Developmental Trajectories of Clinically Significant Attention-Deficit/Hyperactivity Disorder (ADHD) Symptoms From Grade 3 Through 12 in a High-Risk Sample: Predictors and Outcomes

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Developmental trajectories of clinically significant attention-deficit/hyperactivity (ADHD) symptoms were explored in a sample of 413 children identified as high risk because of elevated kindergarten conduct problems. Symptoms of inattention and hyperactivity-impulsivity were modeled simultaneously in a longitudinal latent class analyses, using parent reports collected in Grades 3, 6, 9, and 12. Three developmental trajectories emerged: (1) low levels of inattention and hyperactivity (low), (2) initially high but then declining symptoms (declining), and (3) continuously high symptoms that featured hyperactivity in childhood and early adolescence and inattention in adolescence (high). Multinomial logistic regressions examined child characteristics and family risk factors as predictors of ADHD trajectories. Relative to the low class, children in the high and declining classes displayed similar elevations of inattention and hyperactivity in early childhood. The high class was distinguished from the declining class by higher rates of aggression and hyperactivity at school and emotion dysregulation at home. In contrast, the declining class displayed more social isolation at home and school, relative to the low class. Families of children in both high and declining trajectory classes experienced elevated life stressors, and parents of children in the high class were also more inconsistent in their discipline practices relative to the low class. By late adolescence, children in the high class were significantly more antisocial than those in the low class, with higher rates of arrests, school dropout, and unemployment, whereas children in the declining class did not differ from those in the low trajectory class. The developmental and clinical implications of these findings are discussed.

General Scientific Summary
This study supports the notion that clinically significant ADHD symptoms persist into adolescence for some children, but not for others. Children who are more hyperactive or aggressive, or whose parents are inconsistent or ineffective with discipline, are more likely to have clinically significant and stable ADHD symptoms and show more antisocial activities and worse graduation and employment rates in late adolescence. In contrast, children with clinically significant ADHD symptoms who are less hyperactive and aggressive, and who are more socially isolated, tend to show a declining pattern of ADHD symptoms and better functional outcomes.

Keywords: ADHD, aggression, developmental trajectories, adolescent maladjustment

Attention-deficit/hyperactivity disorder (ADHD) is considered a biologically based but heterogeneous disorder associated with an array of negative outcomes (Barkley, 2006). Although typically conceptualized as chronic, longitudinal research indicates continuity and discontinuity in the course of ADHD (Lahey, Pelham, Loney, Lee, & Willcutt, 2005; Willoughby, 2003). In general,
longitudinal studies suggest that inattention persists, whereas hyperactivity-impulsivity (referred to as hyperactivity in the remainder of the article) declines with age (Biederman, Mick, & Faraone, 2000). However, more recent person-oriented analyses suggest more nuanced developmental trajectories (Arnold et al., 2014; Larsson, Dilshad, Lichtenstein, & Barker, 2011). Adding to prior trajectory research, this study modeled inattention and hyperactivity simultaneously to better understand the longitudinal covariation of clinically significant ADHD symptoms across developmental periods (from elementary school through late adolescence). The primary goal of this study was to examine conceptually relevant early child characteristics and family adversity factors that might differentiate children in the developmental trajectories. In addition, late adolescent functioning was explored to enhance understanding of the developmental outcomes associated with the trajectories.

**ADHD Trajectories**

A growing body of research highlights important heterogeneity in the developmental course of ADHD. For example, although a majority of children diagnosed with ADHD show chronic difficulties, 20%–50% of children with ADHD no longer meet diagnostic criteria as they move through adolescence, suggesting remission, or at least a marked reduction in symptom severity for some children (Barkley, 2006; Biederman et al., 1996). In recent years, person-oriented analyses have been applied to track the course of ADHD. Studies modeling parent-reported ADHD (inattention and hyperactivity combined) from childhood into mid-adolescence generally document stability over time, revealing chronically elevated ADHD in one (van Lier, van der Ende, Koot, & Verhulst, 2007) or two classes (Malone, Van Eck, Flory, & Lamis, 2010). It is interesting, however, that studies modeling teacher-rated inattention alone reveal more developmental variability, including high, low, increasing, and decreasing trajectories (Pinaud et al., 2011; Sasser, Beekman, & Bierman, 2014). Modeling inattention in the absence of hyperactivity, however, does not adequately capture ADHD development. For example, Greven, Asherson, Rijssdijk, and Plomin (2011) found that, despite declines in hyperactivity over time, childhood hyperactivity predicted increased adolescent inattention (controlling for early childhood inattention).

Two studies have compared trajectories of parent-rated inattention and hyperactivity to better understand symptom covariation across time. Following a normative sample across the ages of 9–17, Larsson et al. (2011) found that many children in a stable-high inattention trajectory were also in a declining hyperactivity trajectory, suggesting a “shift” from childhood inattention-hyperactivity to adolescent inattention. Similarly, in children at risk for bipolar disorder from ages 6–12, Arnold et al. (2014) found that, in addition to profiles that were stable (high or low on inattention and hyperactivity), another profile demonstrated decreasing hyperactivity but stable high inattention. These studies suggest that developmental patterns of ADHD might be best understood by allowing for covariation between inattention and hyperactivity. In the present study, longitudinal latent class analysis (LLCA; Collins & Lanza, 2010) permitted for the simultaneous inclusion of clinically significant inattention and hyperactivity symptoms in the same longitudinal model, an enhancement over prior studies that compared separate symptom trajectories.

