

Attention-Deficit/Hyperactivity Disorder Developmental Trajectories Related to Parental Expressed Emotion

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In the transition from childhood to adolescence, attention-deficit/hyperactivity disorder (ADHD) developmental trajectories diverge. Family environment, as indexed by parental expressed emotion, may moderate these trajectories. 388 children with ADHD and 127 controls were assessed using multi-informant, multimethod diagnostic procedures at up to 3 time points 1 year apart in an accelerated longitudinal design spanning ages 7–13 years. Latent-class growth analysis was used to identify developmental trajectories for parent- and teacher-rated ADHD and oppositional-defiant disorder (ODD) symptoms within the ADHD sample. Parental expressed emotion, criticism, and emotional overinvolvement were coded from a 5-min speech sample at 2 time points, 1 year apart, for 208 of these children and compared among ADHD trajectory groups. Results: Parent-rated hyperactivity yielded a 4-class trajectory solution in latent-class growth analysis; teacher-rated inattention yielded a 3-trajectory solution. Teacher-rated ODD also yielded 3-trajectory solution. A parent-rated high persistent hyperactive group was more likely than the other ADHD groups to have parents with stable high criticism (34.6%, $p < .001$), with ODD symptoms controlled. A teacher-identified high ODD-worsening group was more likely to experience high criticism, particularly the initial time point; (87.5%, $p < .001$), with hyperactivity controlled. Parental criticism, an index of the family environment, is uniquely associated with divergent developmental trajectories among children with ADHD in addition to those associated with ODD symptoms. Lay summary: For many children, ADHD symptoms decrease as they transition to adolescence. Family environmental factors, such as parental criticism, may help explain for whom symptom remission is less likely.

General Scientific Summary

For many children, attention-deficit/hyperactivity disorder (ADHD) symptoms decrease as they transition to adolescence. Family environmental factors, such as high levels of parental criticism, may help explain for whom symptom remission is less likely.

Keywords: adolescence, attention, developmental psychopathology, family, impulsivity

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Few would dispute that attention-deficit/hyperactivity disorder (ADHD) is heterogeneous with respect to biology, cognition, psychosocial context, and developmental trajectory. Of children with ADHD in childhood, 50–70% continue to have a diagnosis of ADHD during the transition to the teen years (Langberg et al., 2008; Molina et al., 2009; for a review, see Sagvolden, Johansen, Aase, & Russell, 2005). While some individuals appear to remit, others experience persistent

problems and serious negative outcomes, including drug abuse/addiction, school dropout, criminality, and antisocial behavior (Barkley, 1990; Biederman et al., 1996; Sibley et al., 2012). However, the determinants and correlates of this late-childhood to early-adolescent divergence are not well understood.

Clarifying determinants of developmental change in ADHD is complicated by normative age-related changes in behavior. In

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particular, symptoms of hyperactivity and impulsivity normatively decline across adolescence (Molina et al., 2009; Willoughby, 2003; Wolraich et al., 2005). While this may be partly attributed to maturation of key neural networks (Casey, Jones, & Somerville, 2011), it appears that trajectories of remitting hyperactive/impulsive (H/I) symptoms are distinct from overall symptom severity (including inattentive symptoms), impairment, and comorbid diagnoses (e.g., oppositional-defiant disorder [ODD] and conduct disorder [CD]; Sibley et al., 2012), suggesting that either new genetic influences (Kuntsi, Rijdsdijk, Ronald, Asherson, & Plomin, 2005) or relevant familial or social experiences may be contributing. Further supporting the importance of looking at family factors, longitudinal behavioral genetic studies suggest that as children approach adolescence, stability of ADHD symptoms is primarily due to genetic factors, whereas change is markedly influenced by environmental factors (Kan et al., 2013). Thus, further consideration of environmental factors, and family factors in particular, during this developmental period is needed to understand this clinically crucial variation in ADHD's course.

Substantial literature has examined the association of family context with the course of ADHD in children. These contextual factors have included parenting style and behaviors, family conflict, parent and family stress, and more (see review by Johnston & Mash, 2001). Both ADHD and associated behavior problems, such as aggression and defiance, appear more likely to persist in the context of negative and harsh family or parenting environments (Campbell, Pierce, Moore, Marakovitz, & Newby, 1996; Patterson, Reid, & Dishion, 1992).

However, two critical questions render interpretation of this association difficult. The first is that it is not clear whether indices of negative emotional tone in the family environment are correlated with distinct, empirically identified trajectories of ADHD symptoms, independently of co-occurring behavior problems (Cherkasova, Sulla, Dalena, Ponde, & Hechtman, 2013; Johnston & Mash, 2001; Paidipati & Deatrack, 2015; Richards et al., 2014). This paper focuses on that question. If this association is verified in relation to this fundamental test, then follow up work will need to address the second question, which is to evaluate the causal direction of this association.

When it comes to measures of family context and emotional tone, particularly interesting has been resurgent focus on parental expressed emotion (EE) in ADHD, which is theorized to index emotional intensity in the home and thus to potentially influence chronicity of maladjustment (for a review, see Peris & Miklowitz, 2015). EE is classically understood as a two-dimensional coded construct composed of criticism and emotional overinvolvement (Miklowitz, Goldstein, Falloon, & Doane, 1984; Vaughn & Leff, 1976). In particular, the criticism domain is designed to index negativity or resentment directed toward the child, while the emotional overinvolvement category indexes behaviors which are overprotective or overly self-sacrificing (Leeb et al., 1991; Magaña et al., 1986). One frequently used metric is parental EE assessed and coded during a 5-min speech sample (FMSS; Baker, Heller, & Henker, 2000; Leeb et al., 1991; Magaña et al., 1986; Miklowitz et al., 1984).

Exemplifying the core question guiding this study, parental high EE has been classically associated with oppositional/aggressive behavior (Asarnow, Tompson, Woo, & Cantwell, 2001; Caspi et al., 2004; McCarty & Weisz, 2002; Peris & Baker, 2000). How-

ever, ADHD symptom severity also appears to be associated with parental high EE and high criticism (Cartwright et al., 2011; Keown, 2012; Peris & Hinshaw, 2003; Peris & Miklowitz, 2015; Piffner, McBurnett, Rathouz, & Judice, 2005; Psychogiou et al., 2007a, 2007b; Sonuga-Barke et al., 2008, 2009, 2013). Although part of this association may be driven by comorbid oppositional/aggressive behavior in ADHD (Baker et al., 2000; Hirshfeld, Biederman, Brody, Faraone, & Rosenbaum, 1997; Peris & Baker, 2000; Vostanis & Nicholls, 1992), research is mixed as to whether there is also a specific EE-ADHD association. Some prior work has found that EE's association with ADHD remains robust after controlling for comorbid conditions (Peris & Hinshaw, 2003). Cartwright and colleagues (2011) conducted a preliminary study of 60 sibling pairs and found that the association of components of maternal EE with ADHD were fully explained by comorbid conduct problems, with the exception of low maternal warmth, which was uniquely associated with ADHD. However, this conclusion was somewhat qualified in a follow-up analysis in the same data set (Sonuga-Barke et al., 2013), showing that family characteristics other than child misbehavior also influenced maternal EE. That result further implicates the potential clinical importance of understanding EE as an index of the family environment in shaping ADHD, and those authors called for longitudinal studies to further clarify matters.

Lifford, Harold, and Thapar (2008) conducted a longitudinal cross lagged twin study of parental hostility and ADHD and concluded that the association was driven either by genetic effects or child-on-parent effects. However, that study and did not examine divergent symptom trajectories or EE per se. Richards et al. (2014) found no reliable association between baseline EE and ADHD severity 6 years later, in a sample of 385 children with ADHD age 5-18 years at baseline and 10-24 at follow-up. Again, differential ADHD developmental symptom trajectories were not examined. Moreover, maternal EE was assessed using two different structured clinical interviews at the two time points, neither initially designed to assess for EE.

