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Relations of Growth in Effortful Control to Family Income, Cumulative Risk, and Adjustment in Preschool-age Children

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Abstract

The study examined growth in effortful control (executive control, delay ability) in relation to income, cumulative risk (aggregate of demographic and psychosocial risk factors), and adjustment in 306 preschool-age children (50% girls, 50% boys) from families representing a range of income (29% at- or near-poverty; 28% lower-income; 25% middle-income; 18% upper-income), with 4 assessments starting at 36–40 mos. Income was directly related to levels of executive control and delay ability. Cumulative risk accounted for the effects of income on delay ability but not executive control. Higher initial executive control and slope of executive control and delay ability predicted academic readiness, whereas levels, but not growth, of executive control and delay ability predicted social competence and adjustment problems. Low income is a marker for lower effortful control, which demonstrates additive or mediating effects in the relation of income to children's preschool adjustment.

Keywords

Effortful Control; Income; Cumulative Risk; Academic Readiness; Social Competence; Adjustment Problems

Poverty and low income have pervasive adverse effects on children's developmental outcomes (Duncan, Ziol-Guest & Kalil, 2010) which might be accounted for by disruptions to children's developing self-regulation associated with low income (Raver et al., 2011). Children growing up in economically disadvantaged households tend to demonstrate lower self-regulation (Raver, Blackburn, Bancroft & Torp, 1999). In turn, self-regulation is a critical predictor of social, emotional and academic competence and adjustment problems. Thus, the development of self-regulation might represent a pathway through which income impacts childhood problems. To understand the extent to which income-related disruptions to the development of self-regulation account for adjustment problems in children growing

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up in low-income contexts, it is critical to examine growth trajectories of self-regulation and explicitly test whether deviations in growth trajectories account for the effects of income on children's adjustment. A core aspect of self-regulation is effortful control, which was investigated in this study. Specifically, this study examined the relations of income and cumulative risk to the development of effortful control across the preschool period. Further, the relation of growth in effortful control to adjustment was examined, testing the hypotheses that cumulative risk accounts for the effects of income on growth in effortful control, which in turn mediates the effects of low income on academic readiness, social competence and adjustment problems.

Effortful control is a temperament construct conceptualized as the executive-based core of self-regulation that includes executive attention and inhibitory control (Rothbart & Bates, 2006). It includes the ability to shift attention from irrelevant or distracting stimuli, focus on relevant stimuli, and inhibit an undesired or dominant response to produce a preferred or correct non-dominant response, facilitating the regulation of attention, emotions and behavior (Rothbart, Ahadi & Evans, 2000). Effortful control abilities are present as early as 6- to 7- months of age and increase modestly through toddlerhood (Sheese, Rothbart, Posner, White & Fraundorf, 2008). The most marked increase in effortful control occurs in the period from 3 to 6 years (Carlson, 2005; Kochanska, Murray, Jacques, Koenig & Vandegeest, 1996; Reed, Pien & Rothbart, 1984). Given this period of rapid development, it is important to understand the role of contextual experiences in shaping effortful control, which can shed light on processes that promote or divert the development of effortful control and adjustment problems.

Effortful control is a consistent predictor of a range of indicators of children's functioning. It predicts academic competence and readiness (Blair & Razza, 2007; Buckner, Mezzacappa & Beardslee, 2009; McClelland et al., 2007; Obradovic, Bush, Stamperdahl, Adler & Boyce, 2010; Raver et al., 2011; Razza, Martin & Brooks-Gunn, 2010; Valiente, Lemery-Calfant & Castro, 2007), social-emotional competence (e.g., Eisenberg, Valiente et al., 2003; Raver et al., 1999), externalizing (Hughes & Ensor, 2009; Kochanska & Knaack, 2003; Lavigne, Gouze, Hopkins, Bryant & LeBailly, 2012; Lengua, 2003), and internalizing problems (de Boo & Kolk, 2007; Eisenberg, Cumberland et al., 2001; Hopkins, Lavigne, Gouze, LeBailly & Bryant, 2013; Lengua, 2003; 2006; Muris, van der Pennen, Sigmond & Mayer, 2008). Recent research suggests that rates of growth in effortful control, along with individual differences in levels, are important in explaining outcomes. In one study, greater increases in effortful control predicted fewer problems and better social competence above the effects of initial levels of effortful control in pre-adolescent children (King, Lengua & Monahan, 2013). Similar patterns were found in the relation of growth in executive function to adjustment problems (Hughes, Ensor, Wilson & Graham, 2011) and inhibitory control to aggression (Bridget & Mayes, 2011). A lower rate of growth in effortful control might interfere with children's ability to navigate increasingly complex demands, contexts and relationships. However, this has not been examined in preschool-age children. Further, identifying the factors that contribute to the development of effortful control is critical for understanding its role in children's adjustment.

Children from lower income families tend to demonstrate lower effortful control or executive function compared to children from higher income families (e.g., Eisenberg, Gershoff et al., 2001; Evans & English, 2002; Hughes et al., 2010; Li-Grining, 2007; Mezzacappa, 2004; Mistry, Benner, Biesanz, Clark & Howes, 2010). These differences are present in preschool-age (Lengua, Honorado & Bush, 2007; Wanless, McClelland, Tominey & Acock, 2011) and school-age children (e.g., Lengua, 2006). However, few studies have examined the relation of income to growth trajectories of effortful control or characterized potential differences in rates of growth across income levels. Evidence suggests that income is related to initial levels of effortful control or executive function, but not to rates of changes during middle childhood (Hughes et al., 2010; King et al., 2013). More evidence is needed on the relation of income to developmental trajectories of effortful control in early childhood to understand the role of income in diverting the development of effortful control. This study was designed to test the relation of family income and its related risk factors to growth in effortful control, with equal representation of families across income levels and assessments of effortful control across 4 time points.