**Predicting ADHD Trajectories: Child Characteristics and Family Adversity**

Recognizing the centrality of cognitive and behavioral self-regulation deficits, models of ADHD development suggest that dysfunction in biologically based regulatory systems precedes ADHD and influences its stability (Barkley, 2006; Campbell, Halperin, & Sonuga-Barke, 2014). Developmental models also recognize that socialization experiences may affect the development of self-regulatory capacities and compensatory skills, thereby altering the course and outcomes of ADHD (Campbell et al., 2014). In particular, high-quality socialization experiences, including positive adult–child interactions and peer relations, appear to facilitate the development of child attention, emotion, and behavior regulation skills (Bernier, Carlson, Deschênes, & Matte-Gagné, 2012; Bierman & Torres, in press). Conversely, inconsistency, nonresponsiveness, or hostility in the socializing environment may impair self-regulatory control and exacerbate child reactivity and impulsivity (Cicchetti, 2002).

It is interesting that a recent review of prospective longitudinal studies of children with ADHD identified risk factors that appear particularly salient in predicting the course of ADHD; among them were the severity of inattention and hyperactivity, concurrent aggression, social isolation, emotional difficulties, and family adversity (Cherkasova, Sulla, Dalena, Pondé, & Hechtman, 2013). These factors may be linked directly with the course of ADHD to the extent that they index dysfunction in biologically based regulatory systems associated with ADHD (Barkley, 2006). In addition, they may affect the developmental course of ADHD indirectly, by increasing or decreasing child exposure to the types of predictable and supportive socialization experiences associated with the development of self-control capacities (Campbell et al., 2014). Evidence supporting the potential influence of each factor is considered briefly in the following sections.

**Severity of inattention and hyperactivity**

Reflecting the degree of cognitive and behavioral dysfunction, the severity of inattention and hyperactivity in childhood predicts ADHD in adolescence (Cherkasova et al., 2013). More severe inattention undermines school performance and effective social interaction, reducing positive support from teachers and peers (Campbell et al., 2014). Elevated hyperactivity is associated with disruptive and rule-breaking behaviors that increase negative exchanges with parents, teachers, and peers, thereby further fueling emotional reactivity and social alienation (Beauchaine, Hinshaw, & Pang, 2010; Campbell et al., 2014). Among children with ADHD, symptom severity may thus affect the course of the disorder by increasing risk for negative socialization experiences and reducing the positive supports that foster the continued development of self-regulation skills.

**Aggression and Social Isolation**

An extensive database suggests that comorbid aggression increases the stability of childhood ADHD (Hawes, Dadds, Frost, &
Russell, 2013). In addition, aggression has been linked to stable high or increasing trajectories of ADHD relative to low trajectories (Arnold et al., 2014; Sasser et al., 2014; Todd et al., 2008). In the early school years, elevated aggression may reflect heightened temperamental reactivity, serving as a direct index of biologically based liabilities (Vitaro, Brendgen, & Tremblay, 2002). In addition, aggressive behavior greatly increases exposure to coercive exchanges in which peers and adults escalate and reinforce aggressive and impulsive behaviors, undermining the development of self-control (Bierman & Sasser, 2014; Vitaro et al., 2002).

Social isolation is also linked with ADHD, particularly inattention (Willcutt et al., 2012), leading some to suggest that cognitive and temperamental characteristics (low inhibitory or effortful control, low social approach) accrue in some children to yield a pattern of general disengagement (Milich, Balentine, & Lynam, 2001). Children who are disengaged cognitively and socially miss out on key developmental opportunities during the school years, including academic instruction and positive interactions with teachers and peers (Campbell et al., 2014). In consequence, socially isolated children with ADHD may be less likely than socially integrated children to develop competencies that might mitigate their difficulties in later years.

**Emotional Difficulties**

Characterized behaviorally by irritability and emotional outbursts, emotion dysregulation has received increasing focus as a key factor in the development of ADHD (Shaw, Stringaris, Nigg, & Leibenluft, 2014). Conceptually, by the early school years, elevated emotion dysregulation reflects high levels of temperamental reactivity and negative transactions with caregivers, resulting in difficulty managing strong feelings and coping effectively with frustration or disappointment (Beauchaine, Gatze-Kopp, & Mead, 2007). Research suggests that children with ADHD and emotion dysregulation are more likely to experience social impairment and more persistent ADHD 4 years later relative to children with ADHD only (Biederman et al., 2012), perhaps as a function of both direct influences and insufficient socialization.

Nearly a quarter of the children with ADHD also express emotional distress, including anxiety and depressed mood (Jarrett & Ollendick, 2008). It has been hypothesized that anxiety or depression may exacerbate problems associated with ADHD by compounding cognitive with emotional difficulties (e.g., Bubier & Drabick, 2009). That said, longitudinal studies have yielded mixed results. Whereas emotional distress (mood or anxiety disorders) differentiated boys with persistent ADHD from those with symptom remission in one study (Biederman et al., 1996), it did not differentiate ADHD trajectories in another (Arnold et al., 2014).

**Family Adversity**

In addition to child factors, family adversity has been implicated in the course of ADHD (Biederman, Faraone, & Monuteaux, 2002; Counts, Nigg, Stawicki, Rapley, & von Eye, 2005). For example, high and low ADHD trajectories are differentiated by low socioeconomic status (SES), large family size, and single-parent status (Galéa et al., 2011; Larsson et al., 2011; Sasser et al., 2014). Theoretically, exposure to family adversity may maintain or exacerbate ADHD symptoms because of heightened stress and reduced support that directly undermine the development and functioning of self-regulatory systems (Bernier et al., 2012; Cicchetti, 2002). In addition, family adversity may impair parenting and increase negative parent–child interactions. For example, Galéa et al. (2011) found that coercive parenting differentiated children in low versus high ADHD trajectory groups, and Hawes et al. (2013) linked inconsistent parenting with increased ADHD symptoms 1 year later. Together, these studies suggest that low SES, single-parent status, exposure to stressful life events, and ineffective parenting may contribute to chronically high ADHD trajectories.

