Predictors of Longitudinal Growth in Inhibitory Control in Early Childhood

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Abstract

In the current study, we examined latent growth in 731 young children's inhibitory control from ages 2 to 4, and whether demographic characteristics or parenting behaviors were related to initial levels and growth in inhibitory control. As part of an ongoing longitudinal evaluation of the Family Check-Up (FCU), children's inhibitory control was assessed yearly at ages 2, 3, and 4. Inhibitory control was initially low and increased linearly to age 4. High levels of harsh parenting and male gender were associated with low initial status in inhibitory control. High levels of supportive parenting were associated with faster growth. Extreme family poverty and African American ethnicity were also associated with slower growth. The results highlight parenting as a target for early interventions in contexts of high socioeconomic risk.

Keywords

inhibitory control; self-regulation; latent growth modeling; parenting; early childhood

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Self-regulation plays an important role in preventing maladjustment and in promoting well being across the lifespan (Gilliom, Shaw, Beck, Schonberg, & Lukon, 2002; Mischel, Shoda, & Rodriguez, 1989; Silk, Steinberg, & Morris, 2003). As a consequence, information about the developmental course and the predictors of growth in self-regulation is necessary to inform efforts to prevent behavioral and emotional problems in early childhood and beyond. More information is needed on the longitudinal stability and growth of self-regulation throughout development, but particularly in regard to the development and antecedents of inhibitory control, which involves young children's abilities to prevent or inhibit behaviors in response to adults' instructions (Rothbart, Ahadi, Hershey, & Fisher, 2001). This gap is exceptionally acute for young children at elevated risk for behavioral and psychological problems, as much of what is known has been established in low-risk, middle-class samples. Thus, the first goal of the current study was to enhance current understanding

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of the course of inhibitory control from ages 2 to 4 years using a large sample of toddlers identified on the basis of socioeconomic, family, and child risk. Existing research points to parenting as an important antecedent of self-regulation during early childhood (e.g., Kopp, 1987), and thus the study's second goal was to investigate the contributions of supportive and harsh parenting to initial levels and growth in inhibitory control. Information on longer-term change during early childhood is essential to advance our understanding of how dimensions of both positive (e.g., responsive) and negative (e.g., rejecting) aspects of parenting may contribute to at-risk children's development of inhibitory control.

Researchers and theorists agree that optimal levels of self-regulation are desirable for success in multiple domains of functioning across the lifespan. However, as there is little consensus on how best to define and measure self-regulation within any given developmental period, below we review the literature on the growth and the correlates of several dimensions of self-regulation in early childhood.

The Development of Inhibitory Control

Theoretical and empirical works illustrate the timing and appearance of specific changes in children's emerging regulatory abilities (e.g., Bronson, 2000; Kopp, 1982). Cumulatively these suggest that internally-based regulation begins in toddlerhood (Kopp, 1987), when toddlers become capable of complying with caretaker instructions (Stifter, Spinrad, & Braungart-Rieker, 1999) and of exercising independent self-control with parental supervision and support (Maccoby, 1984). As children's regulatory abilities improve, they are increasingly responsible to regulate in response to direction from internal cues, situational demands, environmental stimuli, and feedback from others (Kochanska, Coy & Murray, 2001; Kopp, 1982). Inhibitory control begins to emerge after the second birthday (Rothbart, 1989) and continues to develop throughout the preschool years. These developments set the stage for subsequent growth beyond early childhood.

Much of what is known about change in self-regulation during early childhood is from longitudinal studies of rank-order stability. One such study with three cohorts of children revealed that primary and alternate caregivers' initial reports of their child's effortful control at 6, 12, and 18 months were moderately to highly correlated with their reports 6 and 12 months after the initial assessment (Putnam, Gartstein, & Rothbart, 2006). Likewise, in a small, middle-class sample of young children, Kochanska and colleagues (Kochanska, Murray, Jacques, Koenig, & Vandegeest, 1996) found moderate stability in inhibitory control from ages 2 to 3.5 and 3.5 to 4.5 years. In another short-term longitudinal study, preschoolers' effortful control was the most powerful predictor of effortful control assessed 6 months later (Lengua, Honorado, & Bush, 2007). Cumulatively, these studies suggest that self-regulation is a moderately stable attribute from the toddler to the preschool periods.

Fewer studies have tracked mean-level changes in self-regulation across two or more timepoints, but those that have reveal similar findings to studies of longitudinal rank-order stability. For example, one short-term longitudinal study with preschoolers revealed gains in behavioral regulation abilities between the fall and spring assessments (McClelland et al., 2007). In another longer-term investigation of a large sample of low-SES children, 2 to 4 year-old children's abilities to delay gratification improved at a 16-month follow-up (Li-Grining, 2007). Response inhibition also increased between ages 4 and 6 in another investigation conducted with a small-sized sample of young at-risk children (Dennis, Brotman, Huang, & Gouley, 2007). Finally, Head Start toddlers' self-regulation grew positively and linearly between ages 14 and 36 months (Raikes, Robinson, Bradley, Raikes, & Ayoub, 2007). Altogether these studies indicate that self-regulation improves during early

childhood, although it must be acknowledged that these studies focused on dimensions of self-regulation other than inhibitory control.

Although these studies collectively indicate that self-regulation improves during early childhood, clearly more research is needed on this topic, particularly for children at high risk for demonstrating poor socioemotional functioning during the school-age years. Thus, the first goal of the study was to examine the developmental course of inhibitory control at three assessment points from ages 2 to 4 using a sample of children identified on the basis of multiple domains of risk.

The Role of Parenting

Research and theory on the development of self-regulation emphasize the role of caregiving in fostering individual differences in self-regulatory abilities and strategies (see Cassidy, 1994; Stansbury & Zimmerman, 1999; Thompson, 1994). The parent-child relationship is one context of socialization, through which individuals adopt and internalize shared beliefs, worldviews, and behaviors consistent with these values (Jones & Gerard, 1967). Everyday caregiver-child interactions expose children to adults' expectations for regulation, which raises children's awareness of the need to regulate their behavior or emotions accordingly (Laible & Thompson, 2007). Children may also learn regulatory strategies by imitating parents' behavior during these exchanges (Forman & Kochanska, 2001).

A variety of parenting dimensions are believed to support the development of self-regulation during childhood. Unfortunately, much of what is known about associations between dimensions of parenting and self-regulation is based on cross-sectional or short-term longitudinal studies (e.g., Dennis, 2006), in reference to general characteristics of parental behavior (e.g., parent and child questionnaire-based reports of rejection and inconsistency: Lengua, 2006), or rather specific parenting practices (e.g., observed redirection of attention: Grolnick, Kurowski, McMenamy, Rivkin, & Bridges, 1998). In the current study, inhibitory control was examined in light of overall supportive and harsh parenting, using multidimensional, observation-based indices of both positive and negative parenting behaviors. Mechanisms and empirical evidence for associations between these broad dimensions of parenting and developmental change in inhibitory control are presented in turn below.

