing at 4 years of age included: 20 who could not be located, 10 who moved out of the area, 9 who declined participation, and 9 who did not respond to phone and letter requests to participate. There were no significant differences between families who did and did not participate at 4 years of age in terms of gender, $\chi^2 (1, N = 447) = 3.27, p = .07$, race, $\chi^2 (1, N = 447) = .70, p = .40$, 2-year SES, $t (424) = .81, p = .42$, or 2-year externalizing T-score, $t (445) = -.36, p = .72$. At 5 years of age 365 families participated including 4 that did not participate in the 4-year assessment. Families missing at 5 years of age included: 12 who could not be located, 10 who moved out of the area, 13 who declined participation, and 3 who did not respond to phone and letter requests to participate. Again, there were no significant differences between families who did and did not participate at 5 years in terms of gender, $\chi^2 (1, N = 447) = .76, p = .38$, race, $\chi^2 (1, N = 447) = .17, p = .68$, and 2-year externalizing T-score, $t (445) = -1.73, p = .09$. There was a trend for a difference between the families who did or did not participate at 5 years in terms of 2-year SES, $t (424) = 1.93, p = .06$, such that families with lower SES were not as likely to participate, although this effect size was minimal ($d = .22$).

Procedures

Two-year assessment—Mothers brought their children to the laboratory and were videotaped during several episodes designed to elicit frustration reactivity and mother-child interaction. All episodes were videotaped for later coding. If the child became highly distressed (i.e., cried hard for more than 30 seconds), the episodes were ended early. In addition, mothers were asked to complete multiple questionnaires including the CBCL 2–3 (Achenbach, 1992) and a demographic measure. At the end of the laboratory visit, mothers were compensated for their time and children were given a small prize for their participation.

RSA assessment: At the beginning of the 2-year laboratory visit, an experimenter placed three disposable, pediatric electrodes in an inverted triangle pattern on the child's chest. The electrodes were connected to a preamplifier and the output from the preamplifier was transmitted to a vagal tone monitor (VTM-I; Delta Biometrics, Inc. Bethesda, MD) for R-wave detection. The vagal tone monitor displayed HR throughout the baseline, toy/cookie in box, and teaching episodes and every 30 seconds it computed and displayed RSA values. A data file containing the inter-beat intervals (IBIs) for the entire period of heart rate collection was saved on a laptop computer for later artifact editing (e.g., resulting from child movement) and analysis. For the current study, only RSA measures during the baseline and first frustration (Toy/Cookie in box) episodes were used.

For the baseline episode, the child watched a 5-minute segment of the videotape “Spot,” a story about a puppy that explores its neighborhood. Although this episode was not a true baseline, as the child's attention was engaged, it was sufficient to gain a measure of RSA while the child was sitting quietly and showing neutral affect. Given these children were 2 years of age, such a stimulus was necessary in order to limit movement artifact in the heart rate data. Following the baseline episode was the first frustration episode (Toy/Cookie in box) during which, the children either were asked whether they wanted a snack or to play with an exciting toy. If the child was asked to play with a toy they were permitted to play with the toy for 1 minute. Then, the experimenter placed the snack or toy in a clear plastic container that the child could see and touch, but was unable to open, for 2 minutes. Throughout this episode, the mother was

nearby and was instructed to respond to the child as she normally would, but to limit initiating any interaction. This task was adapted from the Laboratory Temperament Assessment Battery procedures (Goldsmith & Rothbart, 1993). Next, the mother was instructed to teach the child how to complete a challenging puzzle or shape sorter for 3 (cohort 3) or 4 (cohorts 1 & 2) minutes. When the RSA assessment period was complete, the electrodes were removed from the child's chest and the child was given a snack break.

Laboratory assessment: Following the break, the second frustration task (High chair) was administered. The child was placed in a high chair, without any toys or snacks, for 5 minutes. Throughout this episode, the mother was seated nearby and was instructed to respond to her child as she deemed necessary. At the end of the 5 minutes, the child was removed from the high chair. Next, a farm or pretend town was provided and the mother was instructed to play with her child as she would at home for 4 minutes. Following the freeplay episode, the mother was instructed to get the child to clean up the toys as they would at home. This episode lasted 2 minutes or until all of the toys were put away, whichever happened first.

Four and Five-year assessments—The mothers were requested to accompany their children to the laboratory when they were 4 and 5 years of age. During these visits, mothers completed multiple questionnaires including the CBCL 4–18 (Achenbach, 1991a). For each visit, mothers were compensated for their time and children were given a small prize for their participation. For the purposes of the current study, only the CBCL data from these visits was examined.

Measures

Demographics—Mother's open response report of children's race and gender were used to measure children's race (Caucasian or minority) and gender (male or female). Mothers also reported their own and the child's father's (if he was contributing to the household) education level, marital status, and type of employment. These measures were used to construct a socioeconomic status score for the 2-year laboratory visit based on the Hollingshead Index (1975). This score is derived from maternal and paternal education level and occupational strata.

Disruptive behavior problems—The Child Behavior Checklist's (CBCL; Achenbach 1991a; 1992) aggression subscale was used as an index of mother-reported disruptive behavior problems at each age. When the children were 2 years of age, mothers completed the CBCL for 2–3 year olds (Achenbach, 1992). When the children were 4 and 5 years of age, mothers completed the CBCL for 4–18 year olds (Achenbach, 1991a). These scales are a reliable index of various externalizing and internalizing behavior problems across childhood (Achenbach, Edelbrock, & Howell, 1987). Both versions included a narrow-band *aggression* subscale, which consisted of items measuring physical aggression, anger, and general cruelty toward others. At 2 years of age, the subscale consisted of 15 items such as “Defiant,” “Fights,” and “Hits others.” At 4 and 5 years of age, the subscale consisted of 20 items such as “Argues,” “Mean to others,” and “Physically attacks people.” The mother indicated how true each item was of her child by circling 0 if not true, 1 if sometimes true, or 2 if often true. Although Achenbach (Achenbach, 1991a; 1992) labeled this factor aggression, an examination of the items suggests that it is measuring a somewhat broader construct of disruptive behavior, including defiance, destructiveness, and physical aggression (Beauchaine et al., 2002). Thus, the term “disruptive behavior” will be used with regard to this measure.

Although the CBCL includes T-scores for each subscale, for the purposes of this study the total scores of the subscales were used in order to allow for maximum variation across the sample with a possible range from 0 to 30 for the measure at 2 years of age and 0 to 40 for the measures

at 4 and 5 years of age. It is noted that the range and items of each scale are different, since they measure identifiable and expected disruptive behaviors for either the 2–3 (15 items) or 4–18 year old (20 items) age range. On average, for this sample, the 4 and 5 year old scores were lower than the 2 year old scores (Table 1). In order to control for the different number of items at each age, the mean of the subscales was created by dividing the raw scores by their respective number of items, creating a possible range of scores between 0 and 2 at each age. Averages and standard deviations of the “disruptive behavior” total raw and mean scores are in Table 1.