**Validating ADHD Trajectories: Evidence of Differential Outcomes**

A significant limitation in the earlier literature is a lack of studies examining the link between different developmental patterns of ADHD and later youth outcomes (Pingault et al., 2014; Willoughby, 2003). In general, ADHD significantly increases risk for maladjustment in late adolescence and adulthood, including antisocial activities, school failure, and unemployment (Barkley, 2006). However, only a few studies have validated changes in ADHD by examining developmental outcomes. It is possible that children may show declining patterns of ADHD without necessarily reducing their risk for negative outcomes. For example, Pingault et al. (2011) and Sasser et al. (2014) both found that children with high levels of inattention at school entry experienced significant academic difficulties in the later elementary years, even if their symptoms declined, perhaps because inattention during the early school years impeded acquisition of basic academic skills key for later learning. Links between ADHD trajectories and adolescent antisocial activities or adaptation difficulties (high school dropout, unemployment) are understudied. The current study added to this important database.

**Present Study**

In summary, the current study had three research aims. First, longitudinal patterns of clinically significant inattention and hyperactivity were estimated simultaneously using parent ratings collected in Grades 3, 6, 9, and 12. Consistent with prior studies that modeled parallel trajectories of inattention and hyperactivity (Arnold et al., 2014; Larsson et al., 2011), it was anticipated that profiles reflecting stable high and low ADHD symptoms would emerge, as well as profile(s) that reflected discontinuity in inattention and/or hyperactivity. Second, child characteristics (inattention, hyperactivity, aggression, social isolation, emotion dysregulation, and emotional distress) and family adversity (low SES, single-parent status, life stress, inconsistent parenting) were explored as predictors of ADHD trajectories. Predictors were measured in the early school years (kindergarten to Grade 2), when children faced new demands for self-regulation, social interaction, and learning, thereby providing an index of functioning in both home and school contexts (Campbell & Von Stauffenberg, 2008).

It was anticipated that elevations in child and family risk factors would be associated with more chronic ADHD profiles. Finally, ADHD trajectories were examined in relation to late adolescent outcomes (antisocial activities, high school dropout, unemployment). It was expected that children with more chronic profiles of ADHD would experience more impairment in later adolescence.
Participants

This study included participants of the Fast Track project, a multisite, longitudinal study of children at risk for conduct problems. Children were recruited from 55 schools serving high-risk communities located within four sites (Durham, NC; Nashville, TN; Seattle, WA; and rural PA). Using a multiple-gating screening procedure, all 9,594 kindergartners across three cohorts (1991–993) were screened for classroom conduct problems by teachers (TOCA-R Authority Acceptance; Werthamer-Larsson, Kellam, & Wheeler, 1991). Children scoring in the top-40% within cohort and site were then screened for home behavior problems by parents, using items from the Child Behavior Checklist (Achenbach, 1991) and similar scales (91% of those eligible participated, n = 3,274). Teacher and parent screening scores were standardized and summed to yield a total severity-of-risk screen score, and children were selected for inclusion into the study based on this screen score, moving from the highest score downward. Deviations were made when a child failed to matriculate in the first grade at a core school (n = 59) or refused to participate (n = 75). The outcome was that 891 high-risk children (n = 445 for intervention and 446 for control) participated in the Fast Track project. On the kindergarten Teacher’s Report Form of the Child Behavior Checklist (TRF), which provides national norms, the average Externalizing T score (available for 88% of the sample) was 66.4, and 76% of these children scored in the subclinical or clinical range (T scores of 60 or higher). The sample used in this study included participants from the high-risk control group (48% African American, 49% European American, 3% other; 66% male) who did not receive any prevention services. At the first home assessment (end of kindergarten) they were on average 6.5 years (SD = 0.48 years).

Developmental trajectories of clinically significant ADHD symptoms were estimated for 413 children (93% of the high-risk control sample) who had parent ratings of ADHD from at least one assessment (Grades 3, 6, 9, and 12). During trajectory estimation using LLCA, missing data was handled using full information maximum likelihood technique (FIML: Lanza, Dziak, Huang, Wagner, & Collins, 2014). This allowed the inclusion of children who had parent ratings at all four time points (50%), three time points (24%), two time points (11%), or one time point (8%). The 33 children dropped from the study because they lacked parent ratings did not differ significantly from those included on any child or family characteristics studied here. Missing data in the outcome variables (ranging from 14–39% of the sample) was multiply imputed.

Procedures

Parents were interviewed annually at home in the summers by trained research staff. Parents provided informed consent at each time. In the spring of the early elementary years (kindergarten, Grades 1 and 2), research assistants delivered and explained measures to teachers, who completed and returned them to the project. During summer home visits following Grade 12, youth completed computer-administered interviews in which they listened to questions via headphones and responded directly on the computer. Teachers, parents, and youth received financial compensation for study participation. All study procedures complied with American Psychological Association (APA) ethical standards and were approved by the institutional review boards of the participating universities.

Measures

Measures used in the current study are described here, with greater details available at http://www.fasttrackproject.org/data-instruments.php.

ADHD. When children were in Grades 3, 6, 9, and 12, parents completed the computerized version of the National Institute of Mental Health’s Diagnostic Interview Schedule for Children (CDISC; Shaffer & Fisher, 1997), a structured interview designed to assess psychiatric disorders and symptoms defined by the DSM–III–R (for Grade 3; American Psychiatric Association [APA], 1987) or DSM–IV (for Grades 6, 9, and 12; APA, 2000). For the ADHD diagnosis module, the parent responded “yes” or “no” to indicate the presence of each of nine inattention and nine hyperactivity symptoms in the prior 6 months (for Grade 3) or prior year (for Grades 6, 9, and 12). To estimate trajectories of clinically significant ADHD symptoms, inattention and hyperactivity were each scored dichotomously, with the presence of six or more symptoms (in Grades 3, 6, and 9) or 5 or more symptoms (in Grade 12; APA, 2013) scored “1” to indicate severity reaching clinically significant levels or “0” if below that threshold.