In addition, studies examining income-related risk factors that predict developmental trajectories of effortful control are needed to elucidate the processes that account for the effects of income, identify families at elevated risk, and clarify potential targets for intervention. Low income is associated with a number of risk factors, including stress, residential instability, neighborhood problems, family conflict, parental mental health problems, and many other factors that often co-occur and have cumulative effects on children's adjustment (Ackerman, Brown & Izard, 2004; Evans, 2003; Linver, Brooks-Gunn & Kohen, 2002; Mistry, Vandewater, Huston & McLoyd, 2002), predicting children's academic achievement, social competence, externalizing and internalizing problems, among other developmental outcomes (Evans, Li, Sepanski-Whipple, 2013). As cumulative risk has been shown to mediate the effects of poverty on a range of health and developmental outcomes (e.g., Evans & Cassells, 2014; Evans & Kim, 2012; Wells, Evans, Beavis & Ong, 2010), it is possible that children's experiences of risk, particularly the burden of stress associated with an accumulation of risk, might account for the effects of low income on children's effortful control (Lavigne et al., 2012; Raver, Blair & Willoughby, 2013; Vernon-Feagans & Cox, 2013). A growing body of evidence indicates that the accumulation of poverty-related risk factors partially accounts for the effects of poverty on children's self-regulation (Buckner, Mezzacappa & Beardslee, 2003; Evans & English, 2002; Evans et al., 2013; Hughes & Ensor, 2009; Lengua et al., 2007; Mistry et al., 2010, Raver, Blair & Willoughby, 2013; Sektnan, McClelland, Acock & Morrison, 2010). Cumulative risk measures have been shown to correlate with lower effortful or executive control (Lengua et al., 2007; Mistry et al., 2010) and delay of gratification (Evans, 2003; Evans & English, 2002), but to date, there is little evidence of the effect of cumulative risk on developmental changes in effortful control. It is possible that cumulative risk might account for the effects of income, or that variations in risk exposure over time might clarify time-specific variations in children's effortful control above the effects of income. Both of these possibilities were tested in the current study.

It should be noted that there has not been a standard approach to creating cumulative risk indices (Evans et al., 2013). There are a variety of risk factors included in cumulative risk scores and numerous approaches to aggregating factors. Decisions about formulating cumulative risk scores should be guided by the research question. In the present study, we were interested in understanding whether the accumulation of risk factors that are associated with income account for the relation between income and growth in effortful control. Therefore, the risk factors included in the cumulative risk score represented demographic (mother education, single parent status), contextual (household density, residential instability) and psychosocial factors (negative life events, maternal depression) that often co-occur with low income and have previously been shown to relate to children's developmental outcomes. Although each of these factors might individually relate to children's adjustment, we are proposing that the burden of stress associated with the co-occurrence of risk is relevant in accounting for the effects of income on the development of effortful control. A cumulative risk score captures the burden of risk experienced by children in low-income families (Vernon-Feagans & Cox, 2013).

Further, comprehensive models that test whether growth in effortful control accounts for the effects of income on children's adjustment can clarify this potential mechanism of the effect of income. Few prior studies have tested whether effortful control accounts for the effects of low income on children's adjustment. One study showed that sustained attention, a component of effortful control, partially mediated the relation of family risk to receptive language, an indicator of school readiness (Razza et al., 2010). Another study demonstrated that effortful control mediated the effects of cumulative risk on academic achievement (Swanson, Valiente & Lemery-Chalfant, 2012). However, the question of whether the effects of income and cumulative risk on children's adjustment are accounted for by their effect on the development of effortful control has not been addressed. In this study, income and cumulative risk were examined as predictors of growth in effortful control, with the hypothesis that changes in effortful control would partially account for the effects of income and cumulative risk on adjustment.

It is important to comment on some issues related to the conceptualization and measurement of effortful control. First, there is considerable overlap in the conceptualization and operationalization of effortful control and executive function (Bridgett, Oddi, Laake, Murdock & Bachmann, 2013; Zhou, Chen & Main, 2012). Although executive functions include attention regulation and inhibitory control, they also include higher-order functions such as planning, decision making, and problem solving. The term effortful control emerges from the temperament literature and includes basic attentional, inhibitory, and delay abilities, perhaps representing the core of executive functions. We focus on these more basic executive functions in this study.

As to measurement, measures of effortful control often combine attention regulation and inhibitory control dimensions with reward delay, and there is empirical support for a single latent factor underlying these (Allan & Lonigan, 2011; Sulik et al., 2010). However, evidence suggests that these aspects of effortful control may differ in their developmental course, predictors and relations with social-emotional and academic outcomes (Brock, Rimm-Kaufman, Nathanson, & Grimm, 2009; Carlson, 2005; Kim, Nordling, Yoon, Boldt & Kochanska, 2013; King, Lengua & Monahan, 2013; Li-Grining, 2007; Razza, Martin & Brooks-Gunn, 2010). Further, executive attention and inhibitory control may reflect more directly activity in the prefrontal cortex, whereas delay ability in reward contexts may reflect an additional motivational component related to the mesolimbic dopaminergic pathway (Dixon, 2010), sometimes characterized as the hot vs. cool distinction (e.g., Brock et al., 2009; Hongwanishkul, Happaney, Lee & Zelazo, 2005). In this study, consistent with previous studies of effortful control (Kim et al., 2013; Li Grining, 2007), we examine separate delay ability and executive control dimensions to explore the possibility of differential relations with income, cumulative risk, and children's adjustment.

This study utilized data from a community sample that oversampled lower income families to test the effects of income on developmental trajectories of effortful control and characterize differences in trajectories across income levels. The study tested the hypotheses that cumulative risk would account for the effects of income on the development of effortful control, and that developmental changes in effortful control would mediate the effects of income and cumulative risk on children's academic readiness, social competence and adjustment problems.

Method

Participants

Participants were 306 mothers and their 36–40 month-old children (M=37, SD=0.84) who were recruited from a university-hospital birth register, daycares, preschools, health clinics, and charitable agencies. Families at these sites received information forms about the study and could indicate their interest in participating in the study on the forms. Recruitment sites, other than the birth register, received an honorarium of $100 when 90% or more of their families returned forms, regardless of the number of families indicating interest in participating. If a site returned 75% or 50% of the forms, the site received $75 or $50, respectively.

Families were recruited to obtain equal representation across income levels. The 2009/2010 Federal HHS Poverty Guidelines (*U.S. Department of Health & Human Services*, 2010), in place at T1, which is an income-to-needs ratio based on the family's income from all sources and the number of people in the home, was used to recruit families and to describe the income levels represented in the sample. The distribution included 29% of the sample at or near poverty (N=90 at or below 150% of the federal poverty threshold), 28% lower income (N=84 between 150% poverty and the local median income of $58K), 25% middle-income (N=77 between the median income and $100K), and 18% upper-income (N=54 above $100K). To participate, families were required to have reasonable proficiency in English (self-determined) to comprehend the assessment procedures, and children diagnosed with a developmental disability were excluded. Participants included 50% girls. The racial and ethnic composition of the sample of children included 64% European American, 10% Latino or Hispanic, 9% African American, 3% Asian American, 2% Native or American Indian, and 12% multiple racial and ethnic backgrounds. Mothers' educational distribution included 3% mothers with some high school attainment, 6% completed high school, 34% with some college, technical school or professional school, 30% college graduates, and 27% with post-graduate education. Eighty-one percent of mothers were married or had stable live-in partners, 12% were never married, 7% were separated, divorced or widowed and were single heads-of-household.