Observed frustration reactivity—Reactivity behaviors were coded from videotapes of both frustration episodes (Toy/Cookie in Box and High Chair). Reactivity was indexed by measures of distress, including whining, pouting, fussing, crying, screaming, or tantrumming. It was coded in three ways: (1) *proportion of distress*: the amount of time (in seconds) the child was distressed divided by the total time of the episode; (2) *global negative reactivity*: coded for the entire episode on a scale from 0, no negative response, to 4, episode ended with the child in extreme distress; and (3) *global episode affect*: coded once for the entire episode on a scale from –3, highly distressed affect, to 3, highly positive affect. These measures were thought to best index a child's level of observable frustration reactivity during episodes with presumed regulatory demands (Calkins, 1997; Stifter & Braungart, 1995). Four coders trained on 10 % of the videotaped sessions and independently coded another 10% for reliability. Inter-coder reliability for the proportion of distress measure was excellent, mean $r = .99$, $p < .00$ (range: .98 to 1.0). Reliability Kappas for the ordinal codes were .83 for global negative affect and 1.0 for global episode affect. Each of the reactivity codes were correlated and averaged across episodes (average $r = .25$, $p < .00$). Descriptive statistics for each average code are reported in Table 1.

In order to compute an “observed reactivity” composite, the average codes were standardized and summed ($\alpha = .86$). This composite had a high skewness value of 1.94 and a kurtosis value of 5.53. Therefore, the composite was transformed using a square root transformation bringing the skewness value to 1.19 and the kurtosis value to 2.25. Then the transformed composite score was centered to allow for ease of interpretation in the model. The mean and standard deviation for this final composite variable are reported in Table 1.

Physiological emotion regulation—Measures of children's RSA during the baseline and toy/cookie in box episodes were obtained by editing the IBI files using MXEDIT software (Delta Biometrics, Inc., Bethesda, MD). The Porges (1985) method of analyzing the IBI data was used to calculate RSA. This method applies an algorithm to the sequential heart period (HP) data. The algorithm uses a moving 21-point polynomial to detrend periodicities in heart period that are slower than RSA. Then, a bandpass filter extracts the variance in HP within the frequency band of spontaneous respiration in young children, 0.24 – 1.04 Hz. The natural log of this variance is taken and reported in units of $\ln(\text{msec})^2$. To edit the files, the data were scanned for outlier points, relative to adjacent data, and the outliers were replaced by dividing or summing them so they would be more consistent with the surrounding data. Only data files in which less than 10% of the data required editing were included in the current study. For the baseline and toy/cookie in box episodes, RSA was calculated every 30 seconds and averaged across epochs. Individual data were excluded if the standard deviation for an episode was over 1.0 (See MXEDIT manual; Porges, 1985).

Measures of RSA during the baseline and toy/cookie in box episodes were used by calculating a difference score (Calkins, 1997; Moore & Calkins, 2004) to create an index of “physiological regulation” during the frustration episode; thus, taking into account the level of baseline RSA. This was done by subtracting RSA during the frustration episode from RSA during the baseline episode. Positive change scores occurred when there was a decrease from the baseline to the frustration episode, which reflects attempts to regulate emotion. Negative change scores

occurred when there was an increase from the baseline to the frustration episode, which reflects a lack of physiological regulation. The RSA change score was then centered to allow for ease of interpretation in the model. Descriptive statistics for the measures of RSA during baseline and frustration episodes and the “physiological regulation” score are reported in Table 1.

Maternal behavior—Maternal behavior, during the interactive episodes (teaching, freeplay, and cleanup), was coded with two coding systems. One system (Rubin, Booth, Rose-Krasnor, & Mills, 1995; Smith et al., 2004) recorded the implied goal of each maternal statement: *Adult-oriented* goals included initiating a new activity (a beginning) or stopping the child's activity (a stop), as opposed to continuing or facilitating the child's own activity. The duration of episodes varied across dyad, so the sum of adult-oriented statements (beginnings and stops) were standardized for each participant by dividing the total number by the total time of the individual's episode and multiplying this value by the maximum time of the episode (teaching episode: 4 minutes, freeplay episode: 4 minutes, cleanup episode: 2 minutes). Four coders trained on 10 % of the videotaped sessions and independently coded another 10% for reliability. The average inter-coder reliability for the maternal goal measures was $r = .86, p < .00$ (range: .81 to .88).

The second coding system (Smith et al., 2004; Winslow, Shaw, Bruns, & Kiebler, 1995) examined a global index of *strictness/punitiveness* (being too strict, demanding, or harsh relative to the child's behavior; exerting influence toward completion of the child's activity; displaying a no-nonsense attitude; constantly guiding the child and creating a very structured environment). This was coded once for each episode on a 4-point scale, ranging from low levels of the behavior to high levels of the behavior. Four coders trained on 10 % of the videotaped sessions and independently coded another 10% for reliability. The reliability Kappas between each pair of coders was .71 for strictness/punitiveness.

The *adult-oriented* goals and the global code for *strictness/punitiveness* were each averaged across episodes (average $r = .44, p < .00$; average $\alpha = .58$). Descriptive statistics for each average code are reported in Table 1. Following Smith and colleagues (2004), a composite “maternal control” was created by standardizing and summing the average adult-oriented goals and global strictness/punitiveness measures ($\alpha = .76$). This composite was then centered to allow for ease of interpretation in the model. The mean and standard deviation for this “maternal control” measure are reported in Table 1.

Summary of Measures

The observed reactivity, physiological emotion regulation, and maternal control measures at 2 years of age and the CBCL (Achenbach, 1991a; 1992) subscales of aggression at 2, 4, and 5 years of age were examined in the present study. Of the possible 441 participants, only 318 (72%) had complete data at 2 years of age: 97 had technical difficulties with the physiological data collection; 12 could not be contacted by phone to schedule a laboratory visit, but completed questionnaires through the mail; 11 had technical difficulties with the video equipment; and 3 refused to complete socioeconomic information. These families were not significantly different from the overall sample by gender, $\chi^2(1, N = 447) = .38, p = .54$, race, $\chi^2(1, N = 447) = .04, p = .85$, 2-year socioeconomic status, $t(424) = .00, p = 1.0$, or 2-year externalizing T-score, $t(445) = -.21, p = .84$. Of these 318 participants, 274 had complete 4-year CBCL data and 252 had complete 5-year CBCL data. These families were not significantly different from those with incomplete CBCL data by gender, $\chi^2(1, N = 318) = 1.49, p = .22$, race, $\chi^2(1, N = 318) = .99, p = .32$, or 2-year externalizing T-score, $t(316) = -1.35, p = .18$. However, there was a trend for those with missing data to have significantly lower 2-year socioeconomic status, $t(313) = 1.95, p = .05$. Further analysis determined that the patterns of missing data at 4 and 5 years of age were missing completely at random (MCAR), Little's MCAR test, $\chi^2(28, N =$

318) = 16.26, $p = .96$. In addition, the present analysis used maximum likelihood estimation, which allows for missing data longitudinally and assumes the missing data across repeated measures are missing at random (Little & Rubin, 1987; Muthén & Muthén, 2006). Thus, despite missing data across time, 318 families provided data for the current study, 124 (39%) with children above the borderline clinical range on 2-year externalizing behavior and 194 (61%) with children below the borderline clinical range on 2-year externalizing behavior.