Early child characteristics. In the early school years (kindergarten to Grade 2), inattention, hyperactivity, aggression, social isolation, and emotional distress were assessed with the Child Behavior Checklist-Parent Report Form (CBCL-PRF; Achenbach, 1991) and Child Behavior Checklist-Teacher Report Form (CBCL-TRF). Scale scores of inattention, hyperactivity, and aggression were based on narrow-band scales previously validated by the Fast Track project (Stormshak, Bierman, & Conduct Problems Prevention Research Group, 1998). Fifteen items assessed inattention, including cannot finish things, cannot concentrate, inattentive, and does not finish tasks (average α = .66 for parents, α = .95 for teachers). Thirteen items assessed hyperactivity, including hyperactive, fidgets, disturbs others, impulsive, talks out of turn (average α = .75 for parents, α = .95 for teachers). Nine items assessed aggression, including gets in many fights, physically attacks people, threatens, and cruels (average α = .70 for parents, α = .81 for teachers). Social isolation was assessed using a 9-item CBCL narrow-band scale, including prefers to be alone, shy, and withdrawn (average α = .70 for parents, average α = .81 for teachers). Emotional distress was assessed with the anxiety and depression CBCL narrow-band scale, including 14 items, such as lonely, cries, feels worthless, self-conscious, unhappy, and worries (average α = .81 for parents, α = .84 for teachers). Each CBCL item was rated on a 3-point scale (0 = not true, 1 = somewhat/sometimes true, 2 = very/often true). Raw scores were averaged across the three years within rater and divided by the number of items in the scale to represent average item ratings. Emotion dysregulation was assessed with the Emotion Regulation subscale of the Social Competence Scale (Conduct Problems Prevention Research Group, 1995), which included 6 items for parents and 10 items for teachers (e.g., accepts things not going his or her way, copes well with failure, controls temper in a disagreement, appropriately expresses needs and feelings). Each item was rated on a 5-point scale (from 0 = not at all to 4 = very well; average α =
.85 for parents, $\alpha = .97$ for teachers). Scores were reversed to reflect emotion dysregulation and averaged across the 3 years.

**Early family adversity.** In kindergarten to Grade 2, parents reported on their occupation and educational level, which were scored using Hollingshead’s (1975) system to create 5 levels of SES ranging from $1 = \text{professional/major business}$ to $5 = \text{unskilled labor/service worker}$. In two-parent families, the codes for SES for each parent were averaged each year, and scores across the 3 years were averaged to reflect family SES. Parents reported on marital status ($0 = \text{married},\ 1 = \text{single parent-separated/divorced},\ \text{widowed, or never married}$).

During the interviews, parents completed the Life Stress scale of the Life Changes Questionnaire (Dodge, Bates, & Pettit, 1990), which included 16 items describing stressful life events during the past year (e.g., medical problems with target child, medical problems with family, separation of target child’s parents, financial problems, legal problems, pregnancies). Items represented a selection of common stressors represented on life event checklists (Dohrenwend, 2006), and were rated on a 3-point scale ($0 = \text{did not occur},\ 1 = \text{minor stressor},\ 2 = \text{major stressor}$). Scores were averaged across the 3 years (average $\alpha = .61$). Parents also reported on discipline strategies using the Consistent Discipline setting (e.g., When you give your child a command or order to do something, what fraction of the time do you make sure that your child does it? How often do you think that the kind of punishment you give your child depends on your mood?). Scores were reversed to reflect inappropriate and inconsistent discipline and were averaged across the 3 years (average $\alpha = .71$).

**Late adolescent outcomes.** At the end of Grade 12, parents completed the Parent Daily Report (Chamberlain & Reid, 1987), which included an 8-item assessment of antisocial behavior (e.g., physically fight with anyone, tell a lie, take anything that didn’t belong to him/her, purposely destroy property, scream/yell/or shout at anyone, argue or talk back to an adult; $\alpha = .73$). Youth completed the Self-Reported Delinquency scale (Hawkins, Catalano, & Miller, 1992), responding yes/no to describe delinquent behavior during the past year (e.g., property damage, theft, assault; $\alpha = .87$). Juvenile arrest data was collected from the court system in the child’s county of residence and surrounding counties through Grade 12. Records included any crime for which the individual had been arrested and adjudicated, with the exception of probation violations or referrals to youth diversion programs for first time offenders. Arrests were categorized into five severity levels, ranging from $1 = \text{status or traffic offenses}$ (e.g., curfew violation, runaway, truancy) to $5 = \text{violent crimes that involve serious harm to others}$ (e.g., aggravated robbery or assault, murder, rape). A “lifetime severity weighted frequency of arrests” index was used in the current study reflecting both the number and severity of offenses for which an individual had been arrested through Grade 12 (Cernkovich & Giordano, 2001).

High school noncompletion was recorded if school records did not indicate a diploma within two years after a nonretained student would have completed Grade 12, and the youth had not passed a high school graduation equivalency test (GED). If school records were missing, participant and parent interviews were used to assess high school graduation. Youth reported on employment status using the Employment Report Form (ERF; Howe & Frazis, 1992) at 2 years after Grade 12. Employment status in the present study was categorized into three levels ($0 = \text{full time job},\ 1 = \text{part time job},\ 2 = \text{unemployed}$), with higher scores reflecting unemployment.

**Results**

**Analysis Plan**

Analyses proceeded in three steps. First, parent ratings of clinically significant ADHD symptoms at Grades 3, 6, 9, and 12 were submitted to LLCA, a mixture model approach for identifying trajectory classes based on categorical observed indicators (Collins & Lanza, 2010). Second, a classify/analyze approach was used to assign children to the best trajectory class and multinomial logistic regression analyses examined early elementary child characteristics and family adversity as predictors of trajectory membership. Finally, ANCOVAs compared the late adolescent outcomes of children in different trajectories.