In addition, it is unclear whether parental EE is related to behavioral outcome in children in terms of mere exposure (at one time point) or to chronicity of elevated EE. It may be that simply being exposed to high parental EE (or aspects of it, such as high criticism) is associated with worse outcomes, in which case intervention would have to target prevention of harsh and emotional family environments in ADHD cases or support of parental mental health in response to ADHD in the child. Alternatively, it may be that children exposed to chronic and stable high parental EE are at the greatest risk for poor outcomes, due to sustained exposure across time, in which case interventions could target interruption of the emotional environment among families where it is occurring. Supporting this logic, Sonuga-Barke and colleagues (2008, 2009) investigated gene-by-environment effects and concluded that parental EE is a moderator of genetic influences on both ADHD and associated externalizing behavior problems. While prior work (cited earlier) suggests these associations may be bidirectional or else child-driven, our focus here is simply to determine if chronicity is a correlated.

In summary, the goal of the current study was to examine parental EE domains' unique associations with differential ADHD and ODD symptom trajectories over the transition from childhood to early adolescence in this context. We also tested the hypothesis

that chronic exposure to high parental EE (particularly criticism) will be associated with the worst outcomes.

Method

Participants

A community-based recruitment strategy was employed in an effort to avoid bias introduced by clinic ascertainment, as ADHD comorbidity and severity differ markedly in clinically ascertained versus community or population samples (Willcutt & Pennington, 2000). Families were recruited by public advertisements and mass mailings, seeking participants for studies of the development of attention and impulsivity in children. ADHD cases were identified following procedures outlined below. All *Diagnostic and Statistical Manual of Mental Disorders (DSM)-IV* or *DSM-5* ADHD subtypes and presentations were allowed. The local Institutional Review Board approved the studies. Parents provided written informed consent and children provided written informed assent. The sample of 515 children included 388 with ADHD and 127 typically developing children, ages 7–11 at the baseline assessment. Not all had parental measures at multiple time points. Details related to sample size for each analysis are in the Analysis Plan section.

Case identification procedures. All families underwent a multigate screening process to establish eligibility and ADHD diagnosis. After completing a brief telephone screen to determine interest and to identify major rule outs, families visited the university for a research-based diagnostic-evaluation. A Kiddie Schedule for Affective Disorders and Schizophrenia–Epidemiological version (KSADS-E; Puig-Antich & Ryan, 1996) was administered to a parent by a trained master's level clinician. Interinterviewer reliability was $\kappa > 0.70$ for all diagnoses with base rate $> 5\%$ in the sample. Parents and teachers completed the following widely used, well-normed standardized rating forms: (a) The ADHD Rating Scale for *DSM-IV* (ADHD-RS; DuPaul et al., 1998), (b) the Conners 3rd Edition (Conners, 2008), and (c) the Strengths and Difficulties Questionnaire (Goodman, 2001). Each of these measures has established validity and reliability and all yielded satisfactory intrascale reliabilities in the current sample. Impairment was scored using the impairment section of the parent and teacher Strengths and Difficulties Questionnaire and the clinician impairment rating from the KSADS.

Children completed a valid ($r = .88$) and reliable ($\alpha = .93$; Sattler, 2008) short IQ screen comprising Information, Vocabulary, and Block Design subtests of the Wechsler (2003) Intelligence Scales for Children, fourth edition, and Wechsler (2005) Individual Achievement Test, second edition, Word Reading, Numerical Operations, and Pseudoword Decoding subtests.

All of this information was presented to a clinical diagnostic team in order to establish a best estimate diagnosis (Roy et al., 1997). The team included a board-certified child psychiatrist and a licensed clinical psychologist, both blind to the parental EE data. They independently reviewed all information to arrive at diagnoses using *DSM-IV* criteria, taking into careful account age of onset, duration, impairment, cross-informant convergence, and likelihood that another diagnosis would better account for the ADHD symptoms. Their agreement rate was acceptable for ADHD and as well as ODD and for all disorders with base rate $> 5\%$ in the study (all $k > .80$). Disagreements were resolved by discussion. Youth in

the current ADHD cohort also meet ADHD criteria according to *DSM-5*.

Exclusion criteria. Exclusion criteria include an estimated Full Scale IQ < 75 by our IQ screen, use of long-acting psychotropic medication (e.g., antidepressants) by parent report, as well as presence of current major depressive episode, lifetime mania or psychosis, pervasive developmental disorder (including autism), or major medical/neurological disorders or injuries as identified on the KSADS, rating scales, or diagnostic team review. Other psychiatric disorders were free to vary. Children were also excluded if they could not be diagnosed with ADHD or designated a qualified control case at baseline (e.g., parent and teacher gave very different ratings; or ADHD symptoms were subthreshold).

Measures

ADHD symptom change. ADHD symptoms were obtained at all data collection time points using the parent- and teacher-report ADHD-RS (DuPaul, Power, Anastopoulos, & Reid, 1998). Parents and teachers rated each of the *DSM* ADHD symptoms on a 4-point scale ranging from 0 (*never/rarely*) to 3 (*very often*). For children taking stimulant medications, parents and teachers were asked to rate the child's behavior when not taking medication. Symptom counts were determined using standard scoring procedures in which a symptom is considered present if rated as a 2 or 3 (DuPaul et al., 1998).

ODD symptom change. Parent-rated ODD symptoms for the growth models were obtained at all data collection time points using the symptom count from the KSADS-E ODD module because a symptom checklist was not available. Each symptom was coded as absent (0), maybe (1/2) or present (1) and a total symptom score created in this way. Teacher-rated ODD symptoms were obtained using a *DSM*-based symptom checklist (using the same scale as the ADHD-RS) in which symptoms rated a 2 or a 3 were counted as present and a total symptom count was created and analyzed.

Expressed emotion. Parental EE was measured via the FMSS (Magaña et al., 1986), which asks parents to describe their child and their relationship for 5 min in their own words without interruption or guidance from the administrator. The FMSS was audio-recorded and blindly coded. Tapes were transcribed to aid in interpretability and accuracy. Two expert, independent raters each blind to ADHD symptom trajectories or parent-teacher ratings, as well as to one another's codes, independently coded the FMSS for EE. The two raters were trained in the University of California, Los Angeles, Family Project Lab where the measure originated and have served as coraters and/or reliability raters across numerous independent samples.

Parental EE was coded in two steps, following established procedures and an established coding manual (Magaña et al., 1986). First, the two subscales (Criticism and Emotional Overinvolvement) are coded as low, borderline, or high. These subscale scores are derived from coding specific aspects of the speech sample including the initial statement, the description of the parent-child relationship, critical remarks, and evidence of extreme self-sacrificing behavior or a lack of objectivity. Coding considered the respondent's speech content (via a transcript of the session) and tone (via listening to the session).

Then, a global EE score of “low” or “high” is assigned. A “high” final EE score is obtained only when a parent receives a “high” score in either (or both) of the Criticism and/or Emotional Overinvolvement domains. For the present report, the Criticism and Emotional Overinvolvement subscale scores. 10% of tapes were coded blindly by both raters percentages of agreement were 92% ($k = .81$) for the overall final score, 87% ($k = .78$) for criticism, and 84% ($k = .74$) for emotional overinvolvement.

Analysis Plan

Symptom growth models. Age-based growth models were estimated separately for parent- and teacher-reported inattention, H/I, and ODD symptoms in the sample of children with ADHD. Of the 388 ADHD children, 253 were enrolled in a prospective longitudinal study and had multiple time points of data. The remaining children completed a single time point of assessment. Thus, for the ADHD youth, 38% ($n = 147$) had one time point of assessment; 19% had two time points ($n = 73$), and 43% had three time points ($n = 168$). Retention was satisfactory for those for whom a follow-up visit was planned (exceeding 95%).