Supportive Parenting

Supportive parenting encompasses parenting qualities such as warmth and acceptance, and behaviors such as responsivity, involvement, and proactive support. These dimensions of parenting are thought to promote the development of self-regulation by reducing children's negative affect (e.g., Kochanska & Aksan, 1995). Supportive parents are sensitive to their children's emotional states and promptly respond to the children in a manner that down-regulates their children's negative emotions prior to an overwhelming flood of feelings (Sroufe, 1996). By responding early and effectively, parents may be able to prevent their children from experiencing extreme levels of emotional arousal, which in turn may help children learn strategies for controlling emotions and behavior (Kochanska & Aksan, 1995). Likewise, parental provision of developmentally-appropriate structure may help children learn to identify circumstances in which inhibitory control is necessary (Olson, Bates, & Bayles, 1990).

Substantial evidence from cross-sectional and short-term longitudinal studies supports associations between various dimensions of supportive parenting and self-regulation during early and middle childhood. For example, in a cross-sectional study conducted with a small sample of middle-class children aged 6-8 years, Davidov and Grusec (2006) revealed that

maternal and paternal responsivity to children's distress was predictive of children's better regulation of negative emotions, and that maternal warmth was related to children's regulation of positive emotions. In a longitudinal study of children close in age to families in the current investigation, prior maternal sensitivity and stimulation was related to children's later affect dysregulation at 24 and 36 months (NICHD Early Child Care Research Network, 2004). Another study suggested that high levels of "dyadic connectedness" for children aged 2 to 4 predicted better delay of gratification 16 months later (Li-Grining, 2007). Finally, a meta-analysis of cross-sectional studies on parenting and self-regulation in preschool-aged children revealed consistent, albeit modest, effects of positive parental control (i.e., behavioral support) on children's compliance (Karreman, van Tuijl, van Aken, & Deković, 2006). Overall, high levels of parental support have been correlated with high levels of children's regulation, although research using samples of children at high risk for early socioemotional maladjustment is wanting.

The same contention has been supported in longitudinal studies on supportive parenting with respect to change or growth in children's self-regulation, although these studies are even fewer in number. One six-month longitudinal study revealed that parental limit-setting and scaffolding for children ages 33 to 40 months predicted subsequent improvements in effortful control (Lengua et al., 2007). The same effect was not observed for parental warmth. In another study, while controlling for children's initial levels of observed effortful control, high levels of maternal responsiveness at 22 months predicted high levels of effortful control observed at 33 months (Kochanska, Murray, & Harlan, 2000). Likewise, another study indicated that high levels of maternal responsiveness at 13 and 24 months were associated with children's better delay of gratification and task-focusing at 24 months (Olson et al., 1990). Overall, there is some initial support for the notion that supportive parenting promotes the growth of self-regulation in early childhood, but again these studies have been primarily conducted with lower risk, predominantly middle-class samples.

Harsh Parenting

Empirical evidence also indicates that harsh parenting serves to undermine the development of self-regulation. In keeping with our conceptualization of supportive parenting, harsh parenting was operationalized as a multidimensional factor that tapped both general parenting qualities (i.e., overall harshness) and specific parental behaviors (i.e., parents' negative verbal comments, physical behaviors, and the use of negative directives during parent-child interactions). Harsh parental behavior may frighten children into suppressing displays of negative emotion (Sroufe, 1996) and in the short term quickly stop children's misbehavior (Coplan, Hastings, Lagacé-Séguin, & Moulton, 2002). However, demanding and obtaining instant compliance has its costs. As specified by the Early Childhood Coercion Model (e.g., Scaramella & Leve, 2004), such unpleasant interactions are thought to deprive children of opportunities to practise controlling emotion or behavior in a supportive context (Colman, Hardy, Albert, Raffaelli, & Crockett, 2006). Simultaneously, harsh parenting is postulated to elevate children's levels of negative affect, which also increases the need for effective regulation (Scaramella & Leve, 2004). Finally, harshness may also shift children's attention from the parenting message to their feelings, which reduces the likelihood that children will internalize parental expectations and children's subsequent willingness to comply with parental directions (Grusec & Goodnow, 1994).

There is empirical evidence to support negative associations between harsh parenting and self regulation, but both the number of studies on this topic and the effect sizes of harsh parenting tend to be modest. For example, a meta-analysis of cross-sectional studies on parenting and self-regulation in preschool-aged children revealed small detrimental effects of negative parental control (e.g., parental hostility, criticism) on children's compliance with adult directives (Karreman et al., 2006). Another study linking parenting processes and self-

regulation in early adolescence revealed modest, negative associations between high levels of conflicted-harsh parenting and children's contemporaneous self-regulation (Brody & Ge, 2001). The few longitudinal studies exploring change in self regulation in relation to harsh parenting show a similar pattern, although it should be pointed out that most of these studies were conducted using samples of older children. In one study examining parallel latent growth models of parenting and effortful control during the transition to adolescence, initial levels of parental rejection and inconsistency were linked only to initial levels and not growth of children's effortful control (Lengua, 2006). In another study, physically punitive discipline in early childhood made a small, negative contribution to rank-order change in self-regulation between early and middle childhood (Colman et al., 2006). In sum, past research on associations between harsh parenting and child self-regulatory development is limited, with some evidence to suggest that harsh parenting undermines self-regulatory development during childhood. As with supportive parenting, however, more information is needed about the role of harsh parenting in the development of inhibitory control in early childhood, especially for children at risk for poor socioemotional adjustment.

Influences of Children's Individual and Socioeconomic Characteristics on Inhibitory Control

We also considered the influence of children's sex, ethnicity, and family poverty on inhibitory control. The broader literature on self-regulation has repeatedly indicated that girls demonstrate better regulation than boys throughout development (Li-Grining, 2007; Weinberg, Tronick, Cohn, & Olson, 1999), but that growth in self-regulation occurs at the same speed for both genders (Raikes et al., 2007). Despite a recent call for increased attention to the sociocultural and socioeconomic contexts of self-regulation (Raver, 2004), little research has explored or found meaningful racial/ethnic differences in self-regulation at any point in childhood, with or without accounting for socioeconomic characteristics. What little evidence is available is contradictory. For example, in one study using a predominantly African American sample of preschoolers, the emotion regulation strategies and abilities of low-income children resembled those of middle-income children (Garner & Spears, 2000). In another study conducted with a large, multiethnic and low-income sample of preschoolers, child race/ethnicity was not associated with children's executive control or with delay of gratification, yet high levels of sociodemographic and residential risk were linked to poorer executive control (Li-Grining, 2007). In the context of the current sample of low-income children, we anticipated that extreme levels of poverty would be associated with low initial levels and slower growth in children's inhibitory control.