**Descriptive Statistics**

Rates of clinically significant levels of hyperactivity were 22.2% (Grade 3), 10.6% (Grade 6), 5.3% (Grade 9), and 5.6% (Grade 12). Rates of clinically significant levels of inattention were 19.6% (Grade 3), 16.5% (Grade 6), 15.8% (Grade 9), and 10.7% (Grade 12). Descriptive statistics for other study variables are shown in Table 1. In early elementary school, rates of child difficulties and family adversity were elevated in this high-risk sample. Teachers rated children as more impaired on each child characteristic than did parents, with the exception of emotional distress. In addition, low SES, high rates of single parenthood (more than half of the sample), and elevated levels of inconsistent parenting and life stress characterized the sample.

Significant sex and demographic (urban European American, urban European American, and rural European American) differences ($p < .05$) emerged for several study variables. Boys received higher scores than girls on inattention, $F_{\text{teachers}}(1, 445) = 4.67$; hyperactivity, $F_{\text{teachers}}(1, 445) = 20.77$; aggression, $F_{\text{teachers}}(1, 445) = 33.06$; $F_{\text{parents}}(1, 445) = 5.49$; emotion dysregulation, $F_{\text{teachers}}(1, 444) = 9.81$; $F_{\text{parents}}(1, 445) = 3.96$; and were more likely to live in single-parent families, $F(1, 435) = 4.57$. In late adolescence, boys reported higher levels of delinquency, $F(1, 407) = 9.77$, and higher rates of juvenile arrest, $F(1, 407) = 17.42$, and school dropout, $F(1, 407) = 6.26$. Urban African American children received higher scores than urban or rural European American children on teacher-rated inattention, $F(2, 442) = 12.81$; hyperactivity, $F(2, 442) = 23.66$; aggression, $F(2, 442) = 23.07$; social isolation, $F(2, 442) = 7.46$; emotion dysregulation, $F(2, 441) = 25.90$; and emotional distress, $F(2, 436) = 12.62$; and were more likely to live in single-parent families, $F(2, 432) = 47.63$. In late adolescence, urban African American children had higher rates of juvenile arrests, $F(2, 407) = 7.83$; high school noncompletion, $F(2, 407) = 3.79$; and unemployment, $F(2, 407) = 5.12$. Rural European American children received higher scores on parent-rated emotion dysregulation, $F(2, 407) = 3.56$, and emotional distress, $F(2, 407) = 2.98$, than the other demographic groups, and urban and rural European American children experienced elevated levels of life stress relative to urban African Amer-
Late adolescent outcomes

Correlations Among Early Child Characteristics and Family Adversity (Grades K–2)

The first step of the analyses was to characterize developmental trajectories, applying PROC LCA Version 1.3.1 (Lanza et al., 2014) parent reports of inattention and hyperactivity, dichotomized at clinically significant thresholds (Grades 3, 6, 9, and 12). To select the appropriate number of trajectory classes, 1,000 iterations of each model were run using randomly generated starting values. Adequate model fit (indicated by a $G^2$ statistic less than the degrees of freedom), and lower levels of the Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), and adjusted BIC, along with model interpretability, were used to identify the optimal number of classes (Collins & Lanza, 2010). Parameters for LLCA models including 1–6 trajectory classes are shown in Table

Table 2

Correlations Among Early Child Characteristics and Family Adversity (Grades K–2)

Note. P = parent rating; T = teacher rating; Y = youth self-report; R = records.

"p < .05. "*" p < .01.
Correlations Among Late Adolescent Outcomes

<table>
<thead>
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<td>.08</td>
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<td>2. Delinquent activity (Y)</td>
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<td>3. Juvenile arrests (R)</td>
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<td>4. School Noncompletion (R)</td>
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<td>5. Unemployed (Y)</td>
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Note. P = parent rating; T = teacher rating; Y = youth self-report; R = records. *p < .05. **p < .01.

Models with two (lowest BIC), three (lowest adjusted BIC), and four trajectory classes (lowest AIC) had adequate fit. However, the difference between the AICs of the three and four trajectory classes was negligible, and therefore the more parsimonious three trajectory class model was favored as the final LLCA model.

Item-response probabilities are shown in Table 6 and illustrated in Figure 1. A low trajectory class (consistently low levels of inattention and hyperactivity) included 71% of the sample, and a declining trajectory (clinically significant inattention and hyperactivity in third grade, declining below clinical levels in adolescence) included 16%. A third trajectory class (labeled high) included 13% of the sample and was characterized by a high probability of clinically significant hyperactivity in Grade 3, inattention and hyperactivity in Grade 6, and inattention in Grades 9 and 12. As shown in Table 4, there were no statistically significant demographic differences associated with trajectory class membership, with statistically equivalent proportions of males and females, urban African American youth, urban European American youth, and rural European American youth represented in each longitudinal profile.

Correlations of Early Child and Family Factors With Late Adolescent Outcomes

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<td>.09</td>
<td>.18**</td>
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<td>-.02</td>
<td>.13*</td>
</tr>
<tr>
<td>Emotional distress (T)</td>
<td>.01</td>
<td>.01</td>
<td>.10*</td>
<td>.12*</td>
<td>.07</td>
</tr>
<tr>
<td>Early family adversity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family socioeconomic status (P)</td>
<td>.08</td>
<td>.01</td>
<td>.22**</td>
<td>.28**</td>
<td>.08</td>
</tr>
<tr>
<td>Single parent (P)</td>
<td>.01</td>
<td>.09</td>
<td>.24**</td>
<td>.12*</td>
<td>.01</td>
</tr>
<tr>
<td>Inconsistent parenting (P)</td>
<td>.09</td>
<td>-.03</td>
<td>.03</td>
<td>.08</td>
<td>.10</td>
</tr>
<tr>
<td>Life stress (P)</td>
<td>.26**</td>
<td>.05</td>
<td>-.03</td>
<td>-.06</td>
<td>.01</td>
</tr>
</tbody>
</table>

Note. P = parent rating; T = teacher rating; Y = youth self-report; R = records. *p < .05. **p < .01.