Models were calculated using *MPlus* version 7.2 (Muthén & Muthén, 2014). Where variability in symptom trajectories was reasonably suspected (operationalized as variability around the slope with $p < .15$ to avoid Type II error, which was the priority at that preliminary stage of analysis), an unconditional linear latent-class growth model (LCGA; Muthén & Muthén, 2000) with no predictors was fit. LCGA defines three latent factors (class, intercept, and slope) from a structural equation modeling framework. The latent class variable was regressed onto the intercept and slope factors to examine differences between the latent trajectory classes in the sample. Intercepts and slopes within each class were held equal. Two-, three-, and four-, and five-class LCGA models were fit to the data and the best-fitting model was selected based on comparison of standard fit indices (Bayesian information criterion [BIC], comparative fit index [CFI], root-mean-square error of approximation [RMSEA]) and the parametric bootstrapped likelihood ratio test (LRT), which assesses whether the k -class model significantly improves on the $k - 1$ class model (Asparouhov & Muthén, 2012). Missing data modeling was handled using full information maximum likelihood.

EE domain analyses. EE analyses focused on a randomly selected subset of the longitudinal sample, for whom EE data were collected and coded at two time points 1 year apart ($n = 208$ with ADHD, $n = 127$ controls), using logistic regression analyses. To code stability of EE, Criticism, and Emotional Overinvolvement were dummy coded separately as present/absent for each variable at each of the two assessments. Children rated at high in a particular domain (i.e., EE, Criticism, Emotional Overinvolvement) at *both* assessments were considered “stable high,” those with high scores at only one assessment were “ever high,” and the others were “never high” in that particular domain of interest. To examine EE domain effects on longitudinal symptom trajectories, the 208 ADHD participants with two time points of EE data were subjected to conditional growth models using EE domain (i.e., criticism, emotional overinvolvement) dummy codes as predictors of the above described symptom trajectory classes. For ease of presentation only results for parental criticism and emotional overinvolvement are presented. Results for “overall” EE scores largely

mirrored that of the criticism domain (available from the first author).

Selection of covariates. The following variables were considered for use as either invariant or time-varying covariates as appropriate: age at assessment, sex of child, ethnicity and race of child, child stimulant medication use, two-parent family versus single-parent family status, family income, child estimated full-scale IQ, comorbid diagnoses, and sex of respondent for FMSS. Over 80% of FMSS respondents were women (mothers or female caregivers) at both time points. Covariates were selected for inclusion if they either (a) differed by EE rating or (b) differed by latent-trajectory class using a criterion of $p < .05$. This resulted in inclusion of the following covariates in all diagnostic group comparisons: age at assessment, sex, two-parent family versus single-parent family, income, IQ, and comorbid diagnoses (anxiety, mood disorders, ODD, and CD). For trajectory class analysis, it resulted in inclusion of IQ, comorbid diagnoses, and income. Respondent sex was also treated as a covariate in all analyses of parental EE domain. ODD was treated as a covariate in ADHD symptom trajectory analyses, and ADHD was treated as a covariate in ODD trajectory analyses.

Results

Table 1 provides a descriptive overview of the sample of 388 ADHD and 127 control youth. No significant differences emerged between (a) the sample in Table 1 and the subset used in the EE analyses or (b) those with any EE data ($n = 419$) and the subset with two time points of EE data ($N = 208$; all $p > .31$). Thus, random selection for EE coding succeeded.

ADHD Diagnosis and Expressed Emotion

High parental EE Criticism was more likely among children with an ADHD diagnosis at each time point (Table 1). Logistic regression (with covariates described earlier), showed that this result held for at Time 1 (Cox and Snell $R^2 = 0.088$, $\beta = 0.270$, $p < .001$) and Time 2 (Cox and Snell $R^2 = 0.053$, $\beta = 0.128$, $p < .001$). Parental emotional overinvolvement was not associated with ADHD diagnosis at Time 1, but was more likely among children with ADHD at Time 2 (Cox and Snell $R^2 = 0.013$, $\beta = 0.061$, $p = .021$). Stability in high parental criticism was more common in the ADHD than non-ADHD group (21.6% vs. 1.6%) even after controlling for covariates and comorbid anxiety, mood, and disruptive behavior diagnoses (i.e., ODD and CD; Cox and Snell $R^2 = 0.072$, $\beta = 0.076$, $p = .003$), suggesting a specific association with ADHD, despite the prior literature linking EE to externalizing symptomology. ADHD and non-ADHD children did not differ with respect to stable high emotional overinvolvement ($p = .51$).

ADHD and ODD Symptom Trajectories: Preliminary Results

Change in symptoms over time were modeled in six separate analyses (parent- and teacher-rated inattention, hyperactivity, and ODD symptoms) using age-based growth models. Quadratic models did not converge and indicated model misspecification. Linear growth models provided good fit for parent-rated inattention (Adjusted BIC = 3,229.9, RMSEA = 0.04, CFI = 0.95), H/I (Adjusted BIC =

Table 1

Descriptive, Diagnostic, and Cross-Sectional Parental-Expressed Emotion Statistics for ADHD and Control Groups in the Sample of Children With Parental-Expressed Emotion Data at One or More Time Points

Variable	Control (<i>n</i> = 127)	ADHD (<i>n</i> = 388)	<i>p</i>	<i>ES</i>
Demographic data (at Time 1)				
Age at Time 1 (<i>M, SD</i>)	104.5 (14.2)	114.4 (18.2)	<.001	.06
% Male	47.7%	69.2%	<.001	.20
Race (% White)	80.6%	78.7%	.617	.02
Income (\$K; <i>M, SD</i>)	89.3 (25.7)	80.0 (26.9)	.334	.01
% Two-parent homes	87.7%	75.5%	<.001	.18
% Prescribed stimulant	.0%	52.6%	<.001	.43
FSIQ estimate (<i>M, SD</i>)	115.7 (12.2)	108.2 (14.3)	<.001	.06
Parent-rated ADHD and ODD symptoms^a (<i>M, SD</i>)				
Time 1				
Hyperactive symptoms	.3 (.8)	4.4 (2.9)	<.001	.36
Inattentive symptoms	.3 (.9)	5.9 (2.7)	<.001	.55
ODD symptoms	.2 (.9)	1.5 (1.9)	<.001	.10
Time 2				
Hyperactive symptoms	.3 (.9)	3.8 (2.9)	<.001	.32
Inattentive symptoms	.2 (.9)	5.1 (2.9)	<.001	.46
ODD symptoms	.3 (.8)	1.2 (1.8)	<.001	.09
Time 3				
Hyperactive symptoms	.2 (.8)	3.3 (2.9)	<.001	.28
Inattentive symptoms	.1 (.7)	4.9 (3.1)	<.001	.45
ODD symptoms	.2 (.9)	1.2 (1.7)	<.001	.10
Teacher-rated symptoms (<i>M, SD</i>)				
Time 1				
Hyperactive symptoms	.1 (.4)	3.4 (2.9)	<.001	.27
Inattentive symptoms	1 (.3)	4.7 (3.0)	<.001	.40
ODD symptoms	.0 (.1)	1.3 (2.2)	<.001	.09
Time 2				
Hyperactive symptoms	.4 (1.1)	2.9 (2.9)	<.001	.20
Inattentive symptoms	.6 (1.3)	4.0 (3.0)	<.001	.31
ODD symptoms	.0 (.3)	1.0 (1.9)	<.001	.09
Time 3				
Hyperactive symptoms	.4 (1.0)	2.8 (2.8)	<.001	.22
Inattentive symptoms	.8 (1.7)	3.6 (3.2)	<.001	.22
ODD symptoms	.1 (.6)	.7 (1.4)	<.001	.06
Comorbid disorders^b (%; via diagnostic team)				
Time 1				
Mood disorder (lifetime)	1.2%	7.80%	.004	.14
Anxiety disorder	8.8%	17.6%	.014	.12
ODD or CD	.6%	21.1%	<.001	.29
Learning disorder	.6%	1.6%	.653	.04
Time 2				
Mood disorder (lifetime)	1.5%	5.7%	.089	.10
Anxiety disorder	6.7%	22.6%	<.001	.21
ODD or CD	2.2%	20.8%	<.001	.20
Learning disorder	2.2%	5.2%	.263	.07
Time 3				
Mood disorder (lifetime)	.0%	4.1%	.060	.15
Anxiety disorder	5.8%	16.5%	.013	.17
ODD or CD	3.3%	13.2%	.009	.18
Learning disorder	2.5%	7.4%	.029	.16
Parental-expressed emotion for participants with data at two time points (<i>n</i> = 335)				
	<i>n</i> = 127	<i>n</i> = 208		
Time 1				
EE high	23.2%	50.5%	<.001	.27
Crit high	13.6%	40.4%	<.001	.28
EOI high	11.2%	13.9%	.470	.04
Time 2				
EE high	14.4%	45.7%	<.001	.32