Data Analyses Goals

To investigate individual differences in longitudinal patterns of disruptive behavior a structural equation mixture model (SEMM) was used. As a semi-parametric group-based approach, SEMM allows for estimation of qualitatively different groups (i.e., classes) when group membership cannot be observed a priori (Bauer & Curran, 2004). Recent work of Nagin and Tremblay (1999) and Muthén (2001) showed how SEMM models can be used in testing differential longitudinal patterns of psychological phenomena. In the current study, disruptive behavior at age 2 was measured with a different form of the CBCL (age 2–3) than disruptive behavior at age 4 and 5 (CBCL 4–18). Thus, linear growth trajectories of disruptive behavior were not estimated (e.g. Nagin & Tremblay, 1999) due to the possibility of change in measurement; rather the average level of disruptive behavior at each age was estimated independently within each class (i.e., latent profile analysis (LPA), Gibson, 1959). For this reason, classes are referred to as “longitudinal profiles” rather than trajectories. In this study, the longitudinal profiles described levels of disruptive behavior at 2, 4, and 5 years of age.

As mentioned, one benefit of using a SEMM model such as LPA is that it performs maximum likelihood estimation, which includes all longitudinal observations in a dataset (Little & Rubin, 1987). This method assumes the data are missing at random and has been recently recommended by methodologists as an appropriate way to accommodate missing data (Schafer & Graham, 2002). Using this method of estimation allows the model parameters to be informed by all cases that contribute a portion of the data. As a sub model of SEMM, LPA is a multiple group structural equation model in which the group variable is unobserved. Thus, LPA assumes observed associations are explained by differences in the means of the continuous measures over latent classes (Bauer & Curran, 2004). With this framework, individual's probabilities of membership in each profile and the predictor's effects on those probabilities are estimated in the same analysis. As with a multinomial logistic regression, the analysis compares the probability of membership in all of the profiles in reference to one of the profiles (e.g., 1, 2, 3 vs. 4). In addition, the statistical package used (Mplus 4.1) estimated all possible comparisons in the same analysis (i.e., tests all of the other profiles as the reference profile).

Although similar to logistic regression and cluster analysis, LPA differs from past methods used to identify groups in two ways. First, LPA relies on a formal statistical model rather than an ad-hoc algorithm based on decision rules (e.g., cluster analysis) and allows for flexibility in the model (Everitt & Hand, 1981). Second, the flexibility of model-based LPA allows for the possibility of uncertainty in which classes people may belong to, allowing one to predict the *probability* of membership in a group (rather than *membership* in that group per se). In other words, unlike cluster analysis, people are not forced into a group so that additional analyses can be performed to examine predictors; rather all analyses are performed within one formal statistical model.

The function for LPA takes the general form:

$$Y_{(tik)} = \mu_{(tk)} + \varepsilon_{(tik)}$$

Where $\mu_{(tk)}$ is the class-specific mean for the observed variable Y at time t for class k , and $\epsilon_{(tik)}$ are within-class individual differences from $\mu_{(tk)}$. Within each class, $\epsilon_{(tik)}$ is assumed to be normally distributed with variance $\sigma_{(tk)}$, allowing for potential heteroscedasticity across time and classes. In this study, the Y variables are disruptive behavior scores at ages 2, 4, and 5, and the estimated class means $\mu_{(tk)}$ for these variables describe the longitudinal latent profile for each class.

In the current study, data were analyzed using Version 4.1 of Mplus (Muthén & Muthén, 2006) and models with 2 through 6 profiles were estimated. Determination of best model fit was assessed using Bayesian information Criteria (BIC), where the smallest negative number indicates best fit. This index has been shown to identify the appropriate number of groups in finite mixture models (D'Unger, Land, McCall, & Nagin, 1998) and penalizes the model for the number of parameters, thus guarding against models overfitting the data. In addition, when fitting models like these, issues such as convergence are important, especially for more complex models (Hipp & Bauer, 2006), and sometimes start values must be specified in order to reach convergence. For this case, the model was relatively simple and random start values resulted in a converged solution. Predictors of the probabilities of membership in the above profiles were entered into the model in a hierarchical fashion. The log likelihoods of each step were compared with the prior step to determine whether the predictors significantly affected the model (McArdle, 2005). If they did not affect the model, then they were taken out to conserve power needed to detect interactions effects. Additionally, interaction effects were probed similarly to how one would test interactions in logistic regression using the guidelines of Aiken and West (1991).

Results

Descriptive Analyses

A two-way MANOVA, with race (caucasian vs. minority) and gender, was used to test for group differences on all outcome variables (disruptive behavior at 2, 4, and 5 years of age). There were no significant main effects of race or gender on the outcome variables. In addition, follow-up analyses indicated that the demographic factors and their moderation effects did not significantly impact the latent class analysis above and beyond the effects of the main predictors. Thus, in subsequent analyses, gender and race are not included in the model. Correlations between 2-year socioeconomic status (SES), baseline RSA, and all outcome variables (disruptive behavior at 2, 4, and 5 years of age) revealed a single significant association. Family SES at 2-years of age was negatively related to disruptive behavior at 2-years of age ($r = -.17, p < .01$). Thus, children rated by their mothers as displaying more disruptive behavior at age 2 also had parents with lower average SES at age 2; subsequently, SES was tested in the model. Baseline RSA was not significantly related to the measures of disruptive behavior and was not controlled for in the model. Finally, correlations were computed between the predictor variables themselves (frustration reactivity, physiological regulation, and maternal control). Maternal control was not significantly associated with frustration reactivity or physiological regulation; however, frustration reactivity and physiological regulation were modestly inter-correlated, $r = .15, p = .01$.

Latent profile model comparisons

Latent profile models with two through six profiles were fit to determine the optimal number of profiles to describe disruptive behavior from 2 to 5 years of age in the current sample. Model fit was assessed using the Bayesian Information Criterion (BIC), where the smallest negative number (closest to zero) indicates best fit. The BIC for the current sample was -311 for two profiles, -248 for three profiles, -238 for four profiles, -244 for five profiles, and -275 for six profiles. The 4 profile model had the smallest negative BIC and therefore was selected as

the best number of disruptive behavior profiles for the current sample. As a secondary test of model fit, the Lo-Mendell-Rubin Likelihood ratio test was also used, which tests the significance of the -2 Loglikelihood difference between models with k and $k-1$ profiles (Lo, Mendell, & Rubin, 2001). Indeed, the 2-profile model was significantly better than the 1-profile model ($p < .001$), the 3-profile model was significantly better than the 2-profile model ($p < .001$), and the 4-profile model was significantly better than the 3-profile model ($p < .05$). However, the 5-profile model was not significantly better than the 4-profile model ($p = .18$) and the 6-profile model was not significantly better than the 5-profile model ($p = .91$). Figure 1 displays the mean levels and standard errors of disruptive behavior at each time point for each of the four profiles.