Whereas we did not formulate any *a priori* hypotheses for direct effects of race/ethnicity on initial levels or growth in inhibitory control, we did consider the possibility that associations between parenting and inhibitory control may be moderated by ethnicity, as previous studies have documented distinct relations between parenting and child behavior for specific ethnic groups (e.g., Pinderhughes, Nix, Foster, Jones, & the Conduct Problems Prevention Research Group, 2001). For example, high levels of harsh parenting and low levels of responsive parenting have previously been linked to low levels of child compliance (Whiteside-Mansell, Bradley, Owen, Randolph, & Cauce, 2003), and to poorer adjustment (e.g., Deater-Deckard, Dodge, Bates, & Pettit, 1996) in European American but not African American children. Consequently, we examined whether associations between harsh parenting and self-regulation would be moderated by ethnicity, specifically whether low levels of harsh parenting or high levels of supportive parenting were more strongly associated with higher levels of inhibitory control among European American versus ethnic minority children.

The Current Study

The current study was executed with three goals in mind. First, we sought to examine growth in inhibitory control during the transition from the toddler to preschool period among a large sample of families facing high levels of socioeconomic, family, and child risk. We anticipated that children's inhibitory control would increase between ages 2 and 4 based on prior studies' results indicating positive growth in other dimensions of self-regulation during childhood (e.g., Raikes et al., 2007). Second, we also examined the associations between observed parenting and initial levels and growth in inhibitory control. In keeping with previous studies, we anticipated that high levels of supportive parenting (e.g., Kochanska et al., 2000) and low levels of harsh parenting (e.g., Colman et al., 2006) would be related to high initial status and faster growth in inhibitory control. Finally, we investigated potential interactive effects between child ethnicity and parenting on latent growth in inhibitory control, specifically whether negative associations between harsh parenting and inhibitory control or positive associations between supportive parenting and inhibitory control would be stronger in European American versus ethnic minority families (i.e., African American, Hispanic, or other ethnicities).

In comparison to prior research, this study is particularly well situated for examining latent growth and parenting correlates of inhibitory control in early childhood. Data for the current study were collected as part of the Early Steps Multisite Project, which is a multisite prevention program for young children at increased risk for clinically elevated levels of conduct problems. This intervention specifically targets family management and socialization practices in early childhood to reduce and prevent early-onset problem behavior and factors that disrupt parenting (e.g., maternal depression). The Early Steps sample is large, predominantly low-income, and ethnically diverse, in contrast to the small sized, predominantly middle class samples employed in much existing research on the development of self-regulation during early childhood (e.g., Dennis, 2006). Furthermore, inhibitory control was assessed annually when children were 2, 3, and 4 years old, which permitted an examination of latent growth. This is an improvement over existing studies with just two assessments of self-regulation (e.g., studies of change in rank ordering over time, or studies of stability: Colman et al., 2006), and investigations that do not control for prior self-regulation in analyses (e.g., Li-Grining, 2007). Finally, this study also employed two multifactor observation-based indices of parenting and a widely used maternal report questionnaire of children's inhibitory control (i.e., from the Child Behavior Questionnaire; Rothbart et al., 2001).

Methods

Participants

Participants included 731 families recruited between 2002 and 2003 from Nutritional Supplement Centers for Women, Infants and Children (WIC) Programs in the metropolitan areas of Pittsburgh, Pennsylvania, and Eugene, Oregon, and within and outside the town of Charlottesville, Virginia. Families were approached at WIC sites and were invited to participate if they had a son or daughter between 2 years 0 months and 2 years 11 months of age, following a screen to ensure that they met the study criteria by having socioeconomic, family, and/or child risk factors for future behavior problems. Of the 1666 parents who were approached at WIC sites, 879 met the eligibility requirements and had children in the appropriate age range (52.8%), and 731 (83.2%) of these families agreed to participate (88% in Pittsburgh, 84% in Eugene, 76% in Charlottesville). The final study sample consisted of 272 (37%) families in Pittsburgh, 271 (37%) in Eugene, and 188 (26%) in Charlottesville. More participants were recruited in Pittsburgh and Eugene because of the larger population of eligible families in these regions relative to Charlottesville.

Children in the sample (49% female) had a mean age of 29.9 months ($SD = 3.2$) at the time of the age 2 assessment. Across sites, the children were reported to belong to the following racial groups: 27.9% African American, 50.1% European American, 13.0% Biracial, and 8.9% other races (e.g. American Indian, Native Hawaiian). In terms of ethnicity, 13.4% of the sample reported being Hispanic. During the period of screening from 2002 to 2003, more than two-thirds of those families enrolled in the project had an annual income of less than $20,000, and the average number of family members per household was 4.5 ($SD = 1.63$). Most children lived with two biological parents (37%), or with a cohabiting single parent (21%). Forty-one percent of the population had a high school diploma or had passed the General Educational Development (GED) equivalency tests, and an additional 32% had one to two years of post-high school training (see Table 1 for a more detailed breakdown of demographic data by site).

Retention—Of the 731 families who initially participated, 659 (90%) were available at the one-year follow-up and 619 (85%) participated at the two-year follow-up when children were between 4 and 4 years 11 months old. At ages 3 and 4, selective attrition analyses revealed no significant differences in project site, children's race, ethnicity, or gender, levels of maternal depression, or children's externalizing behaviors (parent reports). Furthermore, no differences were found in the number of participants who were not retained in the control versus the intervention groups at both ages 3 ($n = 40$ and $n = 32$, respectively) and 4 ($n = 58$ and $n = 53$), respectively. 720 children had sufficient data to be included in growth modeling analyses (i.e., the participating child had at least one report of inhibitory control at any timepoint).

Design and Procedure

Mothers and, if available, alternate caregivers such as fathers or grandmothers, who agreed to participate in the study were scheduled for the initial age 2 home assessment. Caregivers completed several questionnaires at each assessment, which also involved a series of interactive tasks and lasted approximately 2.5 hours. The home visit protocol was repeated at ages 3 and 4 for both the control and intervention groups. The age 3 home assessment occurred approximately 12 months after the age 2 study assessment, and the age 4 visit took place approximately 12 months after the age 3 home assessment. Families received $100, $120, and $140 for their participation in the age 2, 3 and 4 assessments, respectively.