A classify-analyze approach was used to assign each child to the LLCA trajectory class in which he or she had the highest posterior probability (Lanza et al., 2014). Average posterior probabilities were fairly high (0.95, 0.84, and 0.85 for the low, declining, and high class, respectively) and the proportions of children assigned to each group corresponded closely with the prevalence estimates in the LLCA model, indicating little classification error.

Early Child Characteristics and Family Adversity as Predictors of ADHD Trajectories

To identify factors that differentiated the trajectories, multinomial logistic regression models were estimated for each early elementary child characteristic and family risk. Type III tests provided an omnibus assessment of the contribution of each risk factor (controlling for child sex and site/race); odds ratios (ORs) provided pairwise comparisons of the effect of each risk factor for each trajectory versus the others. First, as shown in the left column of Table 7, relative to those in the low ADHD trajectory, children...
Low trajectory.

Regarding family adversity, children in the high ADHD trajectory (social isolation) did not differentiate the high and low trajectories.

To examine group differences in late adolescent outcomes, analyses of covariance (ANCOVAs) controlling for sex, race/site, and early parent-rated aggression were conducted. Results, presented in Table 8, revealed omnibus differences on each of the outcomes assessed. Consistent with expectations, children in the low trajectory demonstrated the best outcomes in late adolescence. Post hoc pairwise comparisons revealed that children in the high ADHD trajectory had significantly higher levels of antisocial behavior (by parent and self-report), arrests, and unemployment compared with children in the low trajectory. Children in the declining and low trajectories did not differ on any late adolescent outcomes. Children in the high trajectory had significantly greater levels of antisocial behavior (by parent report) and higher rates of school dropout than children in the declining group, but the two groups did not differ on self-reported antisocial behavior or unemployment, or juvenile arrests.

### Discussion

Although ADHD is often considered a chronic disorder, emerging longitudinal research suggests variability in its developmental course. In this study, LLCA methods identified three developmental trajectories of inattention and hyperactivity (modeled simultaneously) in a high-risk sample of children screened for early conduct problems. Overall, 71% of the sample showed a low trajectory, with no clinically significant levels of inattention or hyperactivity across Grades 3 to 12. The other 29% exhibited clinically significant ADHD symptoms at one or more points in time. This rate is higher than the level of parent-reported ADHD symptoms in normative populations (around 8.8%, Willcutt, 2012, reflecting the high-risk status of this sample. Of these, 16% showed a declining trajectory, with clinically significant levels of inattention and hyperactivity symptoms in Grade 3, declining below clinical levels in late childhood and adolescence (Grades 6, 9, and 12). The other 13% of the sample fell into a high trajectory class characterized by clinical levels of hyperactivity symptoms in Grade 3, inattention and hyperactivity symptoms in Grade 6, and inattention in Grades 9 and 12. A major study goal was to better understand the early elementary risk factors that predicted ADHD outcomes.

#### Late Adolescent/Early Adult Outcomes Associated With ADHD Trajectories

To examine group differences in late adolescent outcomes, analyses of covariance (ANCOVAs) controlling for sex, race/site, and early parent-rated aggression were conducted. Results, presented in Table 8, revealed omnibus differences on each of the

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**Table 6**

**Longitudinal Latent Classes: Item Response Probabilities and Demographics**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Low (71%)</th>
<th>Declining (16%)</th>
<th>High (13%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Third grade</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inattention</td>
<td>.01</td>
<td>.75</td>
<td>.49</td>
</tr>
<tr>
<td>Hyperactivity</td>
<td>.05</td>
<td>.67</td>
<td>.61</td>
</tr>
<tr>
<td>Sixth grade</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inattention</td>
<td>.03</td>
<td>.30</td>
<td>.66</td>
</tr>
<tr>
<td>Hyperactivity</td>
<td>.03</td>
<td>.06</td>
<td>.58</td>
</tr>
<tr>
<td>Ninth grade</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inattention</td>
<td>.05</td>
<td>.15</td>
<td>.73</td>
</tr>
<tr>
<td>Hyperactivity</td>
<td>.01</td>
<td>.07</td>
<td>.24</td>
</tr>
<tr>
<td>Twelfth grade</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inattention</td>
<td>.02</td>
<td>.12</td>
<td>.60</td>
</tr>
<tr>
<td>Hyperactivity</td>
<td>.00</td>
<td>.00</td>
<td>.46</td>
</tr>
</tbody>
</table>

**Demographics**

- Male: 64.5% 75.0% 77.6%
- Urban African American: 46.9% 46.7% 52.3%
- Urban European American: 26.5% 23.3% 23.7%
- Rural European American: 26.5% 30.0% 24.0%

**Note.** Boldface indicates item response probabilities over .50.

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**Figure 1.** Item-response probabilities for longitudinal three-class model of attention-deficit/hyperactivity disorder (ADHD) symptoms.
adolescent/early adult outcomes. These developmental trends are consistent with findings from prior studies of ADHD symptoms, with hyperactivity declining somewhat over time and inattention remaining relatively stable (Biederman et al., 2000; Willcutt et al., 2012). The pattern found here is also consistent with the findings of Larsson et al. (2011), who compared separate models of inattention and hyperactivity trajectories and suggested that elevated hyperactivity symptoms in childhood are associated with elevated inattention in adolescence. Some researchers have speculated that hyperactivity becomes increasingly internalized with age, manifesting as mental restlessness and distractibility in adolescence (Greven et al., 2011; Weyandt et al., 2003). It is also possible that delays in attention become more pronounced over time as the gap between executive function skill development and increased task demands widens with age (Huizinga, Dolan, & van der Molen, 2006; Willcutt et al., 2012).