Analyses suggested that minimal bias was introduced as a result of missing data. Complete data were available on 222 cases (73%), with 53 cases missing 1 variable (17%), 13 cases missing 2 variables (4%), and 18 cases (6%) missing 3 or more. All participants had complete T1 income and cumulative risk data. Complete effortful control data were available for 88% of participants at T1, 95% at T2, 94% at T3, and 94% at T4. T4 Teacher reports of child adjustment were available for 77% of participants. Missingness was related to lower income and lower effortful control. However, the effect sizes of the associations of missingness were modest, M = .16, Range = .01–.28, and did not reach suggested thresholds for introducing substantial bias (i.e., r>.40, Collins, Schafer & Kam, 2001). Thus, all analyses were conducted using missing data estimation and were based on the complete sample of 306.

Procedures

Families were assessed in offices on a university campus. They were assessed at 4 time points separated by 9 months each when children were 36–40, 45–49, 54–58, and 63–67 months. With approval by the Human Subjects Institutional Review Board, both active parental consent and child assent were secured prior to data collection. Assessments included, behavioral, neuropsychological, and questionnaire measures administered by trained experimenters. Children completed neuropsychological and behavioral measures of effortful control while mothers completed questionnaire measures in a separate room. Families received $70 for their first assessment and compensation increased by $20 for each of the 3 subsequent assessments. With parental consent, children’s teachers were mailed a questionnaire and asked to complete measures about children’s adjustment once they had the children in their classrooms for at least a month. Teachers received $15 for returning the questionnaires.

Measures

Income—Mothers reported on household income from all sources on a 14-point Likert scale that provided a fine-grained breakdown of income at the lower levels facilitating identification of families at the federal poverty cutoff (e.g., *1* = $14,570 or less, *2* = $14,571–$18,310, *3* = $18,311–22,050, etc.). However, the 14-point variable representing the full range of income was used for analyses (*M* = 8.75, *SD* = 3.93, *Range* = 1.00–14.00). Correlations among T1–T4 income ranged from .80 to .88. Given the high stability in income, only T1 income was analyzed.

Ethnic or racial minority status—Mothers reported on their children’s racial and ethnic background. Although 31% of the children were from ethnic or racial minority groups, the numbers of children in each group were small, precluding comparisons across ethnic or racial groups. However, a variable representing a child’s status as a racial or ethnic minority was created. If parents reported their children to be Latino/Hispanic, African American, Asian American, Native American or Alaskan Native, Pacific Islander, multiple or other, their minority status was coded as 1. European-American children’s status was coded as 0.

Adolescent parent—Mothers reported their age at the time of the study child's birth, and 3% were adolescent parents (≤19 years) when the child was born.

Cumulative risk—Cumulative risk was assessed at all 4 time points and included 7 risk factors: low education, single parent, residential instability, family structure transitions, household density, negative events, and maternal depression, which represent risk factors commonly included in cumulative risk indices. There are numerous approaches to calculating a cumulative risk index, including efforts to avoid artificially dichotomizing continuous variables (Evans et al., 2013). Dichotomous risk factors (education, single parent, residential instability, divorce) were scored as *0*=not present, *1*=present. Continuous risk factor scores (household density, negative events, depression) were converted into proportions of the total possible score so that each score ranged from 0 to 1, and thus, were on a similar scale as the dichotomous variables. The total cumulative risk score was the sum of all component factors.

Mothers reported on their education. Risk was indicated by mothers' not graduating from high school (3% of the sample at T1). Mothers reported on marital status and were identified as single parents if they indicated being never married, currently widowed, separated or divorced, or having a live-in partner for <1 year (19% at T1). Residential instability was indicated by the family changing households ≥3 times in the previous 3 years at T1 (10%) and any move in the 9 months between assessments at T2–T4. Family structure transitions were indicated by mothers reporting being divorced in the child's lifetime at T1 (3%) or during the 9 months between assessments at T2–T4. Household density was calculated as the number of individuals living in the home divided by the number of rooms in the home. At T1 the ratio ranged from .18–1.75, with a mean of .52, i.e., on average, there were twice as many rooms as individuals in the home. The score was converted to a proportion of the highest score in the sample.

Negative life events were assessed with parent report on the General Life Events Schedule for Children (Sandler, Ramirez & Reynolds, 1986). The 29 events include moderate to major negative events including changing schools, death of a family member or friend, parental arrest, and loss of friends. Parents reported whether events occurred in the previous 9 months, and total scores were the number of events. The average number of life events at T1 was 5.3, SD = 4.0, range 0–26. The total score was converted into a proportion of the possible 29 events.

Mothers reported on their depressive symptoms over the previous month using the 20-item Center for Epidemiological Studies–Depression Scale (CES-D; Radloff, 1977), designed to measure depressive symptoms in the general population. Participants indicated whether each symptom was present on a scale of 0 (rarely/never) to 3 (most of the time), and the items were summed for a total score. Internal consistency was .88. The T1 average score was 10.01, SD=8.38, range 0–46.67. The total score was converted into a proportion of the total possible score of 60. Correlations among T1–T4 cumulative risk scores ranged from .49 to .80.

Effortful control—Effortful control was assessed at all 4 times with identical measures of attention, inhibitory control, and delay ability. Modeled after traditional cognitive tests, measures were selected to be of varying difficulty for children across childhood so that identical measures could be used over time. Although some of the measures were normed for children older than those in the sample, there was variability in performance even at these early ages. Conversely, some measures were developed for younger children, and as a result showed less variability at the later time points. Averaging across these test scores resulted in adequate variability at each time point. Proportion scores were used so that scores were on a comparable scale. The mean, standard deviation and range for each task across time-points are reported in Table 1. Given growing evidence that delay ability operates differently than the attention and inhibitory control aspects of effortful control, separate variables were created for executive control and delay.

Executive control was assessed using 6 tasks. The Inhibition and Auditory Attention subscales of the NEPSY developmental neuropsychological assessment battery (Korkman, Kirk, & Kemp, 1998) were designed for use with children 5 and older. However, the scales were administered to the children in this study to allow for use of identical measures of effortful control longitudinally. Thus, these tasks were difficult for children at the start of the study, but age-appropriate by the end. The Inhibition subtest assesses the ability to inhibit a dominant response to enact a novel response. Children are shown an array of circles and squares and asked to label each shape in an opposite manner (e.g., say circle when shown a square). Auditory Attention is a continuous performance test that assesses the ability to be vigilant and to maintain and shift selective sets. Children are required to listen to a series of words and respond only when they hear a target word, refraining from responses to other words. Scores on the Inhibition and Auditory Attention subscales were the proportion of correct responses.