Variable	Control (<i>n</i> = 127)	ADHD (<i>n</i> = 388)	<i>p</i>	<i>ES</i>
Crit high	10.4%	36.1%	<.001	.28
EOI high	4.0%	13.5%	.005	.15

Note. ADHD = attention-deficit/hyperactivity disorder; *ES* = effect size (η_p^2 , except for Child Sex, Race, % Two-parent homes, % Prescribed stimulant, ADHD presentation, Comorbid diagnosis, and EE variables, which are all ϕ); FSIQ = Full-Scale IQ (estimated) from Wechsler Intelligence Scales for Children, fourth edition; ODD = oppositional-defiant disorder; CD = conduct disorder; EE = parental expressed emotion from coding of the Five-Minute Speech Sample; Crit = parental criticism rating from expressed emotion coding of the Five-Minute Speech Sample; EOI = parental emotional overinvolvement rating from expressed emotion coding of the Five-Minute Speech Sample. All data from Time 1 unless otherwise indicated.

^a Parent-rated hyperactive and inattentive symptoms and all teacher-rated symptoms from ADHD-Rating Scale and parent-rated ODD symptoms from the Kiddie Schedule for Affective Disorders and Schizophrenia. ^b 0% of the sample had autism, eating disorders, learning disorders, posttraumatic stress disorder, psychosis, or substance use disorders.

3,840.4, RMSEA = 0.04, CFI = 0.97), and ODD (Adjusted BIC = 3,100.1, RMSEA = 0.05, CFI = 0.92) with similar results for teacher-rated inattention (Adjusted BIC = 3,579.7, RMSEA = 0.03, CFI = 0.90), H/I (Adjusted BIC = 3,454.6 RMSEA = .01, CFI = 0.99), and ODD (Adjusted BIC = 2,898.1, RMSEA = 0.03, CFI = 0.95).

Linear decreases with age were observed for parent-rated inattention (intercept = 5.68, $p < .001$; slope = -0.39 , $p < .001$) and H/I (intercept = 4.37, $p < .001$; slope = -0.47 , $p < .001$), with marginally significant decreases in ODD (intercept = 1.37, $p < .001$; slope = -0.08 , $p = .057$) across the 7–13 year age range. Similar decreases were observed for teacher-rated inattention (intercept = 4.51, $p < .001$; slope = -0.43 , $p < .001$), H/I (intercept = 3.36, $p < .001$; slope = -0.46 , $p < .001$), and ODD (intercept = 1.17, $p < .001$; slope = -0.13 , $p = .006$).

Variability around the intercept was significant for all symptom domains and all reporters (all $p < .001$), capturing initial heterogeneity in symptom severity. Variability in slope, however, failed to meet our criterion for further analysis for parent-rated inattention ($p = .52$) or ODD ($p = .87$) or for teacher-rated H/I ($p = .99$); but met our criterion for parent-rated H/I ($p = .12$) and teacher-rated inattention ($p = .02$) and ODD ($p = .11$), warranting examination of individual differences in trajectories for those measures.

Primary Symptom Trajectory Findings

Parent-rated hyperactivity-impulsivity (H/I). For parent-rated H/I, the unconditional model yielded a best-fitting four-trajectory solution (four-class model: Adjusted BIC = 3,775.2, parametric bootstrapped LRT test for three vs. four classes, $p < .001$; five-class model: Adjusted BIC = 3,831.5, parametric bootstrapped LRT test for four vs. five classes, $p > .05$). These classes are depicted in Figure 1. They were labeled as (a) low H/I (hereafter, low), (b) moderate H/I decreasing (hereafter, moderate), (c) remitting (high symptoms but improving), and (d) persistent (high symptoms and remained high). In order to present results concisely, data is provided by symptom trajectory class by parent-rated H/I, teacher-rated inattention, and teacher-rated ODD in Tables 2–4, respectively, along with significant demographic and

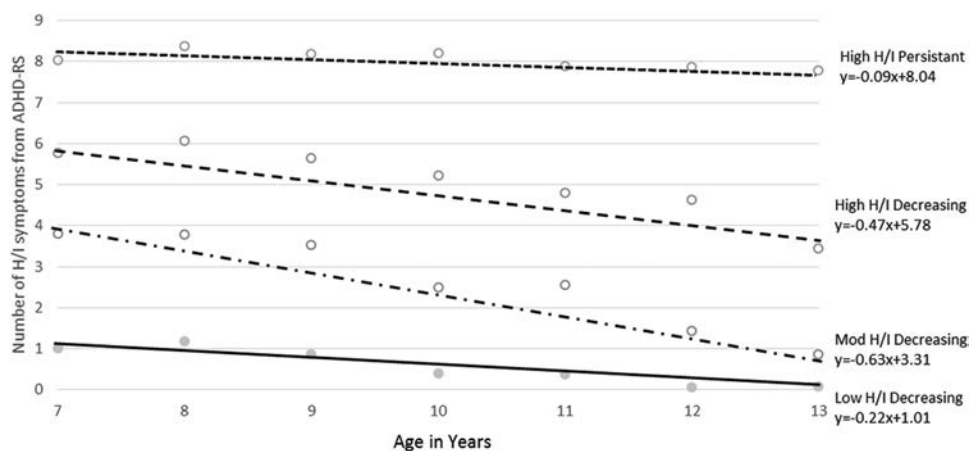


Figure 1. Change in parent-rated hyperactive/impulsive (H/I) symptoms numbers according to latent-class growth analysis (LCGA) class across 7–13 years of age. Parent-rated H/I trajectory classes with mean symptoms of H/I presented according to age in years, including Class 1: Low H/I ($n = 96$, 25%; average posterior probability = 0.83; intercept estimate = 1.01, $SE = 0.31$, $p < .001$; slope estimate = -0.22 , $SE = 0.10$, $p = .033$), Class 2: Moderate H/I decreasing ($n = 101$, 26.0%; average posterior probability = 0.74; intercept estimate = 3.34, $SE = 0.67$, $p < .001$; slope estimate = -0.63 , $SE = 0.17$, $p < .001$), Class 3: High H/I decreasing ($n = 123$, 31.7%; average posterior probability = 0.85; intercept estimate = 5.73, $SE = 0.21$, $p < .001$; slope estimate = -0.46 , $SE = 0.09$, $p < .001$), Class 4: High H/I persistent ($n = 68$, 17.5%; average posterior probability = 0.87; intercept estimate = 8.04, $SE = 0.19$, $p < .001$; slope estimate = -0.09 , $SE = 0.10$, $p = .336$). ADHD = attention-deficit/hyperactivity disorder; ADHD-RS = ADHD Rating Scale. See the online article for the color version of this figure.

comorbid diagnostic data, while demographic and comorbid diagnostics that did not differ significantly by trajectory group is available in online supplemental Tables S1–S3. Thus, symptom trajectories and significant descriptive and diagnostic group differences are in Table 2 with nonsignificant differences in Table S1.

Teacher-rated inattention. Here, the unconditional model yielded a best-fitting three-trajectory solution (three-class model: Adjusted BIC = 3,535.6, parametric bootstrapped LRT test for two vs. three classes, $p < .001$; four-class model: Adjusted BIC = 3,782.1, parametric bootstrapped LRT test for three vs. four classes, $p > .05$). This solution is depicted in Figure 2, and the classes were labeled as (a) low inattention (hereafter, low), (b) remitting, and (c) persistent. Symptom trajectories and significant descriptive and diagnostic group differences are in Table 3 with nonsignificant differences in Table S2.