Randomization to treatment was balanced on gender to assure an equal number of males and females in the control and intervention sub-sample. To ensure blindness, the examiner opened a sealed envelope, revealing the family's group assignment only after the assessment was completed, and shared this information with the family at the conclusion of the age 2 assessment. Examiners carrying out follow-up assessments were not informed of the family's assigned condition. Families randomly assigned to the intervention condition were then scheduled to meet with a parent consultant for two or more sessions of the Family Check-Up (FCU) intervention. The FCU is a brief, family-based intervention based on motivational interviewing and modeled after the Drinker's Check-Up (Miller & Rollnick, 2002). Data from structured assessments of family and child functioning, including both observations and questionnaires, is shared with parents to motivate change. For a more detailed description of the intervention and procedures, see Dishion et al. (in press). Families randomly assigned to the intervention condition received additional, albeit modest, compensation for participating in the second of two initial intervention meetings (i.e., $25 versus $140-160 for taking part in assessments completed by both intervention and control families). Families in the intervention and control groups did not differ on any demographic or study variables.

Measures

Descriptive statistics and correlations for all study variables are presented in Table 2.

Demographic Characteristics—Children's and families' demographic characteristics at age 2 were dummy-coded for analyses. Single dummy codes were used to indicate intervention group membership (0 = control, 1 = intervention), child sex (0 = female, 1 = male), and family poverty (0 = annual income greater than $20,000 per year, 1 = annual income less than $20,000 per year). Multiple dummy codes were required to describe race/ethnicity (Black: 0 = not African American , 1 = African American; Hispanic/Other: 0 = not Hispanic/Other, 1 = Hispanic/Other) and study site (Pittsburgh: 0 = not Pittsburgh, 1 = Pittsburgh; Eugene: 0 = not Eugene, 1 = Eugene).

Inhibitory Control—The 13-item inhibitory control subscale of the Child Behavior Questionnaire (CBQ; Rothbart et. al., 2001) was used to assess behavioral self-regulation at children's ages 2, 3 and 4. This subscale includes items such as, "Has difficulty waiting in line for something," and "Can easily stop an activity when s/he is told 'no.'" Mothers responded to each item on a 7-point scale, ranging from 1 (*extremely untrue of child*) to 7 (*extremely true of child*). Scale scores were computed by averaging all numeric responses. Mothers could also indicate whether any items were not applicable to their child, and these items were treated as missing (i.e., were not averaged into scale scores). Scale scores were not computed if data were missing for three or more items. The scale demonstrated adequate internal consistency at each timepoint, with Cronbach's alphas ranging from .65 to .74.

Supportive Parenting—Four observational measures of parenting in the home were used to create a supportive parenting composite at age 2 (Dishion et al., in press; Lunkenheimer et al., in press). One measure was the involvement subscale from the Infant/Toddler Home Observation for Measurement of the Environment Inventory (Caldwell & Bradley, 1978), which study examiners completed as part of the age 2 assessment. Examiners responded to three statements about the primary caregiver's observed involvement with the child during the study visit (sample item: "Parent talks to child while doing household work") on a binary response scale (+/-). These responses were summed to create a single index of observed parental involvement. The three remaining measures were derived from videotaped parent-child interactions from the same study visit. Two observed duration proportions of parental positive behavior support and engagement came from the Relationship Process Code (RPC; Jabson, Dishion, Gardner, & Burton, 2004). The RPC is a third-generation code derived from the Family Process Code (Dishion, Gardner, Patterson, Reid, & Thibodeaux, 1983), which has been used extensively in previous research. Twenty four research assistants coded the videotaped interactions, and 15% of the observations were coded twice to establish reliability (average percent agreement = .87; κ = .86). Positive behavior support was the duration of the videotaped interaction in which caregivers provided positive reinforcement (verbal and physical), volunteered prompts and suggestions for positive activities, and provided positive structure (e.g., offered choices in a request for behavior change). Parental engagement was the average duration of parent—child sequences involving talking or physical interactions such as turn taking or playing a game. The final measure was the proactive parenting index from the Coder Impressions Inventory (COIMP). Videotape coders rated each parent on his or her tendency to anticipate potential problems and to provide prompts or other structural changes to avoid young children becoming upset and/or involved in problem behaviors (e.g., "parent gives understandable, age-appropriate reasons for behavior change"). Confirmatory factor analyses indicated that these four indices form a single latent factor (Lukenheimer et al., in press), and consequently, these scores were standardized and summed to form the supportive parenting composite used in the current study (Cronbach's α = .61).

Harsh Parenting—Five items from the COIMP and three duration proportions from the RPC (Jabson et al., 2004) were used to create a composite index of observed harsh parenting at age 2. COIMP items tapped parents' provision of developmentally-inappropriate reasons for children's behavior change, displays of anger or annoyance with the child, criticizing or blaming the child for family problems, use of physical discipline, ignoring/rejecting the child, and messages about the child's worthlessness. RPC codes included duration proportions of parental negative verbal, directive, and physical behavior. These individual items were standardized and summed in order to create a composite index of parental harshness (Cronbach's $\alpha = .75$).

Missing Data

We examined patterns of missing data before addressing substantive research questions. This revealed that between 10 to 15% of cases were missing inhibitory control data at any study wave. A detailed exploration indicated that children at the Pittsburgh site (15%) were disproportionately likely to be missing age 2 inhibitory control data than children at the Eugene site (6%). Pittsburgh mothers ($M = 1.38$, $SD = 1.71$) rated a greater number of inhibitory control items as non-applicable to their child than Eugene mothers ($M = 1.09$, $SD = 1.42$), $F (1, 541) = 4.51$, $p < .05$, $\eta^2 = .01$; thus Pittsburgh mothers were less likely to have rated a sufficient number of items to have a scale score calculated for their child. Also, children living in families with annual incomes below $20,000 per year (18%) were more likely to be missing age 4 inhibitory control data than children living in families with income greater than $20,000 per year (9%). No other study variables or sample characteristics were associated with missing inhibitory control data at any wave. As this suggested data were missing at random (MAR), we employed full information maximum likelihood in model estimation procedures (Enders, 2001).

Analysis Plan

Following preliminary examination of study variables' descriptive statistics and intercorrelations (see Table 2) substantive research questions were addressed in a series of latent growth models. These analyses were based on the multilevel model for change applied within a structural equation modeling framework (for more details, see Bollen & Curran, 2006). Latent growth modeling is a constrained version of confirmatory factor analysis with mean structure. Individuals' scores on a variable assessed repeatedly over time are used to construct latent variables representing the sample's average initial status and growth rates. To accomplish this, all of the intercept's factor loadings are set to "1" and the slope's loadings correspond to the study's time scale (in this case, "0" for age 2, "1" for age 3, and "2" for age 4). The intercepts of the repeated measures are set to zero, and typically the residual variances of the repeated measures are set to be equal. These model constraints "force" specific pieces of information from the repeated measures into the latent factors. Several pieces of information describing the construct's latent growth are obtained through model fitting. The fixed effects describe growth as an average intercept and slope for the sample, and the random effects represent sources of variability. The intercept and slope variances indicate whether there is significant variability in individuals' starting points or slopes, and the residual variance captures the "leftover" variance that is not explained by the latent intercept and slope factors. Finally, the covariance between the latent intercept and slope factors can also be interpreted to determine if the speed of growth is associated with initial status values.