An examination of the 4-profile model indicated this model yielded unique information and had an acceptable number of members in each profile. For profiles with a small number of members there could be danger of a local spurious solution (Hipp & Bauer, 2006). For this model, the smallest profile represented 8% of the sample and had similar residual variances to all the other profiles. In addition, the average posterior probabilities of membership ranged from .85 to .93 across the profiles, reflecting a high degree of confidence in profile assignment. In comparison, the 5 and 6-profile models had profiles that represented less than 8 % of the sample, with posterior probabilities below .80 (the lowest was .71).

Finally, the profiles from the 4-profile model were examined for outliers and normality in a post-hoc analysis. The probabilities for profile membership and most likely membership itself were saved from the analysis and diagnostic statistics were performed on each profile. Examination of histograms, skewness, and kurtosis indicated that measures of disruptive behavior at 2, 4, and 5 years of age were normally distributed, within each profile. Examination of box plots indicated that there were no consistent outliers across the measures of disruptive behavior within the profiles. Additionally, of the individuals with a high probability of membership in each profile, on average 55% of them were female and gender was not significantly related to membership in any of the profiles, $\chi^2(3, 318) = 6.23, p = .10$. It is important to note that although profile membership was forced and used to perform these post-hoc analyses, all other analyses described below were conducted within the modeling framework and in relation to the probabilities of membership in the profiles.

Description of longitudinal profiles

The highest profile displayed high average levels of disruptive behavior at age 2 ($M = 1.18, sd = .09$), age 4 ($M = 1.06, sd = .04$), and age 5 ($M = 1.12, sd = .08$) and 8% of the sample had a higher probability of membership in this profile than the other three profiles. On average, this profile was just below the borderline clinical cutoff at age 2 (1.20 – 1.46; Achenbach, 1992), but by ages 4 and 5 was above the borderline clinical cutoff for boys (0.95 – 1.10; Achenbach, 1991a) and girls (0.90 – 1.00; Achenbach, 1991a); therefore, it was named the “high” profile. The second-highest profile displayed average levels of disruptive behavior below the borderline clinical cutoffs, but higher than the two lower profiles, at age 2 ($M = .85, sd = .11$), age 4 ($M = .62, sd = .02$), and age 5 ($M = .61, sd = .04$) and 34 % of the sample had a higher probability of membership in this profile than the other three profiles. Although this profile was not within the clinical range of scores, it still evidenced average elevated levels at each time-point compared to the lower profiles; therefore it was named the “moderate” profile.

Of the two lowest profiles, the second-to-lowest one displayed some disruptive behavior at age 2 ($M = .51, sd = .07$), age 4 ($M = .30, sd = .02$), and age 5 ($M = .28, sd = .02$). However, these average levels of disruptive behavior are lower than those of the profiles above. In addition, 44% of the sample had a higher probability of membership in this profile than the other three profiles. Since this profile displayed somewhat typical, but low, levels of disruptive behavior and the largest amount of the sample had a high probability of membership it was named the

“normative” profile. The lowest profile displayed low average levels of disruptive behavior at age 2 ($M = .40, sd = .10$), age 4 ($M = .11, sd = .01$), and age 5 ($M = .07, sd = .00$) and 14% of the sample had a higher probability of membership in this profile than the other three profiles. This profile was named the “low profile.”

Prediction of probability of membership in profiles

Predictors of the probabilities of membership in the above profiles were entered into the model in a hierarchical fashion (McArdle, 2005). The log likelihoods of each model were compared with the model a step before to determine whether the predictors significantly affected the model. If they did not affect the model they were taken out to conserve power needed to detect interactions effects. First, SES was entered into the model as a covariate; however, comparison of the log likelihoods determined it did not significantly impact the model, $\chi^2(3) = 2.0, p > .05$. In addition, SES did not predict the probability of membership in any of the profiles; therefore, it was removed from all further analyses. Second, the other predictors were entered in the model (frustration reactivity, physiological regulation, and maternal control). Comparison of the log likelihoods determined they significantly impacted the model, $\chi^2(9) = 24.80, p < .01$. In addition, frustration reactivity and maternal control significantly predicted the probability of membership in the profiles (See Table 2). The next model included all of the predictor variables, and two-way interactions between the predictor variables. Interaction terms were calculated by multiplying the centered variables together. The comparison of log likelihoods between the model that included interaction terms and the model that did not determined that the two-way interactions significantly impacted the model above and beyond the main effects, $\chi^2(9) = 21.76, p < .01$. In addition, the interactions significantly predicted the probability of membership in the profiles (See Tables 3 & 4). Finally, a three-way interaction was tested in the model, but it did not significantly affect the model or predict membership in any of the profiles above and beyond the two-way interaction effects, $\chi^2(3) = 4.26, p > .05$.

There were no significant main effects that were not superseded by the interactions and there were no significant effects differentiating the probability of membership in the moderate profile as compared to the normative profile. Therefore, only the two-way interactions are discussed and interpreted below. Table 2 depicts the significant effects found in the main effects model (found only between the low profile and other three profiles). Tables 3 and 4 present the significant effects found in the two-way interactions model, in terms of odds and corresponding significance tests, quantified as a z for each predictor.

The significant two-way interactions were tested, plotted, and interpreted in accordance with Aiken and West (1991; See also Cohen, Cohen, West, & Aiken, 2003). First, the significance of each interaction was determined through the LPA analysis (See Tables 3 and 4), where a z represents the test statistic for each predictor's (i.e., interaction) effect on the probability of membership in the various profiles (similar to a t statistic for each β in a linear regression analysis). Second, in order to plot each interaction, high and low values (± 1 SD) as well as the mean value (0) of one predictor (the “moderator”) were entered into logistic regression equations ($Y = \beta_1 X + \beta_2 Z + \beta_3 XZ + \beta_0$) to generate three regression equations denoting the effect of the other predictor (X) on the probability of membership in the profiles (Y) at each specific value of the moderator (Z). This method is similar to what is explained in Aiken and West (1991) except that in the present case the estimates used (β 's) from the LPA analysis represented the log-odds associated with the probability of membership in the various profiles. The resulting plots of these values are displayed in Figures 2 and 3. Finally, in order to fully interpret the interactions, follow-up analyses were performed in line with Aiken and West (1991) to determine what range of the “moderator” (Z) significantly affected (i.e., was different from zero) the relation between the other predictor (X) and the probability of membership in

the profile (Y). Thus, we first explored these differences around 0 and ± 1 SD. For most of the interactions, the relation of X and Y were significantly different from zero at these ranges of Z. However, for the interaction between observed reactivity and maternal control predicting the probability of membership in the high vs. moderate profiles, these values were not extreme enough to display these effects. Therefore, we expanded our parameters by exploring the effect around ± 2 SD of maternal control (Z) and we found that in this range the relation between observed reactivity (X) and the probability of membership in the high profile (Y) was significantly different from zero around $+2$ SD of maternal control. This suggests that maternal control needed to be more extreme to affect the probability of membership in these profiles. Descriptive statistics revealed that these values of ± 1 and ± 2 SD of the “moderators” were within range of the measures. Overall, these techniques were used in order to more fully interpret each interaction. The significance of the simple slopes (i.e., whether they are different from zero), however, does not affect the significance of the overall interaction (Aiken & West, 1991).