Teacher-rated ODD. Again, a best-fitting three-trajectory solution emerged (three-class model: Adjusted BIC = 2,624.5, parametric bootstrapped LRT test for two vs. three classes, $p < .001$; four-class model: Adjusted BIC = 3,782.1, parametric bootstrapped LRT test for three vs. four classes, $p > .05$). These are depicted in Figure 3. They were accordingly labeled as (a) low ODD, (b) remitting, and (c) worsening (high symptoms and worsened over time). Symptom trajectories and significant descriptive and diagnostic group differences are in Table 4 with nonsignificant differences in Table S3.

Comparison of solutions. Teacher-rated inattention trajectories did not significantly overlap with either the parent-rated H/I ($p = .645$) or teacher-rated ODD ($p = .211$) trajectory classes, suggesting that these are distinct groups of children as rated by both parents and teachers, rather than the same groups being captured three ways. However, there was significant overlap be-

tween parent-rated H/I and teacher-rated ODD trajectory classes, $\chi^2(1) = 19.99$, $p = .003$. This overlap in turn was driven by a group of children ($N = 170$, 43.8%) who both reporters identified as relatively low in externalizing symptoms. Thus, associations of EE may be distinct with ADHD versus ODD trajectories. We next examined that possibility.

Parental Expressed Emotion Domain Stability and Change

Parent-rated H/I groups and parent EE. LCGA including covariates was used to test associations of the H/I trajectory groups with parental *criticism* coded as stable or not stable (see Method). Class 1 (low), Class 2 (moderate), and Class 3 (remitting) were similar to each other (all $p > .55$), but each differed from Class 4 (persistent), which was more likely to be coded as stable high criticism; respective parameter estimate versus Class 4 were 0.561, $SE = 0.233$, $p = .016$, parameter estimate = 0.763, $SE = 0.280$, $p = .009$, and parameter estimate = 0.631, $SE = 0.220$, $p = .012$, respectively, sample-size adjusted BIC = 2,504.13. In contrast, the dummy code for “ever high” criticism (i.e., at Time Point 1 or 2 instead of 1 and 2) failed to detect group effects (all $p > .12$). Thus, it was not the mere presence of parental criticism at either time point that accounted for differences in persistence versus decreasing symptoms of parent-rated H/I, but rather *stability* in criticism across time. With respect to *emotional overinvolvement*, no differences were observed at any time point (all $p > .43$) or with respect to stability (all $p > .24$) for any of the H/I trajectory groups. This suggests that the overall EE effect is due to parental criticism rather than overinvolvement.

Table 2

Significant Trajectory, Descriptive, Diagnostic, and Cross-Sectional Parental-Expressed Emotion Domain Statistics for Parent-Rated H/I LCGA Groups in the Full Sample

Variable	ADHD H/I 1: Low (<i>n</i> = 96)	ADHD H/I 2: Moderate (<i>n</i> = 101)	ADHD H/I 3: Remitting (<i>n</i> = 123)	ADHD H/I 4: Persistent (<i>n</i> = 68)	<i>p</i>	<i>ES</i>
Trajectory information						
Intercept (estimate, <i>SE</i>)	1.0, .3 ⁺	3.3, .7 ⁺	5.7, .2 ⁺	8.0, .2 ⁺	—	—
Slope (estimate, <i>SE</i>)	-.2, .1 ⁺	-.6, -.2 ⁺	-.5, .1 ⁺	-.1, .1	—	—
Posterior probability	.8	.7	.9	.9		
Demographic data (at Time 1)						
% Prescription stimulant	26.0%	28.7%	51.2%	72.1%	<.001	.35
ADHD subtype/presentation (at Time 1)						
Inattentive	69.8%	27.7%	4.9%	1.5%		
Combined	30.2%	72.3%	95.1%	98.5%		
Parent-rated ADHD and ODD symptoms ^a (<i>M</i> , <i>SD</i>)						
Time 1						
Hyperactive symptoms	.9 (1.1)	3.4 (1.6)	5.8 (1.6)	8.0 (1.3)	<.001	.75
Inattentive symptoms	4.7 (2.8)	5.6 (2.6)	6.1 (2.6)	7.6 (2.0)	<.001	.12
ODD symptoms	.6 (1.1)	1.1 (1.4)	1.8 (2.0)	2.8 (2.4)	<.001	.16
Time 2						
Hyperactive symptoms	.7 (.9)	2.7 (1.5)	5.2 (1.6)	7.9 (1.5)	<.001	.76
Inattentive symptoms	3.6 (2.9)	4.8 (2.5)	5.8 (2.8)	6.9 (2.5)	<.001	.15
ODD symptoms	.7 (1.5)	.8 (1.2)	1.7 (1.9)	2.2 (2.3)	<.001	.10
Time 3						
Hyperactive symptoms	.5 (1.8)	1.9 (1.5)	4.8 (1.8)	7.5 (1.8)	<.001	.71
Inattentive symptoms	3.1 (3.0)	4.4 (2.9)	5.9 (2.8)	7.1 (2.4)	<.001	.19
ODD symptoms	.5 (1.2)	.8 (1.4)	1.6 (1.8)	2.0 (2.2)	<.001	.10
Teacher-rated symptoms (<i>M</i> , <i>SD</i>)						
Time 1						
Hyperactive symptoms	2.4 (2.8)	3.2 (2.8)	3.9 (2.9)	4.1 (2.9)	<.001	.06
Inattentive symptoms	4.9 (2.8)	5.2 (3.0)	4.2 (3.1)	4.7 (3.2)	.075	.02
ODD symptoms	.7 (1.7)	1.0 (1.7)	1.7 (2.5)	1.8 (2.4)	.001	.05
Time 2						
Hyperactive symptoms	1.6 (2.3)	3.1 (3.1)	3.5 (3.0)	3.8 (2.9)	.002	.07
Inattentive symptoms	3.5 (3.1)	4.2 (3.1)	4.2 (2.9)	4.5 (2.9)	.459	.01
ODD symptoms	.4 (.9)	.9 (1.6)	1.6 (2.4)	1.2 (2.1)	.009	.06
Time 3						
Hyperactive symptoms	1.6 (2.6)	2.3 (2.5)	3.2 (2.7)	3.7 (3.3)	.002	.10
Inattentive symptoms	3.2 (3.3)	3.6 (3.4)	4.1 (2.9)	3.6 (3.4)	.501	.02
ODD symptoms	.2 (.7)	.7 (1.3)	1.1 (1.7)	.6 (1.2)	.023	.07
Comorbid disorders (%; via diagnostic team)						
Time 1						
ODD or CD	5.2%	9.9%	26.0%	41.2%	<.001	.33
Parental expressed emotion for participants with data at two time points (<i>n</i> = 208)						
	<i>n</i> = 49	<i>n</i> = 53	<i>n</i> = 72	<i>n</i> = 34		
Time 1						
Crit high	36.7% [†]	27.8% [†]	40.8% ^{†,‡}	66.7% [‡]	.004	.25
EOI high	9.1%	11.1%	14.1%	20.4%	.439	.11
Time 2						
Crit high	15.6%	18.8%	19.5%	25.0%	.519	.08
EOI high	5.2%	7.9%	6.5%	10.3%	.635	.07

Note. H/I = hyperactivity/impulsivity; LCGA = latent-class growth analysis; ADHD = attention-deficit/hyperactivity disorder; *ES* = effect size (η_p^2 , except for % Prescription stimulant, ADHD presentation, Comorbid diagnosis, and expressed emotion variables, which are all ϕ); ODD = oppositional-defiant disorder; CD = conduct disorder; Crit = parental criticism rating from expressed emotion coding of the Five-Minute Speech Sample; EOI = parental emotional overinvolvement rating from expressed emotion coding of the Five-Minute Speech Sample. All data from Time 1 unless otherwise indicated. *p* values are for significant pairwise comparisons in ANOVA for continuous and chi-square for categorical variables with EE follow-up comparisons significance represented by differing superscripts at $p < .05$.

^a Parent-rated hyperactive and inattentive symptoms and all teacher-rated symptoms from ADHD-Rating Scale and parent-rated ODD symptoms from the Kiddie Schedule for Affective Disorders and Schizophrenia.

[†] Significance for intercepts and slopes of the relevant groups.