Following the procedures recommended by Singer and Willett (2003), we performed three distinct phases of modeling. An unconditional model (i.e., a growth model without any predictors) was estimated initially to determine whether a linear model adequately fit the data. Preliminary conditional models were computed next (i.e., growth models with

predictors), in which each predictor variable was considered separately without any other predictors included in the model. All continuous predictor variables were mean-centered prior to their inclusion in all conditional models to facilitate the interpretation of their estimated effects. A "full" conditional model was also estimated, in which the intercept and slope terms were regressed simultaneously upon all of the predictors. Finally, the questions about moderation by race/ethnicity were addressed by comparing nested multigroup conditional models that included only the parenting variables. Models with regression path coefficients constrained to be equal across race/ethnic groups were compared to models in which all groups' regression path coefficients were freely estimated for each group. A significant improvement in χ^2 fit for the models in which paths were freely estimated versus constrained was viewed as evidence for moderation.

The minimal requirements for adequate model fit were a non-significant chi-square statistic (χ^2), a Root Mean Squared Error of Approximation (RMSEA) ranging from .05 to .10, and smaller-sized Akaike Information Criterion (AIC) and sample-size adjusted Bayesian Information Criterion (BIC) values (Bollen & Curran, 2006; Singer & Willett, 2003).

Results

Estimating Unconditional Growth in Inhibitory Control

The first research question, whether there was growth in inhibitory control, was addressed through the estimation and examination of a linear unconditional latent growth model. Fit statistics suggested that the linear model provided acceptable fit to the data, χ^2 fit (3) = 2.18, $p > .05$, RMSEA = .00, RMSEA 90% C.I. = .00 - .06, AIC = 4153.18, BIC = 4161.61. On average, initial status in inhibitory control was relatively low (intercept = 3.97, $p < .001$). This was followed by gradual and positive linear growth in inhibitory control from ages 2 to 4 (slope = .25, $p < .001$). There was significant individual variability in intercepts ($\sigma^2_i = .36$, $p < .001$) and in slopes ($\sigma^2_s = .05$, $p < .001$), which suggests that children differed in terms of their age 2 levels of inhibitory control and in their rates of growth over time. The intercept and slope terms were negatively correlated ($r = -.30$, $p < .05$), indicating that higher levels of inhibitory control at age 2 were predictive of slower growth to age 4.

Factors Associated with Initial Levels and Growth in Inhibitory Control

In this section, we focus on the patterns of associations between the predictors and growth parameters, which are evaluated in conditional latent growth models. As a consequence of using centered predictor variables, the unstandardized regression weights were used to interpret the results of these analyses. In any conditional model, with all other predictors in the model held constant, every 1-unit change in the predictor corresponds to a change in inhibitory control equal to the unstandardized regression weight for that predictor. When the analyses revealed associations between a growth parameter and a predictor, we plotted the regression line for growth in inhibitory control at one standard deviation above and below that predictor's mean.

Preliminary Conditional Analyses—Each predictor variable was individually examined to explore their associations with initial status and growth of inhibitory control. Preliminary conditional analyses revealed significant associations between some predictors and model growth components (see Table 3 for regression weights). There was no effect for treatment group; children in the intervention and control conditions did not differ in terms of initial levels or speeds of growth in inhibitory control. There was, however, an effect for study site, such that children at the Pittsburgh site experienced slower growth in inhibitory control compared to children from Charlottesville (see Figure 1a). Initial status was associated with gender, such that girls' levels of inhibitory control were reportedly higher

than boys' levels at age 2 (see Figure 1b). Ethnicity/race was also associated with initial status and slope (see Figure 1c): African American children's initial levels were marginally higher, and their growth rates were significantly slower than European American children's growth. Extreme poverty was predictive of growth, indicating that inhibitory control increased faster for children living in higher-SES families (Figure 1d). Supportive parenting was also linked to growth, such that high levels of supportive parenting corresponded to faster growth in inhibitory control (see Figure 1e). Finally, harsh parenting was predictive of initial status, such that high levels of negative parenting were linked to low levels of inhibitory control at age 2 (see Figure 1f).

Full Conditional Analysis—In the multivariate context, many of the effects observed in the preliminary models were still present (see Table 4 for regression weights). The effect of study site remained, such that children from Pittsburgh experienced slower growth in inhibitory control even when other study variables were included in the model. High initial status continued to be associated with female gender, and at trend-level, African American ethnicity. In the multivariate context, the association between the slope and African American status disappeared: further exploratory analyses revealed that this effect was explained by extreme poverty, which emerged as a marginally-significant predictor of linear growth in the full model. Supportive parenting was still related to faster linear growth in inhibitory control, and harsh parenting was still associated with higher initial status values.

Conditional Analyses of Moderation—Four final conditional models were estimated in order to explore whether the effects of supportive and harsh parenting on inhibitory control were moderated by ethnicity. In both cases, the effect of parenting was not moderated by child race/ethnicity. For supportive parenting, the model with path coefficients constrained to be equal across groups fit as well as the model in which path coefficients were estimated for each group, constrained model χ^2 fit (16) = 13.32, $p > .05$, estimated model χ^2 fit (12) = 8.70, $p > .05$, $\Delta\chi^2$ fit (4) = 4.63, $p > .05$. The same held true for harsh parenting, in that the model with path coefficients constrained to be equal across groups fit as well as the model in which path coefficients were estimated for each group, constrained model χ^2 fit (16) = 15.84, $p > .05$, estimated model χ^2 fit (12) = 9.02, $p > .05$, $\Delta\chi^2$ fit (4) = 6.82, $p > .05$.

Discussion

The current study was executed to address three research goals. First, we examined growth in at-risk young children's inhibitory control between ages 2 and 4. Our results indicated that growth in inhibitory control during early childhood is linear and positive, such that children's improvements in inhibitory control occurred at consistent speeds between ages 2 and 3 and ages 3 and 4. Second, we also examined the roles of demographic characteristics and observed parenting at age 2. Results revealed that girls and children experiencing low levels of harsh parenting had high initial levels of inhibitory control. Furthermore, faster growth in inhibitory control between ages 2 and 4 was linked to high levels of observed supportive parenting at age 2. In addition, children from the Pittsburgh site evidenced slower growth than children from Eugene and Charlottesville. Participation in the Family Check-Up intervention did not appear to influence the relations examined in this study. Third, we also explored whether child race/ethnicity moderated associations between parenting and initial status and growth in inhibitory control. No support for moderation was found.