Behavioral inhibitory control was assessed using Bear-Dragon (an appealing monkey puppet was substituted in this study; Kochanska, et al., 1996), which requires the child to perform actions when the directive is given by the monkey puppet, but not when given by a dragon puppet. Children's actions were scored as performing no movement, wrong movement, partial movement, or complete movement, with scores ranging from 0–3 on 10 trials. Trial scores were summed across both monkey and dragon trials, and the total scores were converted into the proportion of the sum of trials to the total possible score.

Cognitive inhibitory control was assessed using Day-Night (Gerstadt, Hong & Diamond, 1994), which requires the child to say "day" when shown a picture of moon/stars and "night" when shown a picture of the sun. Responses were scored 1=correct non-dominant response or 0=dominant response. Total scores were the proportion of correct responses out of 16 trials.

The Dimensional Change Card Sort (DCCS; Zelazo, Muller, Frye, & Marcovitch, 2003) assesses cognitive inhibitory control, attention focusing and set shifting. In this task, children were introduced to two boxes with slots in the top. Target cards were attached to the front of each box. The target cards included a silhouetted figure on a colored background (star on blue, truck on red). Children were instructed to sort cards first according to shape (6 trials) then according to color (6 trials). The experimenter stated sorting rules before each trial and presented a card labeled according to the current dimension (e.g., on a shape trial, “Here’s a truck. Where does it go?”). If children correctly sorted ≥50% of cards, they advanced to the next level in which the target cards integrated the sorting properties. Target cards consisted of a colored figure on a white background (blue star, red truck), and children were again instructed to sort according to shape (6 trials), then color (6 trials). If they correctly sorted ≥50% of the cards, children advanced to the next level in which they were instructed to sort by color if the card had a border on it and by shape if the card lacked the border (12 trials). The score was the proportion of correct trials out of the total 36 possible trials.

Head-Toes-Knees-Shoulders (HTKS) integrates attention and inhibitory control (Ponitz et al., 2008). Children are asked to follow the experimenter’s instructions, but to enact the opposite of the direction (e.g. touch toes when asked to touch head). Behaviors were coded as *0*=touched the directed body part, *1*=self-corrected, or *2*=correctly touched the opposite. Scores were the proportion of the sum of the item scores across 20 trials to the total possible score.

Delay ability was assessed using a gift delay task (Kochanska et al., 1996) in which children were told that they would receive a present, but that it needed to be wrapped. Children were instructed to sit facing the opposite direction and not peek while the experimenter noisily wrapped the gift. Children’s peeking behavior (frequency, degree, latency to peek, latency to turn) was rated. Also, behaviors indicating difficulty delaying (fidgeting, tensing, out of seat, grimacing) were rated as *0*=not present, *1*=moderate, *2*= strong, and summed for a difficulty delaying score. Peeking frequency, degree, latencies, and difficulty delaying (reversed) were converted to proportions of the total possible score for each and averaged. Twenty percent of all tasks were independently recoded to assess inter-rater reliability with ICC’s = 0.72 to 0.98.

An executive control score was computed at each time point as the mean of the proportion scores of the individual tasks and was considered missing if ≥50% of the component scores were missing (α=0.67, ICC=0.83). A delay ability score was computed at each time point as the mean of the proportion scores for the individual delay indicators and was considered missing if ≥50% of the component scores were missing (α=0.77, ICC=0.91).

Cognitive ability—An estimate of cognitive ability was obtained using verbal and nonverbal NEPSY subtests and included as covariates. An estimate of verbal ability was obtained using the Comprehension of Instructions subtest which is designed to assess the ability to receive, process, and execute oral instructions of increasing syntactic complexity. An estimate of nonverbal ability was assessed with the Block Construction subtest designed to assess the visual-spatial and visual-motor ability to reproduce three-dimensional constructions from models or from two-dimensional drawings. Comprehension and Block Construction scores were correlated .48 and were combined for an overall estimate of cognitive ability (Sattler, 2001).

Child adjustment—At T4, teachers rated children's academic readiness, social competence, and total adjustment problems. Teachers rated children's academic readiness using the School Readiness Survey (National Household Education Survey, 2007) in which teachers report on 9 items indicating children's ability to identify colors and letters, count, write their names, hold a pencil correctly, produce intelligible speech, and recognize letter sounds. Teachers rated children's social competence and total problems using the preschool teacher report form of the Social Skills Rating Scale (SSRS: Gresham & Elliot, 1990). Teachers rated children's cooperation (e.g., puts away toys, helps with tasks; 12 items), assertiveness (e.g., self-confident, introduces self; 8 items) and self-control (e.g., controls temper, attends to instructions; 10 items) for a social competence score (30 items). Teachers rated children's externalizing problems (7 items), internalizing problems (6 items) and hyperactivity (6 items) for a total adjustment problems score (19 items). In this study, alphas for the composite SSRS scales were .91 for social competence and .87 for total adjustment problems.

Results

Analytic Plan

Analyses were conducted to examine the patterns of growth in effortful control, compare patterns of growth across income levels, test the effects of income and cumulative risk on growth in effortful control, and test whether growth in effortful control mediated the effects of income and cumulative risk on adjustment. First, correlations were examined to determine the plausibility of the proposed relations. Second, unconditional growth models of executive control and delay ability were tested to determine whether there was significant variability in latent growth parameters. Third, unconditional growth models were compared across income levels to test for differences in rates and variability of growth. Fourth, time-varying effects of cumulative risk on effortful control were examined to test an alternative model for the effects of cumulative risk on effortful control. Fifth, controlling for gender, cognitive ability and ethnic/minority status, growth of executive control and delay ability was conditioned on income and cumulative risk to test whether they predicted effortful control growth and whether cumulative risk accounted for the effects of income. In turn, effortful control growth factors were tested as predictors of academic readiness, social competence and adjustment problems to test the hypothesis that growth in effortful control would account for the effects of income and cumulative risk on adjustment (see Figure 1). Tests of indirect effects of income on effortful control through cumulative risk and on adjustment through effortful control were used to examine whether effortful control mediated the effects of income and cumulative risk on adjustment. All analyses were conducted in Mplus 6.0 (Muthen & Muthen, 2010) using Full Information Maximum Likelihood Estimation (FIMLE) which uses all the data available simultaneously to calculate parameter estimates. Our examination of the pattern of missing data suggested that missing data introduced minimal bias and aligned with the assumptions of FIMLE. Therefore, data from all families were included in analyses (N=306). To test indirect effects, Mplus produces the Sobel test which is a conservative test of indirect effects (MacKinnon, Warsi & Dwyer, 1995).

