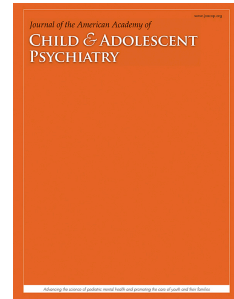


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Predicting the Adult Functional Outcomes of Boys with ADHD 33 Years Later
RH = Functional outcome of ADHD

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Editorial
Clinical Guidance
Supplemental Material

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Abstract

Objective: Little is known of factors that influence the course of childhood attention-deficit/hyperactivity disorder (ADHD). Objectives were to identify early features predictive of the adult outcome of children with ADHD. In the longest prospective follow-up to date of children with ADHD, we examined predictors of multiple functional domains: social, occupational, and overall adjustment, and educational and occupational attainment.

Method: White boys (6-12 years, mean, 8) with ADHD (N=135), selected to be free of conduct disorder, were assessed longitudinally through adulthood (mean age, 41), by clinicians, blind to all previous characteristics. Predictors had been recorded in childhood, and adolescence (mean age, 18).

Results: Childhood IQ was positively associated with several outcomes: educational attainment, occupational rank, social and occupational adjustment. Two other childhood features that had positive associations with adult adjustment were SES and reading ability, which predicted educational attainment. In spite of their low severity, conduct problems in childhood were negatively related to overall function, educational attainment, and occupational functioning.

Among multiple adolescent characteristics, four were significant predictors: antisocial behaviors predicted poorer educational attainment; educational goals were related to better overall function; early job functioning had a positive relationship with social functioning, and early social functioning was positively related to occupational functioning.

Conclusion: Besides childhood IQ, which predicted better outcomes in several domains, there were no consistent prognosticators of adult function among children with ADHD. Providing additional supports to children with relatively lower IQ might improve the adult functional

outcome of children with ADHD. However, predicting the course of children with ADHD remains a challenge.

Keywords: ADHD, follow-up study, functional outcomes, adulthood

ACCEPTED MANUSCRIPT

“Prediction is very difficult, especially about the future.”

Attributed to Niels Bohr

Introduction

Follow-up studies of children with attention-deficit/hyperactivity disorder (ADHD) document relative deficits in multiple functional domains in early adulthood. On average, children with ADHD achieve relatively lower levels of education¹⁻⁹, have poorer social functioning^{3,5,6} and worse occupational outcomes^{3,5-9}. The longest follow-up study of children with ADHD (33 years) found that these deficits persisted well into adulthood (mean age 41): men diagnosed with ADHD in childhood had completed an average of two and a half fewer years of schooling, had lower occupational attainment, and had worse occupational and social functioning scores than their peers who did not have ADHD in childhood³. However, there was variability in the outcome of childhood ADHD, ranging from very poor to benign. The present study examines whether characteristics in the childhood and adolescence of those children are associated with their functioning in adulthood. Identifying early risks for future disability among children with ADHD has significant public health importance, as it has the potential to provide parents information regarding prognosis, identify mechanisms that influence longitudinal course, inform prevention and therapeutic efforts, and support theories about the disorder's developmental trajectory that may inform the disorder's pathophysiology¹⁰.

Table 1 lists the few prospective studies^{6,11-13} that have reported on early (in childhood or adolescence) predictors of adult outcome in children with ADHD. Excluded are longitudinal studies whose first diagnosis of ADHD occurred during adolescence (i.e., beyond age 12), since, by definition, they are enriched for persistent ADHD¹⁴. We also exclude studies that report on

individuals under the age of 21, as they do not provide sufficient time for individuals to reach their educational and occupational potential and do not inform on children's ultimate adjustment in adulthood.

Studies have not consistently identified characteristics that relate to the children's future adjustment. Furthermore, longitudinal studies have not extended beyond young adulthood. In this prospective follow-up of children with ADHD, we aimed to identify childhood and adolescent characteristics that predict functioning at average age 41. Specifically, we examined predictors of educational attainment, occupational rank, and social, occupational, and global functioning. In addition, we aimed to examine whether associations between early characteristics and outcomes varied over time (i.e., whether their strength differed at different developmental points). This was feasible for two outcomes, occupational and social functioning, because these had been systematically assessed at different developmental periods.