Contributions

Describing Growth in Inhibitory Control During Early Childhood—This is the first known study to examine latent growth in inhibitory control during early childhood.

Consistent with prior research on growth in other dimensions of self-regulation (Raikes et al., 2007), the unconditional model of inhibitory control revealed that there was significant linear change from ages 2 to 4. On average, children's initial levels of inhibitory control were moderately low and increased gradually over time. Children with the poorest initial levels experienced faster growth between ages 2 and 4 than children with high initial levels, which is consistent with another study on change in behavioral regulation during middle childhood (Zhou et al., 2007). The current study's findings provide further empirical support for the notion that self-regulation improves gradually throughout childhood (Lengua et al., 2007; Li-Grining, 2007), and that the component of inhibitory control in particular improves during children's early years (Kochanska et al., 1996).

Children's Individual and Socioeconomic Characteristics—Consistent with hypotheses and existing research, child gender covaried significantly with initial status in inhibitory control. As demonstrated by previous studies, girls had higher initial levels of inhibitory control than boys (Li-Grining, 2007), but did not differ from boys in terms of growth rates (Raikes et al., 2007). This provides additional evidence that gender differences in level of self-regulation are maintained in the interim between infancy (Weinberg et al., 1999) and middle childhood (Colman et al., 2006), but that gender is not associated with the speed at which self-regulation develops.

In addition to differences in initial levels of inhibitory control by child gender, African American children's rates of growth in inhibitory control were slower than European American children's growth rates. We further explored the effect for race/ethnicity in subsequent analyses evaluating whether the effects of parenting were moderated by race, which revealed no evidence for moderation. Racial/ethnic differences in self-regulation have rarely been examined, particularly using samples appropriate for studying the confounded effects of race/ethnicity and socioeconomic status (Raver, 2004). When race/ethnicity has been considered, few if any differences have been found, particularly when other socioeconomic risk factors were controlled in analyses (Li-Grining, 2007; NICHD Early Child Care Research Network, 2004). In the full conditional model, the effect for African American ethnicity was eliminated. Further exploratory analyses indicated that this effect was explained by site differences and by extreme poverty. In other words, once the variance attributable to site differences and to low family income was removed, African American children's growth occurred at the same speed as European American children's growth. This finding highlights the value of considering separate dimensions of socioeconomic risk in addition to race/ethnic differences (Raver, 2004), and reiterates the importance of greater exploration of socioeconomic factors related to race/ethnicity such as neighborhood adversity in relation to children's self-regulation. Past research using similar samples of low-income African American and European American children has revealed that African American families live in significantly more adverse neighborhoods than European American families even within studies of predominantly low-income children (Shaw, Criss, Schonberg, & Beck, 2004; Winslow, 2001). Neighborhood effects might take their toll directly on children's developing inhibitory control gradually and cumulatively with children's increasing exposure to extra-familial contexts, or indirectly as neighborhood adversity compromises parental well being and caregiving quality during the toddler and preschool periods.

Effects of Parenting—Consistent with hypotheses, supportive parenting was associated with growth in inhibitory control, such that high levels of observed positive parenting at the age 2 assessment were indicative of children's subsequent growth in inhibitory control between ages 2 and 4. This provides direct support for the hypothesis that supportive, involved parenting promotes the development of self-regulation in early childhood (Kochanska & Aksan, 1995; Kopp, 1989). These results confirm previous findings about the

importance of supportive parenting for children's self-regulation (Davidov & Grusec, 2006; Murry & Brody, 1999) and extend existing knowledge about shorter-term change in children's regulatory capacities (Kochanska et al., 2000; Lengua et al., 2007).

Somewhat contrary to expectations, harsh parenting was associated only with initial levels but not growth in inhibitory control. In this case, high levels of harsh parenting observed at age 2 were associated with low initial levels of inhibitory control. Previous studies examining harsh parenting (Brody & Ge, 2001; Lengua, 2006) have reported conflicting results, with no clear pattern across studies. On one hand, this finding is consistent with one existing study, in which high levels of parental rejection and inconsistency were linked to initial status but not growth in effortful control during the transition to adolescence (Lengua, 2006). On the other hand, however, another study examining change in self-regulation between early and middle childhood suggested that early physically-punitive discipline impeded subsequent change in self-regulation (Colman et al., 2006).

In the absence of direct support for the influence of harsh parenting on growth in inhibitory control, two explanations deserve investigation in future longitudinal investigations. One explanation is that parenting and self-regulation are transactional processes, as specified in the Early Childhood Coercion Model (Scaramella & Leve, 2004). Specifically, children's dysregulated behavior or emotion may elicit harsh parenting, which increases children's levels of hard-to-manage negative affect, and so on. Coercive cycles such as these may slow children's development of self-regulatory skills (Kopp, 1989). Another explanation is that the experience of harsh parenting delays children's early inhibitory control development, as suggested by the association with initial status in this study. Regardless of the stability of parental harshness, early developmental delays might persist over time unless delayed children manage to "catch up." The current results are consistent with this explanation, as on average children at lower initial levels of inhibitory control grew more rapidly between ages 2 and 4 than children at higher initial levels. Full understanding of the role of parental harshness will not be reached without additional research, and as these effects are generally quite small in size (Karreman et al., 2006), it is imperative that these explorations use large samples whenever possible.

Limitations and Future Directions

Despite advancing our understanding of the course of inhibitory control during early childhood and providing novel data on the precursors of such patterns, the study has several notable methodological limitations. First, a single informant provided questionnaire-based reports of children's inhibitory control. Although the CBQ (Rothbart et al., 2001) is a well-validated and widely-used questionnaire for children ages 3 to 7 (e.g., Komsi et al., 2006; Murphy, Eisenberg, Fabes, Shepard, & Guthrie, 1999), confidence in these findings could be increased if additional informants had completed this questionnaire, and the inclusion of observed indices of children's inhibitory control would also be desirable. Future studies should include multiple informants and methodologies for assessing children's self-regulation. Another limitation was in regard to the broad parenting factors included as predictors. Although observational measures of parenting were strengths of this study, including relatively expansive dimensions prohibited the identification of precise mechanisms by which parental harshness and support may influence the development of inhibitory control. Researchers may wish to study more specific elements of parenting in order to elucidate these mechanisms in future studies of longitudinal growth in inhibitory control.

Inhibitory control continues to grow through mid-childhood, but as this study focused only on early childhood, the course and influences on continued growth beyond age 4 remain unknown. Other studies have hinted that the speed of growth in self-regulation changes over

time (Dennis et al., 2007), but as this study included just three timepoints, we were unable to explore changes in growth rates over time. Accelerations or decelerations in growth rates could be captured in such non-linear models (i.e., quadratic or cubic models with 4 or 5 data points, respectively).