Preliminary Analyses

Descriptive statistics for the study predictors, the correlations among them, and their relations with adjustment are presented in Table 2. The correlations show that child gender was related to effortful control and adjustment, with boys demonstrating lower effortful control and social competence and higher adjustment problems. Ethnic or racial minority and adolescent parent status were related to lower income, higher cumulative risk and lower effortful control. Therefore, gender, minority status, and adolescent parent status were included as covariates in subsequent analyses. Income and cumulative risk were related to executive control, delay ability (except for T4), academic readiness, social competence and adjustment problems. Also, executive control and delay ability were related to children's academic readiness, social competence and adjustment problems, indicating the plausibility of the hypotheses that income and cumulative risk predict effortful control, which in turn, accounts for the association of income and cumulative risk to children's adjustment.

Income and Cumulative Risk Predicting Growth in Effortful Control

Unconditional growth—Unconditional growth models of executive control and delay ability were specified with the intercept reflecting T1 levels, and linear and quadratic growth factors indicated by the T1–T4 measures. Both executive control, M = .28, p<.05, SD^2 = .014, p<.05, and delay, M = .62, p<05, SD^2 = .04, p<.05, demonstrated intercepts significantly different than 0 with significant variability in initial levels. In addition, both executive control, M = .25, p<.05, SD^2 = .01, p<.05, and delay ability, M = .17, p<.05, SD^2 = .01, p<.05, demonstrated significant linear growth and significant variance in the linear growth factor, indicating individual differences in children's rates of linear growth. Finally, both executive control, M = −.03, p<.05, SD^2 = .001, p<.10, and delay ability, M = −.04, p<.05, SD^2 = .000, n.s., demonstrated significant quadratic growth. However, in both cases, the variance of the quadratic factor was non-significant. This indicates that growth in executive control and delay ability included a curvilinear pattern, that is, the rate of change decelerated, but that the pattern of deceleration was essentially invariant across children. Models estimating the quadratic growth factor were compared to those excluding the quadratic growth factor. For both executive control, χ^2-difference[1]=100.77, p≤.01, and delay ability, χ^2-difference[1]=72.99, p≤.01, the model including the quadratic growth factor fit the data better than the model excluding the quadratic growth factor despite the nonsignificant variance of the quadratic factor. Therefore, all subsequent analyses included both linear and quadratic growth factors for effortful control. However, the variances for the quadratic factors were set to 0, and as such, quadratic growth was not examined in relation to income, cumulative risk or children's adjustment.

Cross-income comparisons—To rule out the possibility that effortful control growth rate or variability might differ at different levels of income, particularly for families at or near the poverty cutoff, growth rates of executive control and delay ability were compared across income categories representing families who were at- or near-poverty, lower income (below the county median), middle income (median to $100K), and upper income (≥$100K) (Figure 2). Models with all growth parameters set to be equal across groups were compared to those with all growth parameters free to differ across groups. Significant χ^2-difference tests across these models indicated that growth parameters were not equivalent across the groups. To identify the source of the differences, first the intercept growth factors were constrained across groups, and then the linear slope factors were constrained across groups. Chi-square difference tests across these models indicated that intercept factors for executive control, χ^2-difference[3]=18.47, p≤.01, and delay ability, χ^2-difference[3]=12.51, p≤.01, differed significantly across income groups, whereas slope factors did not (executive control: χ^2-difference[3]=3.58, ns.; delay ability: χ^2-difference[3]=2.77, ns.). This means that the income groups differed in initial levels of executive control and delay ability but not in the rate of linear growth, and thus, initial income-related differences in levels of effortful control were maintained across the 4 time points of the study. Analyses were also conducted testing for differences across the quadratic growth factors, even though there was not significant variability in this factor overall, to ensure that there were no differences in rates of deceleration of growth at different income cutoffs. No differences in quadratic growth patterns were found across income groups.

Time-varying effects of cumulative risk—It was possible that varying levels of cumulative risk at different time points accounted for variations in levels of executive control and delay ability, rather than the hypothesized model in which cumulative risk was expected to account for the effects of income on the intercept and slope of the effortful control dimensions. To test this, we tested latent growth models in which the intercept and slope factors of either executive control or delay ability were conditioned on the covariates (child gender, ethnic minority status, cognitive ability, adolescent parent status) and family income, and time-specific effects of cumulative risk were tested by regressing the residual variance of the observed indicators of executive control or delay ability at each time point on the time-corresponding indicator of cumulative risk. These models demonstrated good fit to the data (executive control RMSEA = .05, CFI = .95; delay ability RMSEA = .04, CFI = .93). The results indicated that there were no time-specific effects of cumulative risk on executive control. T2 cumulative risk predicted unique variance in T2 delay ability above the effects of covariates and income on the growth factors, $\beta = -.18$, p = .001. However, none of the other time-specific effects were significant. Given minimal evidence of time-specific effects, subsequent models were tested excluding them.

Conditional growth models—Models in which growth in executive control and delay ability were conditioned on covariates, income and cumulative risk were tested (Table 3). Intercept, linear growth and quadratic growth factors were specified, with the variance of the quadratic growth factors set to 0. The models for executive control, RMSEA = .04, CFI = .94, and delay ability, RMSEA = .03, CFI = .95, demonstrated adequate fit to the data. Child gender, ethnic or racial minority status, cognitive ability, and mothers' adolescent parent status were included as covariates. Boys and children whose mothers were adolescents when they were born demonstrated lower initial levels of delay ability. Minority status was not related to effortful control growth factors. Cognitive ability was related to higher initial executive control, but it was unrelated to the slope of executive control. Cognitive ability was related to higher initial delay ability and also predicted smaller increases in delay across the study. That is, cognitive ability was related to higher initial levels of delay ability that remained higher but grew at a slower rate compared to the children who started with lower levels of cognitive ability. Comparing children below the mean of cognitive ability with those at or above the mean, children who had lower cognitive ability started and ended the study with significantly lower delay ability.

The effects of income on the intercept and linear slope were tested next. Income was related significantly to higher initial levels of executive control, but unrelated to growth in executive control. Income was related significantly to higher initial levels of delay ability and less growth in delay ability. That is, children from families with higher income had higher initial delay ability that remained higher but grew less compared to children from lower income families, whose levels of delay ability grew at a greater rate but remained lower. To characterize this, the mean level of delay ability of children whose family income was at or below 200% of the poverty threshold was compared with children whose family income was above that threshold at each time point, T1 M low income = .57, M high income = .66, $t(266) = 3.07$, $p = .002$; T2 M low income = .72, M high income = .78, $t(272) = 1.99$, $p = .05$, T3 M low income = .75, M high income = .80, $t(282) = 2.21$, $p = .03$, T4 M low income = .74, M high income = .76, $t(278) = 0.75$, indicating that lower-income children started the study with lower delay ability but demonstrated greater gains.