High profile vs. all other profiles—The first comparison examined was between the high profile and the other three profiles. Compared to the low profile, observed reactivity was positively related to the probability of membership in the high profile (Table 2). However, this finding was superseded by a significant interaction between maternal control and observed reactivity (Table 3; Figure 2b). In addition, compared to the moderate profile, interactions between maternal control and observed reactivity and physiological regulation were related to the probability of membership in the high profile (Table 3; Figures 2a and c). Finally, an interaction between children's observed reactivity and physiological regulation was related to the probability of membership in the high profile compared to the normative profile (Table 3; Figure 3a).

Compared to the moderate profile, maternal control interacted with observed reactivity in relation to the probability of membership in the high profile (Figure 2a). Therefore, the relation between observed reactivity and the probability of membership in the high profile varied by the level of maternal control. For children with mothers with high control (control = 3.46), the level of observed reactivity was positively related to the probability of membership in the high profile, $z = 1.86, p = .06$; however, for children with mothers with low control (control = -1.73) or average control (control = 0), the effect of observed reactivity was nonsignificant, $z = -1.48, p = .14$. In addition, maternal control interacted with physiological regulation in relation to the probability of membership in the high profile as compared to the moderate profile (Figure 2c). Thus, the relation between physiological regulation and the probability of membership in the high profile varied by the level of maternal control. For children with mothers with high control (control = 1.73) or average control (control = 0), the effect of physiological regulation was nonsignificant, $z = 1.05, p = .29$; however, for children with mothers with low control (control = -1.73), the level of physiological regulation was negatively related to the probability of membership in the high profile, $z = -2.03, p = .04$. Overall, compared to the moderate profile, children were more likely to be in the high profile when high maternal control was combined with high observed reactivity or when low maternal control was combined with low physiological regulation.

Maternal control also interacted with observed reactivity in relation to the probability of membership in the high profile as compared to the low profile (Figure 2b). Therefore, the relation of observed reactivity to the probability of membership in the high profile varied by the level of maternal control. For children with mothers high on control (control = 1.73), the level of observed reactivity was positively related to the probability of membership in the high profile, $z = 2.44, p = .01$; however, the effect of observed reactivity for children with mothers low on control (control = -1.73) or average on control (control = 0) was nonsignificant, $z =$

$-0.78, p = .44$. This result is similar to the interaction of maternal control and observed reactivity that differentiated the moderate profile from the high profile.

Finally, observed reactivity interacted with physiological regulation in relation to the probability of membership in the high profile, as compared to the normative profile (Figure 3a). Therefore, the relation of physiological regulation to the probability of membership in the high profile varied by the level of observed reactivity. For children high on observed reactivity (reactivity = .43), the level of physiological regulation was negatively related to the probability of membership in the normative profile, $z = -2.45, p = .01$; however, the effect of physiological regulation for children low on observed reactivity (reactivity = $-.43$) or average reactivity (reactivity = 0) was nonsignificant, $z = -1.10, p = .27$. Consequently, children with high observed reactivity and low physiological regulation were more likely to be a member of the high profile, as compared to the normative profile.

Low profile vs. all other profiles—The second comparison was between the low profile and the other three profiles (Tables 2 & 4). Comparisons between the high and low profiles were discussed above and are not repeated. Both observed reactivity and maternal control were related to the probabilities of membership in the normative and moderate profiles in comparison to the low profile (Table 2). However, these effects were superseded by interaction effects (Table 4). Observed reactivity interacted with physiological regulation in relation to the probability of membership in the low profile compared to the normative profile (Figure 3b). Therefore, the relation of physiological regulation to the probability of membership in the low profile varied by the level of observed reactivity. For children low on observed reactivity (reactivity = $-.43$), the level of physiological regulation was positively related to the probability of membership in the low profile, $z = 3.25, p = .00$; however, the effect of physiological regulation for children high on observed reactivity (reactivity = .43) or average on observed reactivity (reactivity = 0) was nonsignificant, $z = -1.10, p = .27$. Overall, the probability of membership in the low profile was greater for children with low observed reactivity and high physiological regulation.

Discussion

The current investigation explored whether distinct longitudinal profiles of disruptive behavior across early childhood could be differentiated in a sample of girls and boys. In addition, observed frustration reactivity, physiological regulation, and maternal controlling behavior were examined for their joint effects on the probability of membership in the profiles. Theoretically, children's level of emotional reactivity, their ability to modulate that reactivity, and maternal behaviors that support or undermine these skills are all integral to social development (Calkins & Degnan, 2006). Furthermore, children's patterns of reactivity and regulation are thought to influence how maternal behavior is related to disruptive behavior over time.

The first goal of the study was to examine longitudinal profiles of disruptive behavior, from 2 to 5 years of age, using a semi-parametric, group-based statistical approach. Multiple developmental patterns of disruptive behavior were expected to emerge due to individual differences in disruptive behavior in toddlerhood and the development of behavioral regulation skills across childhood (Moffitt, 1993; Loeber & Stouthamer-Loeber, 1998). As expected, the latent profile analysis identified 4 profiles of disruptive behavior: a *high* profile, representing high levels of disruptive behavior reaching borderline clinical levels by age 5; a *moderate* profile, representing an elevated level of disruptive behavior at age 2 and more moderate levels at ages 4 and 5; a *normative* profile, representing moderate levels of disruptive behavior at age 2 and lower levels at ages 4 and 5; and a *low* profile, representing low levels of disruptive behavior at each age. Overall, the profiles identified in the current study support the number

and composition of those trajectories of childhood externalizing behaviors found in past research (e.g., Hill et al., 2006; Shaw et al., 2003). Using a semi-parametric approach to examine externalizing behavior across early childhood, there is consistent evidence for a high group, a moderate group, a low group, and a varying fourth group; with the high group typically representing 3–14% of the sample (NICHD, 2004; Shaw et al., 2003). The present study identified 4 profiles and 8 % of the sample had a high probability of membership in the highest profile. Thus, there seems to be some consistency across studies in the patterns of disruptive behavior found in early childhood.

The second goal of this study was to explore possible predictors of these longitudinal profiles in order to further understand the etiology of developmental pathways of disruptive behavior. The joint effects of observed frustration reactivity, physiological regulation, and maternal control were examined on the probability of membership in the four profiles. Although it was hypothesized that the three predictors would all jointly relate to the probability of membership in the various profiles, the three-way interaction did not significantly impact the model or relate to the profiles. However, two-way interactions between the predictors were shown to relate to the probability of membership in the four profiles. Results revealed that maternal control interacted with observed reactivity and physiological regulation to distinguish between the probability of membership in the high profile and the moderate and low profiles. In addition, observed reactivity interacted with physiological regulation to distinguish between the probability of membership in the normative profile and the high and low profiles.