The current findings indicated that growth in self-regulation evidenced in older, more normative, middle-class samples was also evident in this younger, at-risk, heterogeneous sample. This study revealed novel information regarding the roles of supportive and harsh parenting, further supporting theoretical assertions that supportive parenting facilitates positive growth (Kochanska & Aksan, 1995) and parental harshness impedes growth in regulation (Scaramella & Leve, 2004). Finally, this investigation also identified unique effects of socioeconomic risk on growth in inhibitory control, which extends existing knowledge about predictors of self-regulation ability levels in early childhood (Li-Grining, 2007). Information gleaned from these pursuits may highlight additional targets for early interventions focused on parenting in contexts of high socioeconomic risk, in the hopes of promoting early gains in inhibitory control, and consequently, decreased risk of adverse outcomes.

Acknowledgments

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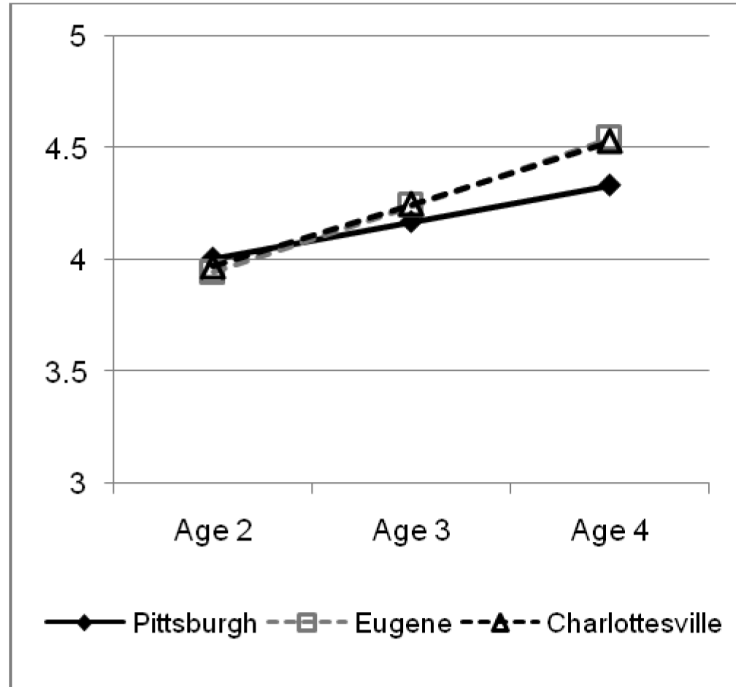
Figure 1a.
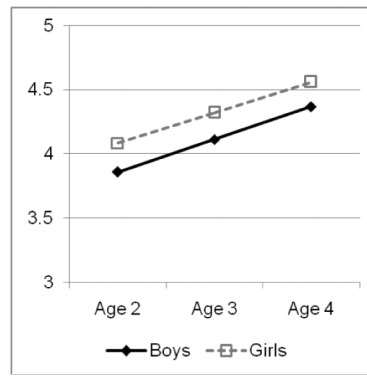Conditional growth in inhibitory control: Study site.

Figure 1b.
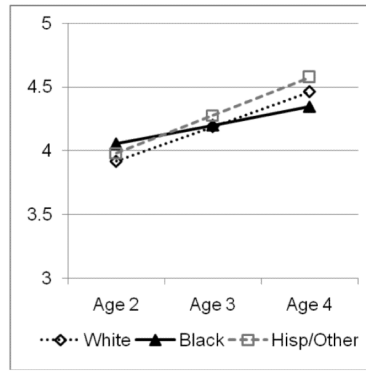Conditional growth in inhibitory control: Child gender.

Figure 1c.
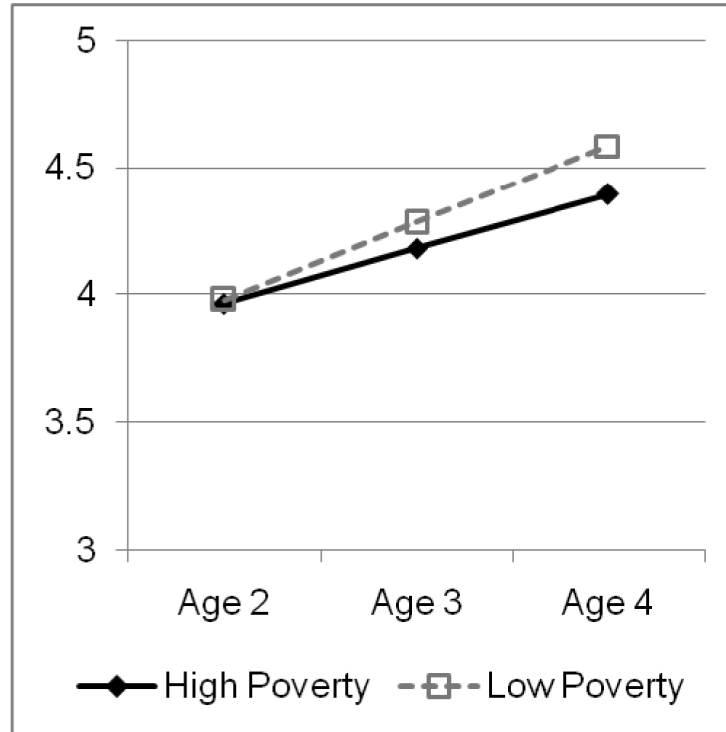Conditional growth in inhibitory control: Child race/ethnicity.

Figure 1d.
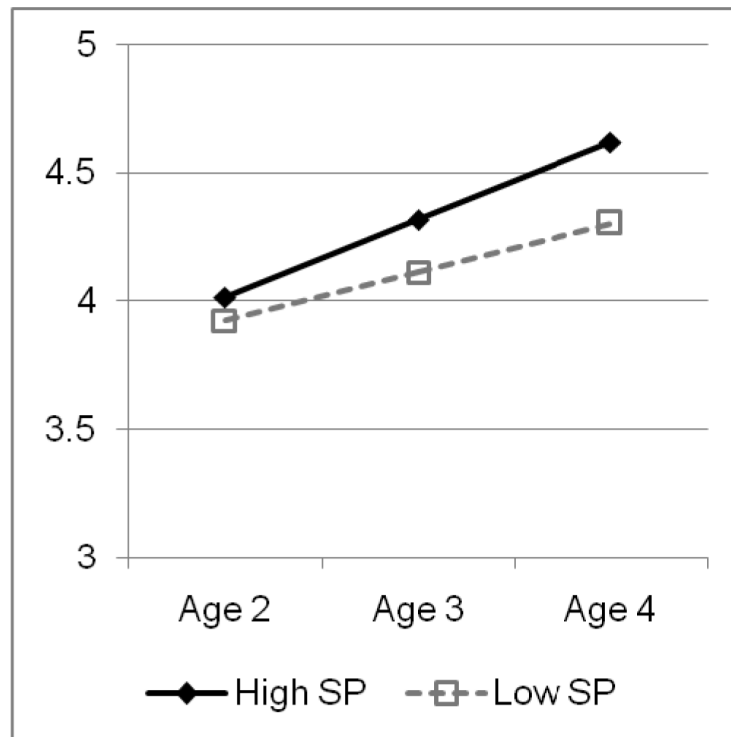Conditional growth in inhibitory control: Extreme poverty.