When cumulative risk was added to the model as a mediator of the effects of income, the effects of income on the intercepts of executive control and delay ability became non-significant. Cumulative risk was significantly related to lower initial delay ability and a greater rate of increase in delay ability across the study. Children with higher cumulative risk started the study with lower delay ability that grew more rapidly across time. To characterize this, we compared level of delay ability in children with cumulative risk scores at or below the mean of cumulative risk with those of children above the mean of cumulative risk at each time point, T1 M low risk = .65, M high risk = .57, $t(266) = 2.27$, $p = .02$; T2 M low risk = .80, M high risk = .67, $t(272) = 4.47$, $p<.00$, T3 M low risk = .80, M high risk = .74, $t(281) = 2.40$, $p = .02$; T4 M low risk = .75, M high risk = .75, $t(276) = 0.28$, ns., showing that children with lower cumulative risk had higher levels of delay ability, whereas children with higher cumulative risk started the study significantly lower, but made greater gains over time.

Indirect effect of income through cumulative risk—Income demonstrated a significant total effect on the intercept of executive control, β=.12, p=.05, but the indirect effect of income through cumulative risk was not significant. Income demonstrated a trend toward an indirect effect on the intercept of delay ability, β=.10, p=.10, and a significant indirect effect on the slope of delay ability, β=−.25, p=.05, through cumulative risk.

Income, Cumulative Risk and Effortful Control Growth Predicting Adjustment

Measures of T4 academic readiness, social competence and adjustment problems were included in the models to test whether growth in effortful control accounted for the effects of income on children's adjustment (Figure 1 and Table 3). Separate models were tested for executive control and delay ability. The intercept and linear slope of either executive control or delay ability were specified as predictors of the T4 adjustment indicators. Income and cumulative risk were included as predictors of the intercept and slope of the effortful control growth factors, as well as of the adjustment indicators.

After accounting for effortful control (executive control or delay ability), neither income nor cumulative risk were significantly related to children's adjustment, although there were trends toward effects of income on lower total problems and cumulative risk on lower social competence and higher total problems. Above the effects of income and cumulative risk, initial levels of executive control predicted higher academic readiness and social competence and lower total problems. Initial levels of delay ability also predicted higher social competence and lower total problems, but not academic readiness. Neither the executive control nor delay ability slope was related to social competence or total problems, whereas both were related to academic readiness. Greater gains in executive control and delay ability were related to higher T4 academic readiness. Tests of indirect effects indicated that there were significant indirect effects of cumulative risk on social competence, $\beta=-.08$, p=.05, and total problems, $\beta=.07$, p=.04, through initial levels of delay ability. There was also a significant indirect effect of cumulative risk on academic readiness through the slope of delay ability, $\beta=-.20$, p=.03. There were no significant indirect effects of income on adjustment through effortful control.

Discussion

This study sought to add to our understanding of the relation of income to the development of effortful control in young children and the role it plays in children's adjustment. Effortful control has been posited to account for the effects of income on adjustment, and the results of this study only partially support that premise. The findings demonstrated that lower income was related to lower effortful control and that the effects of income on effortful control were accounted for by cumulative risk, but only for delay ability, not for executive control. Further, better effortful control was related to better adjustment, with effortful control predicting children's adjustment above the effects of income and cumulative risk. However, the hypothesis that developmental changes in effortful control during the preschool period would account for the effects of low income on children's adjustment was only partially supported.

Income was related to differences in levels but not trajectories of effortful control. That is, initial observed income differences in preschool-age children's levels of effortful control were maintained throughout the study. Also, the rate and variability of growth was equivalent at all levels of income, including for children at- or near-poverty. This is consistent with the results of another study that examined the relation of income to growth in executive function across early- to middle-childhood (Hughes et al., 2010). The findings suggest that income might exert its influence on the development of effortful control earlier in childhood or on other factors that, in turn, impact the development of effortful control. During the preschool period, low income can be used as a marker to identify children who have elevated risk exposure, are at risk for lower effortful control, and are in need of additional support to enhance their effortful control. However, more proximal contextual or socialization factors that account for individual variation in developmental trajectories of effortful control should be identified. There is a growing body of evidence that classroom-based interventions in preschool settings can promote the development of effortful control (Bierman, Nix, Greenberg, Blair & Domitrovich, 2008; Raver et al., 2012). In addition, parenting has been shown to be a key predictor of executive function in preschool-age children relative to other income-related family risk factors (Rhoades, Greenberg, Lanza & Blair, 2011) and to predict changes in effortful control over time (Lengua et al., 2007, 2014). Future studies should examine whether parenting and other socialization experiences predict growth in effortful control, mediate the effects of income, and can promote effortful control when targeted in an intervention for low-income or other high-risk families.

A key aim of this study was to test the hypothesis that growth in effortful control would account for the effects of income on children's adjustment. The findings are consistent with the results of prior research indicating that effortful control mediated the effects of income (Razza et al., 2010) and cumulative risk (Swanson et al., 2012) on academic achievement. However, this study provided little evidence of effortful control, either executive control or delay ability, accounting for the effects of income on adjustment. Rather, we found that delay ability accounted for the effects of cumulative risk on adjustment. There is extensive prior evidence that delay ability, similar to impulsivity, is a critical factor in adjustment (Beauchaine, Hinshaw, & Pang, 2010; Lengua, 2003; Mischel, Shoda & Peake, 1988). The results of the present study suggest that cumulative risk plays a role in children's development of delay ability, which in turn, partially accounts for the effects of risk on adjustment.

However, the pattern of findings, particularly for executive control, was more consistent with additive effects, such that effortful control is an additional, relevant factor in understanding children's developmental outcomes along with low income. Higher initial levels of both executive control and delay ability predicted greater academic readiness and social competence and lower adjustment problems above the effects of income and cumulative risk, pointing to relevant independent effects of effortful control on children's adjustment. The fact that effortful control tends to be lower in low-income children highlights a cascade effect of low income. In addition to the risk conferred on children's adjustment by low income, children in low income contexts have lower effortful control that independently predicts more problematic outcomes.