Specifically, in comparison to the high profile, the effect of observed reactivity on the probability of membership in the moderate or low profiles depended on the level of maternal control (Figures 2a and 2b). It was hypothesized that the high profile would be associated with a combination of high reactivity and low physiological regulation and higher levels of maternal control than the other profiles. As expected, children with high reactivity were more likely to be a member of the high disruptive behavior profile when their mothers were rated high on control. The level of maternal control also affected the relation of physiological regulation to the probability of membership in the moderate profile as compared to the high profile (Figure 2c). Unexpectedly, however, children with low physiological regulation were more likely to be a member of the high disruptive behavior profile when their mothers were rated low on control. Therefore, following a high profile of disruptive behavior across early childhood was related to either a combination of high maternal control and high reactivity or low maternal control and low physiological regulation. These results suggest that while maternal control may escalate child reactivity to maintain disruptive behavior problems, it also may serve as a protective factor for children with lower physiological regulation. These less regulated children might require this additional structure and direction from their mothers in order to display fewer disruptive behavior problems across early childhood. Thus, more than one constellation of maternal and child factors may increase the likelihood of having a consistently high profile of disruptive behavior across early childhood.

A second interaction between the individual child reactivity and regulation factors was found to differentiate the probability of membership in the high and normative profiles (Figure 3a). It was hypothesized that these profiles would display different combinations of the three predictors. Compared to the high profile, the normative profile was expected to show a combination of less reactivity, more regulation, and lower maternal control. As expected, for children with high observed reactivity, high physiological regulation led to a greater probability of membership in the normative profile. Thus, children's physiological regulation seemed to act as a protective factor against high levels of emotional reactivity. Whereas children who are less frustrated in general may be less likely to maintain a high disruptive behavior profile, those who are easily frustrated are at risk for doing so. Therefore, for these highly reactive children, having the physiological capacity to regulate that distress may have compensated for their

temperamental nature, leading them to show lower, more normative, levels of disruptive behavior across early childhood. Without this capacity to manage their emotional reactions to frustration, these children might be more likely to display heightened levels of disruptive behavior.

Unexpectedly, the level of maternal control did not relate to any differences in the probability of membership between the high and normative profiles. Overall, maternal control may have different implications for child externalizing outcomes depending on the child's individual level of frustration reactivity and regulatory capabilities. It was hypothesized that the high profile would be associated with higher maternal control and that the normative profile would be associated with lower maternal control; however, this was not supported by the current findings. Perhaps mothers of children in the normative profile display a more moderate degree of maternal control and this level of control may not influence the level of child disruptive behavior. In addition, for these children, maternal control may not have as profound an influence on how their reactivity or regulation contributes to their behavior problems. In fact, previous work has suggested that environmental factors have a dampened impact on children with less extreme levels of temperamental reactivity (Hane & Fox, 2007).

Observed reactivity and physiological regulation also interacted to differentiate the probability of membership in the two lower profiles (Figure 3b). It was hypothesized that these profiles would primarily differ in their level of observed frustration reactivity, with the normative profile displaying slightly more than the low profile. As expected, for children low on observed reactivity, high physiological regulation was related to having a higher probability of membership in the low profile. Therefore, children who were less reactive and more regulated were much more likely to be in the low profile, than children who were more reactive or less physiologically regulated. In general, the normative profile was characterized as being less physiologically regulated and somewhat more reactive than the low profile. This result supports the notion that neither having lower emotional distress to frustrating events or having the ability to regulate distress internally alone eliminates disruptive behavior altogether. Instead, it is the combination of both low frustration reactivity and high regulation that increases the likelihood of displaying low levels of disruptive behavior across early childhood.

Limitations

Although the present study contributes to the current literature by illuminating the complex relations among maternal behavior, frustration reactivity, emotion regulation, and longitudinal profiles of disruptive behavior, some limitations need to be addressed. Although SEMM is a useful analysis for longitudinal data, the classes (profiles) do not necessarily represent qualitatively distinct groups in the general population. Instead, they represent patterns that exist within the sample examined (Bauer & Curran, 2004). The present sample was over-selected for externalizing behavior problems and thus, the current results may not be generalizable to a randomized sample. In addition, the specific sociodemographic characteristics and measures used to describe the current sample could preclude other samples from displaying the same effects. For instance, using income level to further differentiate families with low-income could be a more definitive measure of socio-economic status. The profiles identified in the current at-risk community sample will only become established with repetition and confirmation in other studies. At least one other sample of low-income boys has shown similar trajectories of conduct problems in early childhood (Shaw et al., 2003). However, future work should examine similar child and maternal factors in relation to disruptive behavior in additional samples with different demographic constellations.

Another limitation of the current study is the individual informant for the measure of disruptive behavior problems. Although the Teacher Report Form (Achenbach, 1991b) was used to confirm the level of externalizing behavior problems at 2 years of age, not every child had a

daycare provider at 2 and they were not collected at 4 and 5 years of age. Similarly, the current study assessed only one example of physiological regulation to frustration. Measuring across multiple frustrating events would lend the ability to test reliability and form a more robust measure. In the future, studies should be designed to provide multiple assessments of each measure at each age point. Indeed, replication of the current findings would be enhanced if multiple informants and multiple assessments were used to test the effects of maternal and child factors on longitudinal patterns of behavior problems.

Finally, the current examination hypothesized a three-way interaction between observed frustration reactivity, physiological emotion regulation, and maternal controlling behavior. This interaction effect was not supported by the current findings. Theoretically, these aspects of the child and the environment are thought to influence each other in a transactional manner in relation to psychopathological outcomes (Calkins, 1994; Calkins & Degnan, 2006). Moreover, the two-way interactions that were observed suggest that these transactional and interactive relations most likely do exist in relation to disruptive behavior problems in early childhood. It is possible that the current sample size was not sufficient enough to capture the three-way effect above those afforded by the two-way interactions. In addition, measuring maternal behavior and child reactivity and regulation over time, and including them in the model as time-varying covariates, might help to uncover these more complex transactional relations. Finally, the measure of maternal control used in the current study may not generalize to all forms of maternal control. For instance, Bates et al. (1998) found that maternal control was related to less child reactivity when the control was aimed at decreasing dangerous behaviors that might cause harm to the child. Therefore, future studies should include measures of control in relation to play behavior and control in relation to risk-taking behavior in order to separate the possible distinguishing effects of these different forms of control on child reactivity, regulation, and disruptive behavior problems. Overall, studies should include slightly larger samples and longitudinal assessments across multiple domains in order to test these higher order interactions within a semi-parametric modeling framework.