In this study, children in the high trajectory class were distinguished from children without clinically significant ADHD symptoms on a host of early childhood characteristics, including elevated inattention and hyperactivity, aggression, emotion dysregulation, and emotional distress. Their parents reported heightened levels of family stress and difficulties with inconsistent and ineffective discipline in the early school years. Children in this high trajectory class had poorer outcomes, including higher rates of antisocial behavior, juvenile arrests, and unemployment than children in the low class, even after controlling for childhood aggression. Considered together, these predictors, trajectories, and outcomes are consistent with negative cascade models of ADHD, in which initial biologically based (i.e., temperamental, cognitive) reactivity and dysregulation contribute to impulsive behaviors and difficulty following rules and routines, as well as a tendency to react to limit-setting with oppositional or aggressive behavior (Campbell et al., 2014). These early difficulties are exacerbated by inconsistent and ineffective parenting and a lack of positive interpersonal support, which undermine the further development of

### Table 8

<table>
<thead>
<tr>
<th>Variables</th>
<th>F(2, 407)</th>
<th>Low</th>
<th>Declining</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antisocial behavior (P)</td>
<td>19.66**</td>
<td>.10</td>
<td>.13a</td>
<td>.22b</td>
</tr>
<tr>
<td>Delinquent activity (Y)</td>
<td>4.68*</td>
<td>.03</td>
<td>.05ab</td>
<td>.07b</td>
</tr>
<tr>
<td>Juvenile arrests (R)</td>
<td>4.34</td>
<td>2.88</td>
<td>4.17ab</td>
<td>5.16b</td>
</tr>
<tr>
<td>School dropout (R)</td>
<td>4.13*</td>
<td>.46ab</td>
<td>.34a</td>
<td>.60b</td>
</tr>
<tr>
<td>Unemployment (Y)</td>
<td>4.09*</td>
<td>1.16</td>
<td>1.24ab</td>
<td>1.58b</td>
</tr>
</tbody>
</table>

Note. P = parent rating; T = teacher rating; Y = youth self-report; R = records. ANCOVAs controlled for child sex, race/site, and parent-rated aggression. Means with different subscripts are significantly different at \( p \leq .05 \).

* Standardized scores.

\( p < .05 \)  \( p < .01 \)
self-regulation capacities, contribute to poor school adjustment and underachievement, and reinforce antisocial activities (Bierman & Sasser, 2014; Campbell et al., 2014).

The Declining Trajectory Class

**Declining trajectory class characteristics.** In contrast to the high trajectory class, slightly more than half of the children with elevated ADHD symptoms in childhood (Grade 3) followed a declining trajectory in which their symptoms fell below clinical cut-offs for each of the subsequent time periods. Previous studies modeling inattention symptoms alone have also found declining trajectories (e.g., Pingault et al., 2011; Sasser et al., 2014). The current study revealed a trajectory class characterized by declines in both inattention and hyperactivity. Relative to children in the low trajectory who never exhibited elevated ADHD symptoms, children in the declining trajectory class showed multiple difficulties during the initial school years (kindergarten to Grade 2), including elevated inattention, hyperactivity, social isolation, and emotion dysregulation by both teacher and parent report (relative to the low group). Their parents also reported elevated aggression at home, and elevated levels of life stressors, which reflect events and experiences that undermined family support, such as moves, job changes, interpersonal losses, and medical problems. By late adolescence, not only were their ADHD symptoms improved, but these children fared better than those in the high trajectory class in areas of parent-reported antisocial outcomes and rates of high school completion. Although they were not significantly different from youth in the low ADHD trajectory on any of the late adolescent outcomes studied here, they had intermediate scores between the high and low classes in areas of self-reported antisocial behavior, arrests, and unemployment, suggesting some compromised long-term adjustment.

**Declining versus high trajectory class differences.** Direct comparisons of the early childhood characteristics of youth who followed a chronic high versus declining trajectory revealed three significant differences. Those who followed a high trajectory pattern were more aggressive and more hyperactive at school (based on teacher report) and more emotionally dysregulated at home (based on parent report) than were children who showed declining symptoms. In addition, although these two groups did not differ significantly on other variables, only the declining class showed elevated social isolation at home and school (relative to the low group), whereas only the high class exhibited elevated emotional distress at school and inconsistent parenting at home (relative to the low group).

These differences are relatively small, and they do not provide definitive information regarding the mechanisms that account for the different developmental pathways experienced by children in the two classes. However, several possibilities exist, which might be explored more fully in future research. First, exposure to stressful life events in early elementary was associated with both high and declining patterns of ADHD, which is consistent with some prior studies that suggest that early family adversity contributes to delays in self-regulatory skill development and thereby may amplify inattentive and hyperactive behavior in early childhood (Bernier et al., 2012; Cicchetti, 2002; Sasser et al., 2014). Theorists have suggested that family adversity might directly increase levels of child emotional distress in ways that distract or overburden regulatory processing and impede executive function matura-
tion in early childhood (Blair & Raver, 2012). In addition, exposure to family life stressors may increase unpredictability and disorganization at home, reducing parental attention, and thereby undermining effective scaffolding of early child self-regulatory development (Sasser et al., 2014).

It is also possible that elevated life stress and biological vulnerabilities contributed to the early ADHD symptoms of children in both the high and declining trajectory classes, but that children in the declining class were more able to benefit from socialization experiences at home and school and thereby showed developmental “catch up” in the later school years. In contrast, children in the high trajectory class, who also experienced inconsistent parenting in addition to elevated life stress, showed more emotional distress at home and more behavioral dysfunction at school, including higher levels of hyperactivity and aggression. The generalization and escalation of hyperactive and aggressive behavior in the school setting may indicate that children with chronic ADHD had greater biological vulnerability and were more impulsive and risk-taking than those in the declining trajectory class; it is also possible that their exposure to inconsistent and ineffective parental discipline in the early years amplified their impulsive and aggressive tendencies (Campbell et al., 2014). These children may have been less amenable to positive socialization efforts at school, and more likely to become enmeshed in coercive interactions with teachers and peers that further undermined self-regulatory skill development, particularly at the transition into adolescence when they gained more autonomy (Beauchaime et al., 2010; Bierman & Sasser, 2014; Cernkovich & Giordano, 2001).