Contrary to our hypotheses, growth in effortful control was unrelated to adjustment except for academic readiness. These findings are inconsistent with prior evidence demonstrating that initial levels as well as growth of effortful control were relevant to children's behavioral, social and emotional adjustment (Bridget & Mayes, 2011; Hughes et al., 2010; King et al., 2013). It should be noted that these prior studies examined the effects of growth in effortful control or executive functioning in older children. Thus, it is possible that the rate of developmental change is more relevant when children are older and required to navigate contexts more independently than during the preschool period, in which case, a more accelerated rate of growth would be beneficial. Alternatively, it is possible that the importance of the rate of growth of effortful control, relative to its level, might depend on the stage-salient developmental tasks or outcomes relevant to the developmental period in question. That is, individual differences in the rate of growth of effortful control might have greater relevance to emerging developmental outcomes, whereas individual differences in levels of effortful control differentiate levels of adjustment regardless of developmental period. The latter possibility is consistent with the results of the current study, in which growth in effortful control predicted children's academic readiness, an outcome specific to the preschool period. Children's gains in effortful control across the preschool period are likely to support their learning behaviors, such as focused and sustained attention, task persistence, and perhaps, frustration tolerance when learning new information and skills. However, this pattern of findings should be replicated prior to drawing conclusions.

It is notable that the pattern of development of executive control and delay ability and their relations to income, cumulative risk, and adjustment differed, pointing to the value of examining delay in reward contexts separately from the more purely "cool" cognitive executive control construct. Cumulative risk predicted initial levels and changes in delay but not in executive control and is perhaps more relevant to the development of delay ability. Cumulative risk may represent children's more proximal experiences of low income or poverty. Higher levels of cumulative risk may be experienced as a chaotic home environment, which could be a common experience for children living in poverty and low income (Evans & Wachs, 2010). The unpredictability inherent in chaotic or high cumulative risk environments may make the experience of rewarding conditions unpredictable, rendering children less able to tolerate the discomfort associated with waiting for a reward, or making it more adaptive to pursue a reward when it is available. In addition, such environments might activate children's physiological stress response systems (Evans & Kim, 2007; Zalewski, Lengua, Kiff, & Fisher, 2012) that might be differentially related to executive control and delay ability (Davis, Bruce & Gunnar, 2002; Lengua, Zalewski, Fisher & Moran, in press), hinting at the possibility that stress has differing effects on the underlying biological systems associated with executive control and delay ability.

The differential relations of executive control and delay ability to adjustment outcomes also highlight the value of examining these separately, with patterns consistent with the findings in other studies. For example, previous research showed that executive control, but not delay ability, predicted academic readiness (e.g., Kim et al., 2013), similar to our findings for levels of executive control and delay ability. However, by examining growth in effortful control factors, we found that growth in both executive control and delay ability predicted academic readiness, even if the initial levels of delay ability did not. Gains in the ability to delay reward-motivated approach might facilitate greater persistence and compliance in a classroom or learning context. Future studies can continue to clarify the potential differences in developmental trajectories, predictors and outcomes of executive control and reward delay components of effortful control.

Strengths of this study include the use of a relatively large sample that was recruited to have equal representation of a range of income categories, including over-representation of lower income families, thus providing a rigorous test of the effects of income. In addition, the use of growth modeling and cross-group analyses clarified the association of income and cumulative risk to developmental changes in effortful control. Also, the multi-method assessments reduce the likelihood that method variance or reporter bias accounts for the observed effects. However, the use of teacher-reported outcomes might limit the findings to children's behavior in classrooms. It is important to note that the sample was recruited to represent the full range of income, and consequently a range of risk. The pattern of associations could be different in a high-risk sample, such as a sample including only families living at or near poverty.

A potential limitation of the study was the measurement of delay ability. Although executive control was assessed using multiple tasks, the delay ability indicators were all drawn from one task, which might have impacted the pattern of findings. However, previous research has shown the longitudinal predictive value of children's delay of gratification even when assessed with a single task (e.g., Mischel, Shoda & Peake, 1988). A larger question that arises is whether delay should be examined separately from executive control. Although some evidence suggests that a single factor underlies both the executive and delay components of effortful control (Allan & Lonigan, 2011; Wiebe et al., 2011), the findings of this study suggest value in examining delay ability separately. It is acknowledged that the pattern of growth of delay ability that was observed might have resulted from the delay task being insufficiently challenging for the children in the later time points. A more pronounced pattern of linear increase might have been observed if the delay period were lengthened or if the demands of the task were increased. However, other studies have also shown a distinct growth pattern across delay and executive tasks (Carlson, 2005). Future research should address the question of the relation of executive control and delay ability using both theoretical and empirical approaches and developmental models.

The findings of this study clarify the relation of income to developmental patterns of executive control and delay ability, highlighting potential additive effects of executive control and the mediating effect of delay ability in the relation of income to children's academic readiness, social-emotional and behavioral adjustment. These findings suggest that, although low income is a marker for lower effortful control, and consequently for greater adjustment problems, researchers need to identify contextual and socialization factors that predict developmental changes in effortful control that can be targets of interventions aimed at promoting effortful control in early childhood.

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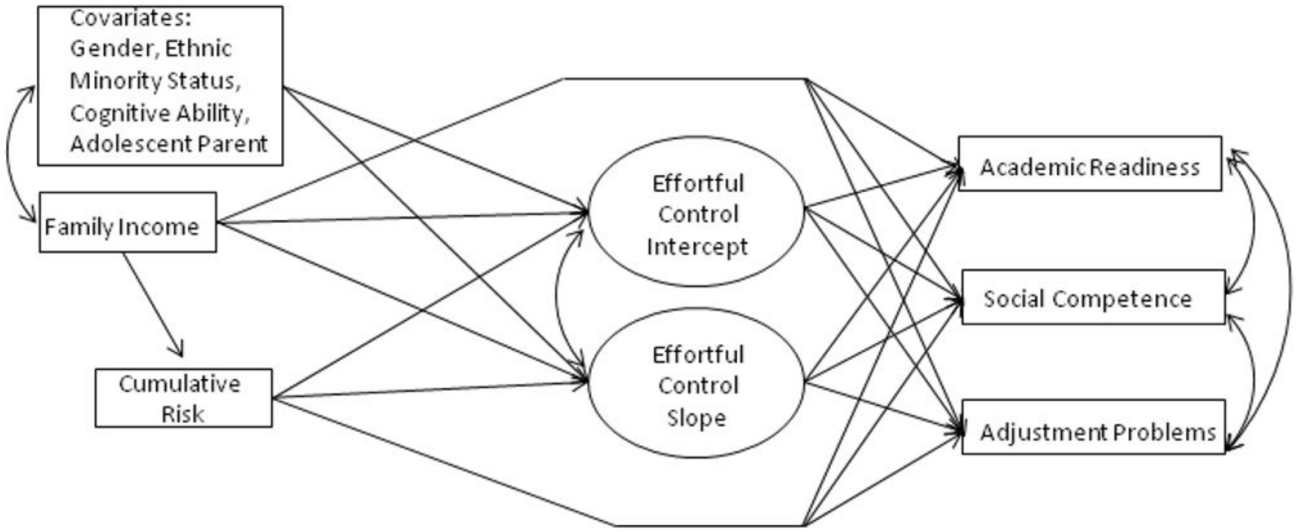

Figure 1.
Model of effortful control growth factors as mediators of the effects of income and cumulative risk on children's adjustment.
Note: The model was tested separately for executive control and delay ability.