Summary and Implications

As hypothesized, four profiles of children's disruptive behavior from 2 to 5 years of age were differentiated by interactions between observed reactivity, physiological regulation, and maternal controlling behavior. Overall, results revealed that children are more likely to be in a high profile when they display high observed reactivity combined with high maternal control or low physiological regulation combined with low maternal control. In contrast to a high profile, children are more likely to be in a moderate profile, when they display low observed reactivity combined with high maternal control or high physiological regulation combined with low maternal control. Moreover, children are more likely to be in a normative profile, compared to a high profile, when they display high observed reactivity combined with high physiological regulation and children are more likely to be in a low profile, compared to a higher profile, when they display low observed reactivity combined with high maternal control or low observed reactivity combined with high physiological regulation. These findings support theory and research that posits interactive effects between emotion reactivity, regulation, and maternal behavior on externalizing behavior problems (Bates & McFayden-Ketchum, 2000; Calkins & Degnan, 2006). Furthermore, these results lend credence to a developmental psychopathological perspective, which has called for an examination of multiple developmental trajectories as well as multiple, interactive child by environment processes leading to these trajectories (Kuperminc & Brookmeyer, 2006). Although the current study cannot attest to the specific mechanisms leading to these interactive processes, the findings reported here suggest that future investigations should examine the transactional mechanisms between temperament, emotion regulation, maternal behavior, and longitudinal patterns of behavior problems across early childhood.

Overall, the analysis used in the current study (i.e., latent profile analysis) improves on past methods used to identify groups. LPA allows for flexibility in profile assignment, predicts the probability of membership in a profile, and describes behavior over time even when the measurement of that behavior changes. In addition, these findings would not have been fully captured with cross-sectional or variable-oriented analyses. The differences between these methods is because LPA takes the level of disruptive behavior at each age into account, not just one time point, and allows for multiple population means, rather than one mean for the whole sample. In addition, LPA accounts for missing data across the time points, allowing for increased power to detect interaction effects. In the current study, maternal control was not associated with greater disruptive behavior in general; rather, it was associated with extreme levels (high and low) of disruptive behavior across early childhood. Thus, LPA is a useful tool for examining multiple patterns of disruptive behavior during early childhood and the differentiation of those patterns with multiple indices of child and family functioning.

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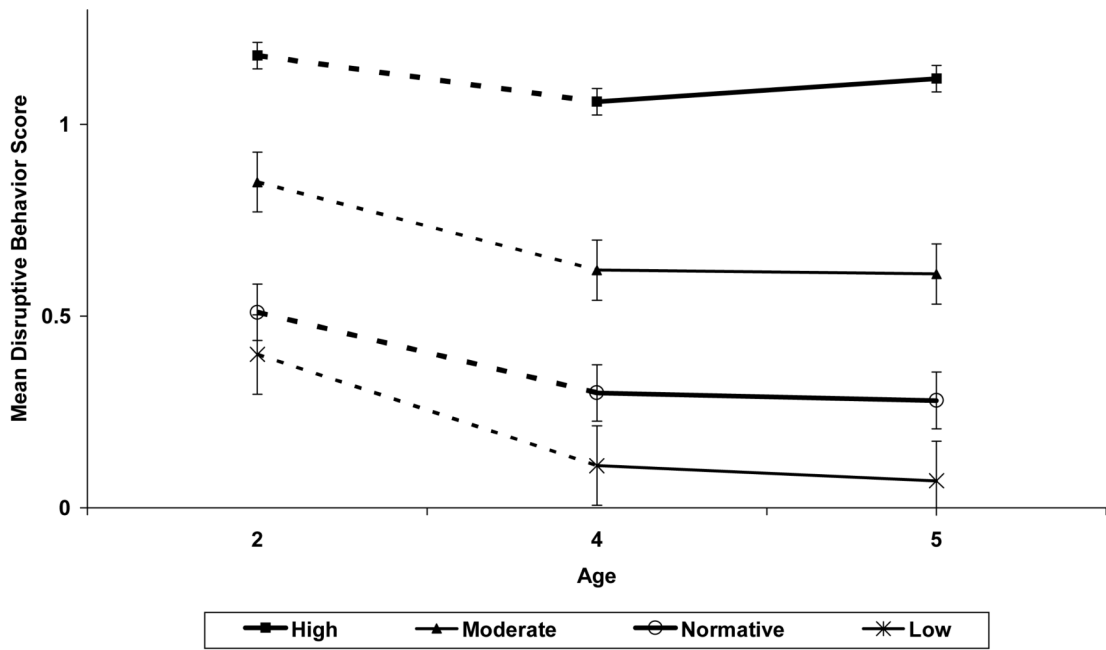
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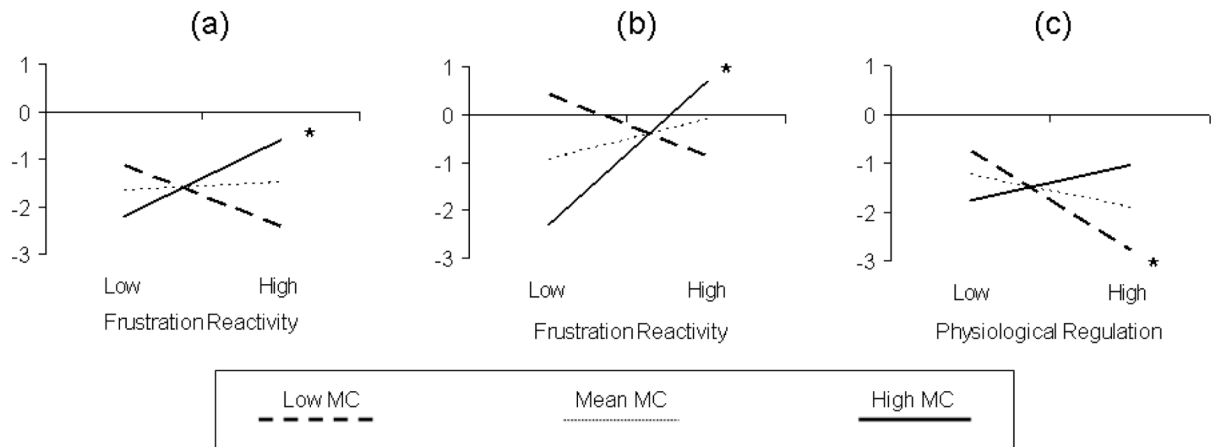
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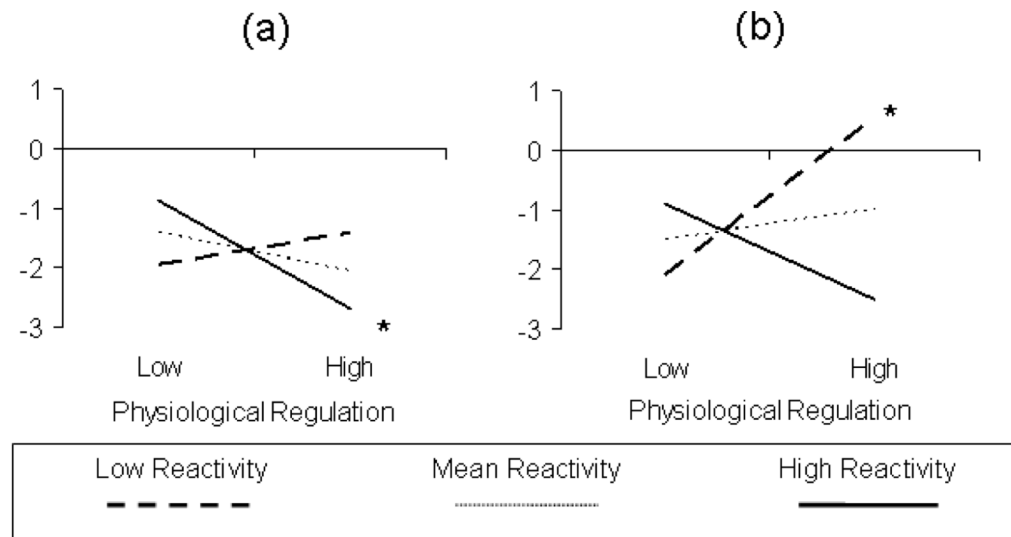
Note: Dotted lines represent the change in measurement between 2 and 4 years of age.