Although the preceding was interesting, it could be because of negative halo effects by parents who experience negative affect and see their child as highly hyperactive also. To evaluate this we looked at teacher data two ways. First, parent H/I groups were compared on teacher rated H/I (recall that these were not able to be

divided into trajectories by teacher-rating). This analysis confirmed the parent-based results: parent-rated H/I trajectory classes significantly differed on teacher-rated H/I symptoms with changes in the anticipated directions based on trajectory classes (all $p < .002$) and ratings over time were also similar (details are presented

Table 3

Significant Trajectory, Descriptive, Diagnostic, and Cross-Sectional Parental Expressed Emotion Domain Statistics for Teacher-Rated Inattention LCGA Groups in the Full Sample

Variable	ADHD A 1 Low (n = 227)	ADHD A 2 Remitting (n = 70)	ADHD A 3 Persistent (n = 84)	p	ES
Trajectory information					
Intercept (estimate, SE)	2.8, .2 ⁺	6.7, .2 ⁺	6.6, .3 ⁺	—	—
Slope (estimate, SE)	-.5, .1 ⁺	-.6, .3 ⁺	.3, .2	—	—
Posterior probability	.9	.6	.6	—	—
Demographic data (at Time 1)					
Age (M, SD)	114.2 (18.5)	108.6 (17.3)	119.4 (17.5)	.001	.04
% Male	62.6%	78.6%	81.0%	.001	.19
Income (\$K; M, SD)	87.5 (21.4)	83.3 (21.1)	76.8 (23.2)	.028	.02
FSIQ estimate (M, SD)	109.9 (13.6)	106.7 (15.2)	104.9 (14.5)	.015	.02
ADHD subtype/presentation (at Time 1)					
Inattentive	29.5%	20.0%	22.6%		
Combined	71.6%	80.0%	77.4%		
Parent-rated ADHD and ODD symptoms ^a (M, SD)					
Time 1					
Hyperactive symptoms	4.2 (2.8)	4.5 (2.9)	4.7 (2.9)	.318	.01
Inattentive symptoms	5.4 (2.8)	6.4 (2.4)	6.5 (2.6)	.002	.03
ODD symptoms	1.4 (1.7)	1.5 (2.1)	1.7 (2.2)	.370	.01
Time 2					
Hyperactive symptoms	3.7 (2.9)	4.2 (2.8)	3.6 (2.9)	.454	.01
Inattentive symptoms	4.7 (3.0)	5.6 (2.7)	5.7 (2.7)	.024	.03
ODD symptoms	1.1 (1.7)	1.3 (1.7)	1.8 (2.1)	.057	.02
Time 3					
Hyperactive symptoms	3.3 (2.9)	3.6 (3.0)	3.1 (3.0)	.069	.01
Inattentive symptoms	4.3 (3.2)	6.0 (2.7)	5.7 (3.0)	.001	.06
ODD symptoms	1.0 (1.6)	1.2 (2.0)	1.5 (1.8)	.336	.01
Teacher-rated symptoms (M, SD)					
Time 1					
Hyperactive symptoms	2.8 (2.7)	5.1 (3.1)	3.7 (2.8)	<.001	.09
Inattentive symptoms	3.1 (2.5)	7.7 (1.7)	6.5 (2.1)	<.001	.45
ODD symptoms	.9 (1.8)	2.1 (2.8)	1.5 (2.3)	<.001	.45
Time 2					
Hyperactive symptoms	1.7 (2.3)	4.0 (3.1)	5.1 (2.9)	<.001	.23
Inattentive symptoms	2.3 (2.2)	6.1 (2.3)	6.9 (1.8)	<.001	.49
ODD symptoms	.6 (1.4)	1.9 (2.3)	1.4 (2.1)	<.001	.08
Time 3					
Hyperactive symptoms	2.1 (2.5)	3.6 (3.0)	4.2 (2.9)	<.001	.11
Inattentive symptoms	1.5 (1.7)	6.0 (2.4)	7.6 (1.7)	<.001	.67
ODD symptoms	.4 (1.1)	1.2 (1.8)	1.1 (1.4)	.004	.08
Parental expressed emotion for participants with data at two time points (n = 208)					
	n = 122	n = 38	n = 48		
Time 1					
⁴ Crit high	39.7%	47.6%	35.9%	.533	.08
⁵ EOI high	15.1%	11.9%	12.8%	.852	.04
Time 2					
Crit high	19.8%	21.4%	17.9%	.854	.03
EOI high	6.2%	12.9%	6.0%	.148	.10

Note. LCGA = latent-class growth analysis; ADHD = attention-deficit/hyperactivity disorder; ES = effect size (η_p^2 , except for % Male, ADHD presentation, and expressed emotion variables, which are all ϕ); FSIQ = Full-Scale IQ (estimated) from Wechsler Intelligence Scales for Children, fourth edition; ODD = oppositional-defiant disorder; Crit = parental criticism rating from expressed emotion coding of the Five-Minute Speech Sample; EOI = parental emotional overinvolvement rating from expressed emotion coding of the Five-Minute Speech Sample. All data from Time 1 unless otherwise indicated.

^a Parent-rated hyperactive and inattentive symptoms and all teacher-rated symptoms from ADHD-Rating Scale and parent-rated ODD symptoms from the Kiddie Schedule for Affective Disorders and Schizophrenia.

⁺ Significance for intercepts and slopes of the relevant groups.

in Table 2). The second check was we examined the parent EE measure in relation to teacher-rated dimensional symptoms of hyperactivity. The result was also confirmatory. Stable high parental criticism was associated with more teacher-rated H/I symptoms at all assessment points (all $p < .05$).

Teacher-rated inattention groups and parental EE. Next, we examined teacher-rated inattention trajectory classes. These did not differ in any respect with regard to parent high EE criticism at either time point or criticism stability, overinvolvement at either time point, or overinvolvement stability (all $p > .3$; see details in Table 3).

Table 4

Significant Trajectory, Descriptive, Diagnostic, and Cross-Sectional Parental Expressed Emotion Domain Statistics for Teacher-Report ODD LCGA Groups in the Full Sample

Variable	ODD 1 Low (<i>n</i> = 312)	ODD 2 Remitting (<i>n</i> = 18)	ODD 3 Worsening (<i>n</i> = 51)	<i>p</i>	<i>ES</i>
Trajectory information					
Intercept (estimate, <i>SE</i>)	.4, .1 ⁺	4.9, .3 ⁺	4.0, .2 ⁺	—	—
Slope (estimate, <i>SE</i>)	.0, .0	-2.0, .4 ⁺	.3, .1 ⁺	—	—
Posterior probability	1.0	.7	.9	—	—
Demographic data					
Income (\$K; <i>M</i> , <i>SD</i>)	88.1 (23.2)	85.3 (25.1)	80.0 (28.1)	.009	.07
FSIQ estimate (<i>M</i> , <i>SD</i>)	108.5 (13.7)	115.0 (12.2)	104.2 (16.9)	.016	.02
ADHD subtype/presentation					
Inattentive	29.8%	.0%	13.7%		
Combined	70.2%	100.0%	86.3%		
Parent-rated ADHD and ODD symptoms ^a (<i>M</i> , <i>SD</i>)					
Time 1					
Hyperactive symptoms	4.1 (2.9)	6.0 (2.0)	5.6 (2.7)	.001	.05
Inattentive symptoms	5.8 (2.7)	6.1 (3.0)	6.1 (2.7)	.682	.00
ODD symptoms	1.3 (1.8)	1.8 (1.9)	2.6 (2.3)	.001	.06
Time 2					
Hyperactive symptoms	3.5 (2.8)	4.7 (2.5)	5.1 (2.6)	.003	.04
Inattentive symptoms	5.0 (3.0)	5.1 (3.3)	5.6 (2.7)	.582	.00
ODD symptoms	1.1 (1.6)	1.6 (2.0)	2.3 (2.3)	.001	.06
Time 3					
Hyperactive symptoms	3.1 (2.9)	3.8 (2.3)	4.4 (3.2)	.041	.03
Inattentive symptoms	4.8 (3.1)	4.2 (3.3)	5.8 (3.3)	.163	.02
ODD symptoms	.9 (1.5)	1.1 (1.6)	2.7 (2.2)	.001	.10
Teacher-rated symptoms (<i>M</i> , <i>SD</i>)					
Time 1					
Hyperactive symptoms	2.9 (2.8)	7.2 (1.9)	5.2 (2.6)	.001	.15
Inattentive symptoms	4.4 (3.0)	5.9 (2.8)	5.7 (2.8)	.006	.03
ODD symptoms	.4 (1.0)	7.1 (1.2)	4.3 (2.0)	.001	.75
Time 2					
Hyperactive symptoms	2.5 (2.8)	4.9 (2.5)	4.6 (3.3)	.001	.09
Inattentive symptoms	3.7 (2.9)	5.8 (3.0)	5.1 (3.1)	.013	.04
ODD symptoms	.5 (1.2)	3.5 (3.0)	3.5 (2.2)	.001	.39
Time 3					
Hyperactive symptoms	2.4 (2.7)	4.7 (2.4)	5.2 (2.8)	.001	.12
ODD symptoms	.4 (1.0)	1.1 (1.0)	3.0 (2.2)	.001	.27
Comorbid disorders (%; via diagnostic team)					
Time 1					
DBDs (CD, ODD)	13.8%	38.9%	43.1%	.001	.27
Parental expressed emotion for participants with data at two time points (<i>n</i> = 208)					
	<i>n</i> = 169	<i>n</i> = 15	<i>n</i> = 24		
Time 1					
Crit high	36.7%	35.7%	70.8%	.006	.23
EOI high	14.3%	13.0%	20.8%	.587	.07
Time 2					
Crit high	19.2%	16.7%	23.5%	.733	.04
EOI high	6.1%	16.7%	11.8%	.106	.11