Although social isolation is generally considered a risk factor, it is possible that children in the declining ADHD class, who were more socially withdrawn than children in the low trajectory class, elicited more positive support from teachers and peers than the more socially prominent and disruptive children in the high trajectory class. Considering the poorer late adolescent outcomes of children in the high trajectory, it may be that social isolation also protected children in the declining class from deviant peer influences at the transition into adolescence (Loeber et al., 1993). Future research is needed to explore these or other potential mechanisms associated with declining versus chronic high patterns of ADHD symptoms. Understanding these mechanisms enhances developmental models of the disorder, and may inform areas to target with early intervention.

**Limitations**

A major strength and unique feature of this study was the availability of repeated parent ratings of ADHD symptoms, which allowed for trajectories that modeled inattention and hyperactivity simultaneously and covered a time period longer than prior studies, from Grade 3 to Grade 12. Additional unique features included data on early child characteristics and family risks that were assessed prior to the trajectories, and a set of important outcomes measured in late adolescence to validate trajectories of clinically significant ADHD symptoms.

At the same time, the study had several limitations. First, the trajectories were based on parent ratings and used dichotomous indicators of clinically significant symptom levels. The availability of repeated parent ratings over time facilitated the modeling of
trajectories, but parent ratings are also subject to biases. It is unclear how many of the children rated as having elevated ADHD symptoms in Grade 3 would have been diagnosed with ADHD had a more comprehensive diagnostic evaluation been completed. Parents reported that 22% of the children in the declining trajectory had received “medication to control behavior or attention” by the end of Grade 2 (age 8), whereas 52% of the children in the high trajectory had received medication (compared with just 7% in the low trajectory). This suggests that a relatively greater proportion of the children in the high trajectory received medication evaluations associated with their ADHD symptoms (or other behavior problems). The quality of the medication evaluations was likely variable, but it is possible that more of the children in the high group than in the declining group would have qualified for a full diagnosis of ADHD had more complete assessments been employed in the current study.

In addition, the nature of this sample must be taken into account when interpreting the findings. Children were selected for this sample based on elevated conduct problem behaviors at kindergarten entry. Hence, the study provides rich information regarding the diverging development and outcomes of a subset of children with ADHD symptoms, specifically those with early aggressive and oppositional behaviors. The results may not adequately characterize the development of children with ADHD symptoms who do not show concurrent early conduct problem behavior. In addition, this study focused on risk factors typically associated with conduct problems; future research should also explore temperament and cognitive factors that might also differentiate developmental trajectories. For instance, it is possible that executive function skill development may predict diverging inattention/hyperactivity trajectories.

Third, the design of this study does not make it possible to determine whether or how the amount and kind of treatment experienced by children may have influenced their developmental trajectories. By the end of Grade 2, many of the parents in the sample reported that their children had received some kind of “treatment for emotional or behavioral difficulties” at school or at home (25% of the children in the low group, 49% of the children in the declining group, 80% of the children in the high group). This high rate of service use reflects the high-risk nature of the sample, which was selected for elevated conduct problems. However, the nature and quality of services across these high-risk settings was likely highly variable. The study findings represent developmental trajectories and outcomes that occur given “treatment as usual” in economically disadvantaged communities in four diverse geographical regions of the United States.

Fourth, this study used person-oriented analyses to characterize subgroups within the sample, making it possible to identify classes that showed diverse, nonlinear covariation in clinically significant inattentive and hyperactive symptom patterns over time. While this modeling strategy has many advantages, direct comparisons with other studies are limited by variations in samples, modeling strategies, and measurement that affect the trajectories identified. In this study, inattention and hyperactivity were modeled simultaneously and clinically significant cut-offs were used to better understand developmental variation in disordered levels of ADHD symptoms. In contrast, other studies have modeled symptom severity, which may provide additional information to inform trajectory patterns.

Finally, although this study utilized a strong longitudinal design to examine predictors of discontinuity, it cannot specify causal relationships, because it is possible that other processes beyond those examined in the current analyses contributed to the observed associations.

**Clinical Implications and Conclusions**

The findings suggest that a developmental perspective may be critical for understanding the clinical course of ADHD. Variable-centered analyses tend to emphasize linear associations across time. In contrast, the person-oriented trajectory model used in this study reveals important nonlinear associations characterizing different developmental profiles of clinically significant ADHD symptoms that may inform clinical assessment and treatment. For example, although hyperactivity symptoms decline over time, the trajectories that emerged in this sample suggest that hyperactivity in childhood may be salient in predicting chronicity, particularly when hyperactivity is observed across the home and school settings, and also when it is accompanied by aggressive behavior. In addition, given their association with differential developmental trajectories in this study, emotional difficulties, including emotion dysregulation and emotional distress, may need more attention in ADHD treatment models that tend to focus primarily on behavioral and cognitive impairments (see Shaw et al., 2014). Recognizing that many children with childhood ADHD improve over time, an important, unanswered question for future research is whether preventive interventions during the early school years designed to target key developmental factors might successfully divert more children with ADHD from the stable high to a declining trajectory class, with corresponding long-term benefits (see Chacko, Walshlag, Hill, Danis, & Espy, 2009). Future research of this kind is needed to help to fill in the gaps in the existing literature, and illuminate the developmental mechanisms that may underlie diverse developmental trajectories of ADHD symptoms. In turn, a better understanding of the developmental course and processes associated with ADHD trajectories may inform more effective prevention and intervention approaches.

**References**


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