Figure 1.
Profiles of disruptive behavior from 2 to 5 years of age



Note. * denotes which level of the moderator showed a significant effect of maternal control on the log-odds of membership in the high profile.

Figure 2. Interactions with maternal control (MC) predicting log-odds of membership in high profile: (a) High profile vs. moderate profile: MC by frustration reactivity, (b) High profile vs. low profile: MC by frustration reactivity, (c) High profile vs. moderate profile: MC by physiological regulation



Note. * denotes which level of the moderator showed a significant effect of frustration reactivity on the log-odds of membership.

Figure 3. Interactions with frustration reactivity and physiological regulation predicting log-odds of membership in high and low profiles: (a) High profile vs. normative profile, (b) Low profile vs. normative profile

Table 1

Descriptive statistics

Measures	N	Min	Max	M	Sd
2-year Socioeconomic Status (SES)	318	14.00	66.00	39.56	10.82
2-year Proportion of Distress	318	0.00	0.98	0.11	0.17
2-year Global Negative Affect	318	0.00	4.00	0.75	0.85
2-year Global Episode Affect	318	-3.00	2.00	-0.11	0.78
2-year Observed Reactivity Score	318	-1.26	1.90	0.00	0.43
2-year Baseline RSA	318	1.10	8.79	5.49	1.27
2-year Frustration RSA	318	1.45	8.57	4.89	1.16
2-year Physiological Regulation Score	318	-3.37	3.34	0.00	1.00
2-year Adult-Centered Statements	318	6.67	41.11	20.03	5.95
2-year Global Strictness/Punitiveness	318	1.00	4.00	2.48	0.64
2-year Maternal Control Score	318	-2.01	2.43	0.00	0.96
2-year Disruptive Behavior Total	318	0.00	29.00	10.04	5.68
2-year Mean Disruptive Behavior Score	318	0.00	1.93	0.67	0.38
4-year Disruptive Behavior Total	274	0.00	28.00	8.93	5.97
4-year Mean Disruptive Behavior Score	274	0.00	1.40	0.45	0.29
5-year Disruptive Behavior Total	252	0.00	33.00	8.73	6.84
5-year Mean Disruptive Behavior Score	252	0.00	1.65	0.44	0.34

Table 2

Odds ratios for significant main effects: Low profile as comparison

Measure	β	SE	z	Odds
High profile				
Observed Reactivity	2.51	0.71	3.52***	12.28 (0.08)
Physiological Regulation	-0.45	0.31	-1.45	0.64
Maternal Control	-0.22	0.19	-1.14	0.80
Moderate profile				
Observed Reactivity	1.95	0.66	2.97**	7.04 (0.14)
Physiological Regulation	-0.28	0.20	-1.38	0.76
Maternal Control	-0.40	0.15	-2.68**	0.67 (1.49)
Normative profile				
Observed Reactivity	2.35	0.67	3.51***	10.48 (0.10)
Physiological Regulation	-0.21	0.21	-1.01	0.81
Maternal Control	-0.46	0.17	-2.74**	0.63 (1.59)

Note: Odds ratios in parentheses are the reciprocals and refer to the odds of membership in the low profile.

**
p < .01,

p < .001

Table 3

Odds ratios for significant interactive effects: High profile as comparison

Measure	β	SE	<i>z</i>	Odds
Moderate profile				
Observed Reactivity	-0.20	0.73	-0.27	0.82
Physiological Regulation	0.33	0.29	1.15	1.39
Maternal Control	-0.11	0.17	-0.61	0.89
Maternal Control \times Observed Reactivity	-0.98	0.41	-2.42*	0.37 (2.70)
Maternal Control \times Physiological Regulation	-0.40	0.18	-2.18*	0.67 (1.50)
Observed Reactivity \times Physiological Regulation	-0.10	0.84	-0.12	0.91
Normative profile				
Observed Reactivity	0.13	0.64	0.21	1.14
Physiological Regulation	0.32	0.26	1.21	1.37
Maternal Control	-0.18	0.17	-1.06	0.83
Maternal Control \times Observed Reactivity	-0.54	0.35	-1.55	0.58
Maternal Control \times Physiological Regulation	-0.33	0.18	-1.88	0.72
Observed Reactivity \times Physiological Regulation	1.35	0.60	2.28*	3.87 (0.26)
Low profile				
Observed Reactivity	-0.97	1.17	-0.83	0.38
Physiological Regulation	0.57	0.41	1.37	1.76
Maternal Control	-0.17	0.23	0.72	1.18
Maternal Control \times Observed Reactivity	-1.39	0.66	-2.12*	0.25 (4.00)
Maternal Control \times Physiological Regulation	-0.29	0.23	-1.30	0.75
Observed Reactivity \times Physiological Regulation	-1.12	1.06	-1.05	0.33

Note: Odds ratios in parentheses are the reciprocals and refer to the odds of membership in the high profile.

* $p < .05$

Table 4

Odds ratios with significant interactive effects: Low profile as comparison

Measure	β	SE	z	Odds
Moderate profile				
Observed Reactivity	0.77	1.10	0.70	2.16
Physiological Regulation	-0.24	0.34	-0.69	0.79
Maternal Control	-0.27	0.18	-1.54	0.76
Maternal Control \times Observed Reactivity	0.41	0.61	0.67	1.50
Maternal Control \times Physiological Regulation	-0.10	0.17	-0.59	0.90
Observed Reactivity \times Physiological Regulation	1.02	1.13	0.90	2.78
Normative profile				
Observed Reactivity	1.10	1.18	0.93	2.99
Physiological Regulation	-0.25	0.39	-0.65	0.78
Maternal Control	-0.35	0.21	-1.62	0.71
Maternal Control \times Observed Reactivity	0.84	0.71	1.19	2.33
Maternal Control \times Physiological Regulation	-0.04	0.23	-0.15	0.97
Observed Reactivity \times Physiological Regulation	2.47	1.05	2.37*	11.87 (0.08)

Note: Odds ratios in parentheses are the reciprocals and refer to the odds of membership in the low profile.

* $p < .05$