Figure 1e.
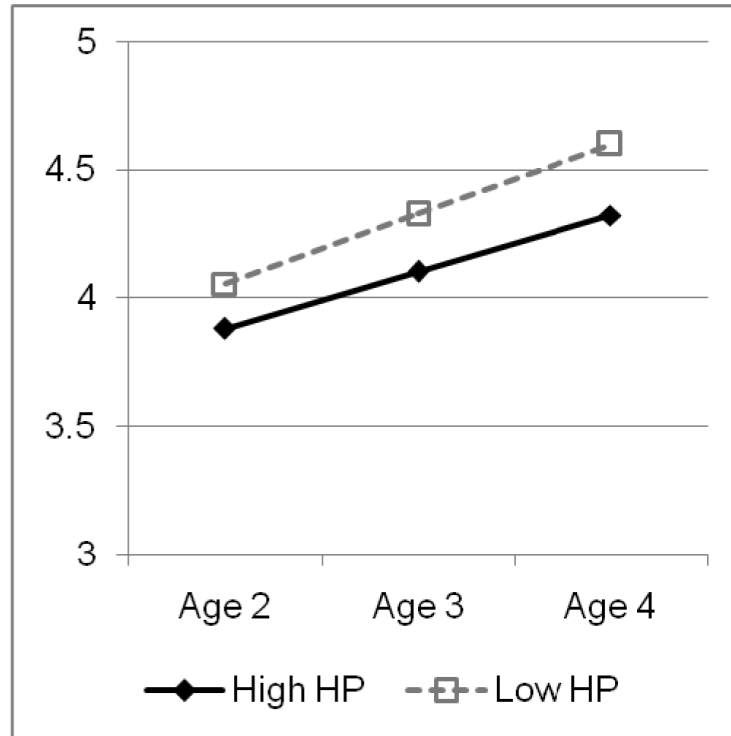Conditional growth in inhibitory control: Supportive parenting.

Figure 1f.
Conditional growth in inhibitory control: Harsh parenting.

Table 1

Demographics and Parenting by Site

Variable	Charlottesville	Eugene	Pittsburgh	F / χ^2
Male Gender	51%	50%	50%	$\chi^2 (2) = .04$, $V = .01$
Race/Ethnicity				$\chi^2 (4) = 186.01$, $V = .36$ ***
White	33% [E]	64% [C, P]	37% [E]	
Black	31% [E, P]	1% [C, P]	50% [C, E]	
Hispanic/Other Race	36% [P]	35% [P]	13% [C, E]	
Extreme Poverty	66%	62%	71%	$\chi^2 (2) = 4.39$, $V = .08$
Supportive Parenting	-.29 (2.60) [E]	.54 (1.93) [C, P]	-.33 (2.22) [E]	$F (2, 728) = 12.55$, $\eta^2 = .03$ ***
Harsh Parenting	.19 (4.72)	-.89 (4.52) [P]	.75 (5.74) [E]	$F (2, 603) = 6.15$, $\eta^2 = .02$ **
N	188	271	272	

Note. Superscripts denote significant group differences. C = Charlottesville, E = Eugene, P = Pittsburgh.

*
$p < .05$

**
$p < .01$

***
$p < .001$

Table 2

Scale Descriptive Statistics & Correlations

Variable	Scale Descriptives		Correlations								
	M	SD	1	2	3	4	5	6	7	8	9
1 Treatment Group											
2 Gender			-.00								
3 Black			.02	-.01							
4 Hispanic/Other Race			-.01	-.05	-.37**						
5 Extreme Poverty			-.04	.01	.17**	.06					
6 Supportive Parenting	.00	2.26	-.03	-.03	-.17**	-.03	-.13**				
7 Harsh Parenting	.00	5.11	.01	.03	.10*	-.03	.04	-.24**			
8 Inhibitory Control Age 2	3.97	.78	-.02	-.13**	.08*	.01	.01	.04	-.12**		
9 Inhibitory Control Age 3	4.24	.77	.05	-.15**	-.04	.05	-.11**	.16**	-.13**	.51**	
10 Inhibitory Control Age 4	4.45	.81	.06	-.11**	-.07	.08*	-.10*	.18**	-.16**	.41**	.53**

Note.

*
$p < .05$

**
$p < .01$ (2-tailed)

Table 3

Results of Preliminary Conditional Growth Models

Variable	Intercept			Slope		
	B	SE B	R²	B	SE B	R²
Treatment Group	-.00	.06	.00	.05	.04	.01
Site			.00			.08
Pittsburgh	.04	.08		-.12	.05 **	
Eugene	-.03	.08		.02	.04	
Gender	-.23	.06 ***	.04	.02	.04	.00
Ethnicity/Race			.01			.07
Black	.13	.07 +		-.13	.04 **	
Hispanic/Other	.07	.07		.02	.04	
Extreme Poverty	-.01	.06	.00	-.09	.04 *	.04
Supportive Parenting	.02	.01	.01	.03	.01 **	.06
Harsh Parenting	-.02	.01 **	.02	-.01	.04	.01

Note.

+ *p* < .10

* *p* < .05

** *p* < .01

*** *p* < .001

Table 4

Results of Final Conditional Growth Model

Variable	Intercept		Slope	
	B	**SE B**	**B**	**SE B**
Site				
Pittsburgh	.06	.08	-.10	.05*
Eugene	-.02	.08	-.02	.05
Gender	-.22	.06***	.03	.03
Ethnicity/Race				
Black	.14	.08+	-.06	.05
Hispanic/Other	-.06	.09	.04	.05
Extreme Poverty	-.02	.06	-.06	.04+
Supportive Parenting	.02	.01	.02	.01**
Harsh Parenting	-.02	.01**	.00	.00

Note.

The full model's R^2s for intercept and linear growth were .08 and .17, respectively.

+ $p < .10$

* $p < .05$

** $p < .01$

*** $p < .001$