Note. ODD = oppositional-defiant disorder; LCGA = latent-class growth analysis; *ES* = effect size (η_p^2 , except for ADHD presentation, comorbid diagnosis, and expressed emotion variables, which are all ϕ); FSIQ = Full-Scale IQ (estimated) from Wechsler Intelligence Scales for Children, fourth edition; ADHD = attention-deficit/hyperactivity disorder; DBDs = disruptive behavior disorders; CD = conduct disorders; Crit = parental criticism rating from expressed emotion coding of the Five-Minute Speech Sample; EOI = parental emotional overinvolvement rating from expressed emotion coding of the Five-Minute Speech Sample. All data from Time 1 unless otherwise indicated.

^a Parent-rated hyperactive and inattentive symptoms and all teacher-rated symptoms from ADHD-Rating Scale and parent-rated ODD symptoms from the Kiddie Schedule for Affective Disorders and Schizophrenia.

⁺ Significance for intercepts and slopes of the relevant groups.

Teacher-rated ODD groups and parental EE. Lastly, we examined teacher-rated ODD trajectory classes. Teacher-rated ODD trajectory classes did not differ with respect to parent criticism stability (all $p > .12$), sample-size adjusted BIC = 1,785.077. However, when looking at “ever critical,” Class 1 (low) and Class 2 (remitting) were similar to each other ($p = .52$), but both differed

from Class 3 (worsening), which was more likely to be coded as ever critical; parameter estimate = 1.115, $SE = 0.386$, $p = .004$ and parameter estimate = 1.352, $SE = 0.5$, $p = .010$, respectively, sample-size adjusted BIC = 1,774.97. Specifically, teacher-rated worsening ODD was significantly associated with parental criticism at Time 1, but not at Time 2 (see Table 4). No teacher-

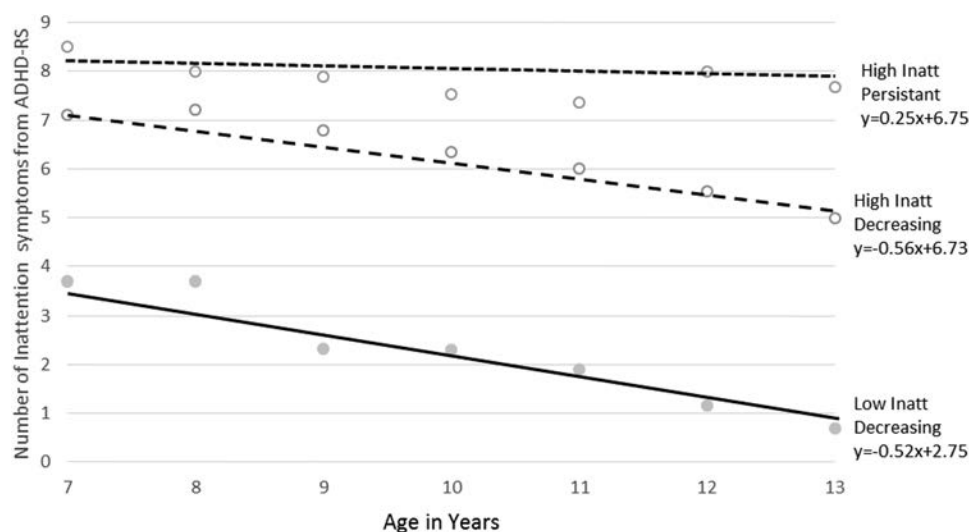


Figure 2. Change in teacher-rated inattention (Inatt) symptoms numbers according to latent-class growth analysis (LCGA) class across 7–13 years of age. Teacher-rated inattention trajectory classes with mean symptoms of inattention presented according to age in years, including Class 1: Low inattention decreasing ($n = 227$, 59.6%; average posterior probability = 0.94; intercept estimate = 2.76, $SE = 0.24$, $p < .001$; slope estimate = -0.53 , $SE = 0.07$, $p < .001$), Class 2: High inattention decreasing ($n = 70$, 18.4%; average posterior probability = 0.57; intercept estimate = 6.74, $SE = 0.17$, $p < .001$; slope estimate = -0.56 , $SE = 0.27$, $p = .028$), and Class 3: High inattention persistent ($n = 84$, 23%; average posterior probability = 0.59; intercept estimate = 6.58, $SE = 0.32$, $p < .001$; slope estimate = 0.25, $SE = 0.15$, $p = .095$). ADHD = attention-deficit/hyperactivity disorder; ADHD-RS = ADHD Rating Scale. See the online article for the color version of this figure.

reported ODD trajectory based group differences were observed with respect to emotional overinvolvement at Time 1, Time 2, or stability over time (all $p > .33$).

Again, we checked results across rater. This confirmed that those in the teacher-rated ODD low, remitting, and worsening groups significantly different parent-rated ODD symptoms (all $p < .001$) with the worsening group having the highest numbers of symptoms and the low group having the lowest number of symptoms at all time points (see Table 4). Furthermore, high parental criticism was associated with more parent-rated ODD symptoms at all assessment points (all $p < .05$). Thus, it appears that the effects of parental criticism held across raters as well.

Discussion

The variable developmental course in ADHD is a central phenomenon to be better understood. Developmental course and severity is likely involved in a bidirectional influence with family characteristics including emotional tone of the home. It is possible both that parental criticism influences children's behavior problems, as well as the reverse. Parental EE is one important index of the family emotional environment. The present report undertook the first empirical examination of whether the parental EE domains of criticism and emotional overinvolvement are related to differential course of ADHD in a longitudinal design. The observed normative decreases in inattention, H/I, and ODD symptoms with age observed in our trajectory analyses were in line with prior studies (Biederman et al., 1996; Sibley et al., 2012), although

variation in this pattern has only been notable in the H/I domain in most studies, most of which have relied on parent report.

Also in line with prior studies, children with ADHD were more likely than their typically developing peers to have parents with high parental criticism as well as stable high criticism over time. Of note, this effect remained even after controlling for oppositional defiant disorder, suggesting a unique association between ADHD and a harsh, critical family environment.