Figure 2.

Growth Patterns for a) executive control and b) delay ability across income levels.

Table 1

Descriptive statistics for executive control subscales and delay ability.

	M	SD	MIN	MAX
Inhibition T1	.18	.32	.00	1.00
Inhibition T2	.49	.40	.00	1.00
Inhibition T3	.74	.32	.00	1.00
Inhibition T4	.86	.23	.00	1.00
Auditory Attention T1	.09	.24	.00	.93
Auditory Attention T2	.26	.34	.00	.98
Auditory Attention T3	.49	.35	.00	1.00
Auditory Attention T4	.62	.35	.00	1.00
Bear/Dragon T1	.62	.20	.33	1.00
Bear/Dragon T2	.87	.20	.33	1.00
Bear/Dragon T3	.95	.12	.47	1.00
Bear/Dragon T4	.98	.07	.43	1.00
Day/Night T1	.44	.33	.00	1.00
Day/Night T2	.62	.30	.00	1.00
Day/Night T3	.71	.28	.00	1.00
Day/Night T4	.83	.22	.00	1.00
Card Sort T1	.42	.20	.00	.89
Card Sort T2	.61	.26	.00	1.00
Card Sort T3	.78	.16	.25	1.00
Card Sort T4	.83	.14	.03	1.00
HTKS T1	.01	.07	.00	.65
HTKS T2	.19	.27	.00	.85
HTKS T3	.42	.32	.00	.95
HTKS T4	.62	.28	.00	.98
Gift Delay T1	.62	.25	.09	1.00
Gift Delay T2	.76	.23	.08	1.00
Gift Delay T3	.78	.19	.17	1.00
Gift Delay T4	.75	.21	.17	1.00

Table 2

Descriptive statistics and correlations among study variables

	M	SD	INC	CR	EC1	EC2	EC3	EC4	DA1	DA2	DA3	DA4	Academic Readiness	Social Comp.	Total Problems
Child Gender[1,3]	--	--	−.06	−.01	−.09	−.13*	−.11*	−.10	−.14*	−.11	−.21**	−.20**	−.10	−.19*	.18*
Eth/Racial Min[2,3]	--	--	−.22*	.21*	−.12*	−.20*	−.11*	−.18*	−.16*	−.13*	−.16*	−.17*	−.10	−.11	.11
Adolescent Par.	--	--	−.24*	.33*	−.09	−.12*	−.14*	−.10	−.13*	−.24*	−.13*	−.11	−.09	−.20*	.20*
Cognitive Ability	0.23	0.07	.23*	−.22*	.52*	.57*	.57*	.51*	.33*	.37*	.25*	.14*	.39*	.31*	−.26*
Family Income	8.75	3.93	--	−.60*	.19*	.24*	.24*	.24*	.24*	.14*	.13*	.08	.22*	.17*	−.27*
Cum. Risk T1	0.86	0.73		--	−.15*	−.21*	−.25*	−.21*	−.19*	−.23*	−.10	−.01	−.22*	−.21*	.27*
Exec. Control T1	0.29	0.15			--	.50*	.53*	.42*	.26*	.27*	.12*	.19*	.29*	.18*	−.10
Exec. Control T2	0.49	0.20				--	.61*	.46*	.31*	.36*	.25*	.15*	.41*	.21*	−.22*
Exec. Control T3	0.68	0.17					--	.65*	.29*	.40*	.26*	.17*	.52*	.25*	−.24*
Exec. Control T4	0.78	0.15						--	.29*	.35*	.24*	.19*	.54*	.30*	−.25*
Delay Ability T1	0.62	0.25							--	.49*	.40*	.22*	.26*	.21*	−.25*
Delay Ability T2	0.76	0.23								--	.45*	.34*	.20*	.30*	−.35*
Delay Ability T3	0.78	0.19									--	.40*	.18*	.24*	−.29*
Delay Ability T4	0.75	0.21										--	.04	.15*	−.14*

* $p \leq .05$.

[1] Child gender coded 0=girl, 1=boy.

[2] Ethnic/Racial Minority coded 0=not minority, 1=minority.

[3] Point biserial correlations are reported for dichotomous variables.

INC=Income, CR=Cumulative Risk, EC=Executive Control, DA=Delay Ability.

Table 3

Standardized coefficients of the effects of income and cumulative risk on executive control, delay ability, and T4 adjustment.

	Executive Control				Delay Ability				Academic Readiness	Soc. Comp.	Tot. Probs.
	Intercept T1		Linear Slope		Intercept T1		Linear Slope				
	At Entry	Step 2	At Entry	Step 2	At Entry	Step 2	At Entry	Step 2			
Step 1											
Child Gender[1]	−.03	−.03	−.03	−.03	−.18**	−.18**	−.05	−.04			
Ethnic/Racial Min[2]	−.03	−.01	−.08	−.07	−.10	−.08	−.10	−.13			
Cognitive Ability	.76**	.75**	−.04	−.06	.59**	.54**	−.69**	−.66**			
Adolescent Par.	−.10	−.07	.03	.06	−.19**	−.16**	.06	.02			
Income[3]	.12*	.10	.05	−.02	.20**	.05	−.35*	−.06	.07	.01	−.14 ^{t}
Step 2											
Cumulative Risk[2]	--	−.01	--	−.13	--	−.16	--	.41*	.01	−.12 ^{t}	.12 ^{t}
Step 3											
Executive Contr.									.48**	.33**	−.22**
Intercept T1											
Slope									.47**	.11	−.15
Or											
Delay Ability									.14	.34**	−.39**
Intercept T1											
Slope									.38**	−.14 ^{t}	−.01

^{t}p≤.10

*p≤.05

**p≤.01.

[1]Child gender coded 0=girl, 1=boy.

[2]Ethnic/Racial Minority coded 0=not minority, 1=minority.

[3]The effects of income and cumulative risk on adjustment differ slightly depending on whether executive control or delay ability is included in the model, but the magnitude of the effects and pattern of significance remain the same.