The novel finding here, however, is that children with ADHD whose families expressed stable, high criticism violated the normative decline in symptoms and had persistent high ADHD H/I symptoms. Again, and crucially, this effect held with ODD covaried. Further, teacher ratings of H/I symptoms showed the same pattern of association with parental criticism as the parent ratings, suggesting that the observed results are not likely due to parent halo effects. Taken together, results suggest that family environment, and particularly parental criticism, is not only associated with oppositional/aggressive behavior, but is also uniquely associated with ADHD symptoms, particularly when patterns of parental criticism remain stable over time.

We observed four empirical trajectories of parent-rated H/I symptoms across the 7- to 13-year-old period. One of these had consistent low H/I and, unsurprisingly, overlapped with the ADHD inattentive subtype/presentation. The children with substantial H/I fell into three additional trajectories. Of these, one was fairly mild and moving toward true "recovery." Another was more severe, but also showed a normative trajectory toward symptom reduction over time. Crucially, one group failed to show the normative

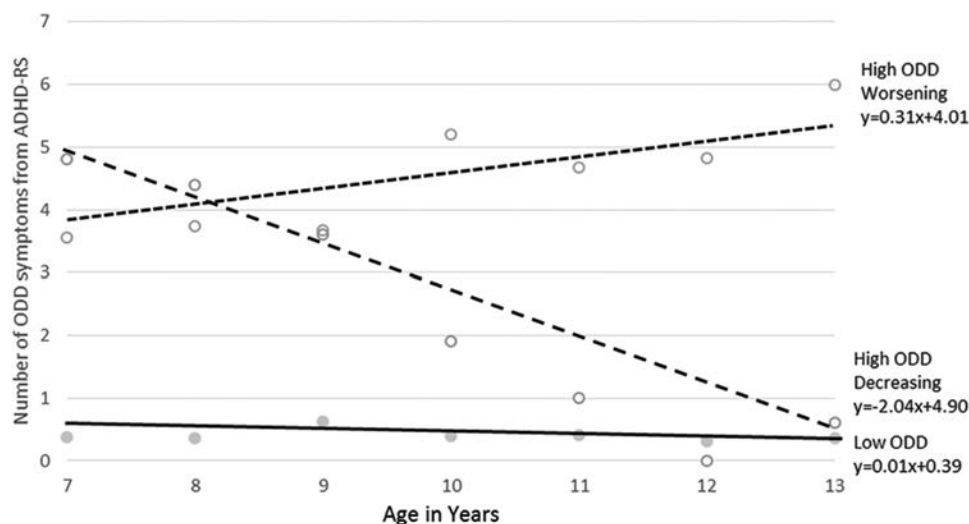


Figure 3. Change in teacher-rated oppositional-defiant disorder (ODD) symptoms numbers according to latent-class growth analysis (LCGA) class across 7–13 years of age. Teacher-rated ODD trajectory classes with mean symptoms of ODD presented according to age in years, including Class 1: Low ODD ($n = 312, 81.9\%$; average posterior probability = 0.98; intercept estimate = 0.39, $SE = 0.05, p < .001$; slope estimate = 0.001, $SE = 0.03, p = .996$), Class 2: High ODD decreasing ($n = 18, 4.7\%$; average posterior probability = 0.74; intercept estimate = 4.90, $SE = 0.28, p < .001$; slope estimate = $-2.04, SE = 0.35, p < .001$), and Class 3: High ODD worsening ($n = 51, 13.4\%$; average posterior probability = 0.89; intercept estimate = 4.00, $SE = 0.24, p < .001$; slope estimate = 0.31, $SE = 0.11, p = .005$). ADHD = attention-deficit/hyperactivity disorder; ADHD-RS = ADHD Rating Scale. See the online article for the color version of this figure.

declining pattern (“persistent”). These groups help validate the theory that children with ADHD diverge developmentally into a remitting and persistent pattern with regard to their H/I symptoms. The persistent group was associated with persistently higher parental EE criticism as just noted.

A similar developmental picture emerged for teacher-rated inattention. Again, we saw a group with low symptoms moving toward normalization, a group with significant but improving symptoms, and a group with persistent problems. This further supports differential and complex developmental pathways for ADHD for which different reporters may be differentially sensitive in lawful ways. That is, attention demands are greater at school, whereas structure is reduced at home and multiple difficult transitions are necessary at home (morning, meals, bedtime) that increase chances to observe hyperactivity and impulsivity. Interestingly, persistent EE criticism was not associated with any particular inattention group, suggesting that the effects may be specific to hyperactivity, while something different may be at play for inattention development.

A key question was specificity of effects to ADHD symptoms. To examine this, ODD symptom trajectories were evaluated in the same way. In this case, trajectories were seen again in teacher-rated ODD symptoms. Trajectory groups were low or no ODD, high ODD but remitting, and high ODD with persistent or worsening symptoms. While only this last group was associated with parental EE criticism, this association was somewhat different from that observed in the hyperactivity trajectories. Specifically, the ODD worsening group was more likely to have a parent with high EE criticism at Time 1, but not necessarily at Time 2. Thus, while persistence in hyperactivity over time appears to be associ-

ated with stability in high levels of parental criticism, persistent or worsening ODD symptoms are associated with “mere exposure” such that this behavior may develop early in childhood in the face of parental criticism and remain relatively stable despite changes in parenting behavior over time.

Although direction of effects was not evaluated here, the suggestion that oppositional defiant symptoms are particularly sensitive to parental criticism while H/I symptoms are more dependent on chronicity of parental criticism, opens the door to a more differentiated description of how these overlapping symptoms develop and interrelate.

Because these data do not indicate the direction of effects, different implications can be considered. One possibility is that intervention to reduce high parental criticism could assist children to return to a normatively improving course of development. Alternatively, improving the severe symptoms of this group of children could enable a “virtuous cycle” to emerge in the home in which parental criticism improves along with child symptoms.

It was notable that parental emotional overinvolvement was not uniquely associated with any ADHD or ODD symptom trajectories. This is consistent with prior work that has shown that the emotional overinvolvement domain may be more strongly associated with internalizing symptoms, such as anxiety, while the criticism domain tends to be more strongly associated with the types of externalizing symptoms examined here (Hale et al., 2011).

This study addressed a key “first question,” helping to confirm that ADHD trajectories can be empirically identified, that they are associated significantly with parental high EE criticism, and that this association is distinct from ODD associations with parental EE. To our knowledge, this study is the first of its kind, as it

examined child ADHD and ODD symptoms, as well as parental EE domains longitudinally, using well-validated assessment measures for both constructs, in a well-characterized group of children with ADHD. It extends our knowledge of ADHD developmental course and clarifies its correlation with high parent EE.

The next step now is to evaluate causal direction of these effects, which are likely to be to some extent bidirectional. Fine tuning of causal understanding will require experimental designs (intervention studies), the use of younger (toddler or preschool-aged) samples, and we also plan to undertake sibling analysis and cross-lagged designs in future studies. It may be that high parental criticism emerges as a response to difficult temperament in children at-risk for psychopathology, and then, in a recursive chain, maintains symptoms (Hale et al., 2011).

Despite the strengths of this study, some limitations and necessary next steps should be noted. First, the overall variability around the slope for both parent-rated H/I and teacher-rated ODD was only marginally significant, which presented a potential limitation to identifying trajectories. However, well-fitting models with multiple trajectory classes could be identified, indicating there was adequate variability for modeling distinct trajectory classes. While our sample size with multiple EE assessments was respectable ($N > 200$), it was still too small for a reliable age-based cross-lag model, which would allow for a stronger (though still not definitive) inference about directionality. Thus, a key future direction will be to extend these analyses in a larger sample, which we are now undertaking. Finally, while data suggest that the H/I and ODD results are partially distinct, given that unique children composed these groups and results were similar across raters, rater bias and/or rater effects cannot be entirely ruled out. It may be that the context in which these two raters observe the child influences the way in which they perceive H/I versus ODD related behaviors.

In conclusion, longitudinal findings demonstrate that the emotional climate of the home, as indexed by parental EE, is uniquely associated with developmental course of ADHD and ODD symptoms. This study breaks new ground in linking variability in ADHD developmental course with stability of high parental criticism and variability in ODD course to early exposure to criticism. Further work to understand these associations, in regard to possible impacts of ADHD on families and of families on ADHD, is warranted.

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