Our early assessments of the sample generated voluminous data. From these, we selected, a priori, characteristics in childhood and in adolescence as potential predictors, based on previous studies and clinical judgment. We hypothesized that (+ sign=positive relationship; - sign=negative relationship): parental SES (+), IQ (+), ADHD severity (-), CD/APD problems (-), ODD behaviors (-), aggression (-), immature behavior (-), social functioning (+), school dropout (-), non-alcohol substance use disorder (SUD) (-), and parental psychopathology (-) would be significantly associated with functioning in adulthood (specific functional outcomes are noted in Table 2). We also conjectured that reading competence (+) in childhood, and job functioning and self-reports of educational and occupational goals (+) in adolescence would enhance a child's potential for successful adaptation. The importance of goal setting for task performance has been established¹⁵, but its potential to foster positive functioning in the long run

among individuals with deficits in executive functioning skills, has not been explored. We did not advance specific hypotheses regarding the influence of early predictors on the course of social and occupational functioning over time (beyond an overall association), but explored whether the strength of the associations with those outcomes was similar across time.

Method

Participants

Participants were 207 6 to 12-year-old white boys ($M=8.36\pm 1.63$) of middle and lower-middle class referred by schools to a child psychiatric clinic due to behavior problems. Inclusion criteria were: previous history of behavior problems, elevated teacher and parent ratings of hyperactivity, behavior problems at home and school, verbal $IQ\geq 85$, and English-speaking parents. The children's clinical picture was consonant with the DSM-5 definition of ADHD combined presentation as they had elevated teacher ratings of inattention and hyperactivity/impulsivity symptoms, symptoms were impairing and cross-situational, and they were present before age 12³. Children with neurological, significant medical disorders, psychosis, or conduct disorder were excluded. The presence of an exclusionary pattern of antisocial/aggressive behavior was obtained from parent and teacher reports and a comprehensive psychiatric evaluation with the parent and child^{16,17}.

Three follow-ups were conducted: at mean age 18.1 ± 1.3 (range, 16-22; FU18) ($n=195/207$, 94%)^{16,17}, at mean age= 25.3 ± 1.4 (range, 22-30; FU25) ($n=176/207$, 85%)^{1,2,18}, and in adulthood (mean age= 41.4 ± 2.9 ; range, 30-47; FU41) ($n=135/207$, 65%)^{3,19} (refer to Klein et al.³ for chart depicting the study design and sample attrition). Of the 135 participants at FU41, 126 were interviewed; informant interviews were obtained for the remaining. Twenty two percent of participants met criteria for DSM-IV ADHD at FU41. A matched group of children without

ADHD were recruited at FU18, but they are not relevant to the prediction of course among the ADHD children.

Participants who were assessed did not differ from those who were lost to follow-up in any of the childhood characteristics assessed here, or age at referral³. Participants assessed at FU41 did, however, score higher on ratings of severity of inattention, hyperactivity, and impulsivity in adolescence than those not assessed, and endorsed more antisocial behaviors than those lost to follow-up, but they did not differ in the prevalence of ADHD or any mental disorder.

The study was approved by the Institutional Review Board of the New York University Langone Medical Center. Participants and informants provided informed signed consent.

Measures

Predictors. Predictors were selected step-wise from the large number of measures obtained in childhood and adolescence. First, we identified constructs of interest from the literature. Second, we examined their frequency distributions and eliminated those with low variability (e.g., abnormal findings on clinical neurological exams (130 items) were too scarce to consider any as potential influences on course) or large missing data (e.g., information on parent-child relationship had large amounts of missing data (> 20%)). Third, two experts in ADHD independently selected characteristics they deemed possibly important. Thus, to avoid inflating the risk for Type I errors, predictors represent a subset of measures obtained in childhood and adolescence.

Childhood Characteristics. These have been detailed in previous publications^{20,21}. Briefly, based on a clinical evaluation, psychiatrists rated the child's behavior. IQ was assessed with the full Wechsler Intelligence Scale for Children (WISC)^{22,23} and reading competence with the Wide

Range Achievement Test (WRAT)²⁴. Parents and teachers completed the Conners Rating Scales²⁵. Predictors, described in Table 2, include parents' SES, children's full-scale IQ, reading level, severity of: hyperactivity, inattention, conduct problems, oppositional defiant behavior, eruptive aggression, immature behavior, and social functioning.

Adolescent Characteristics. At FU18, adolescents and their parents were interviewed by trained, doctoral-level psychologists blind to group and antecedent data^{16,17} with a structured clinical diagnostic interview (modified DIS)²⁶, expanded to inquire about friendships, academic performance, work experience and performance, and future goals. Parental psychopathology was assessed through direct or informant interviews using the DIS and the Spouse Interview Schedule (SIS) (99% of mothers and 32% of fathers directly interviewed; informant interviews were obtained on the remaining fathers). Table 2 describes the predictors. We restricted mental disorders as potential predictors only if they were significantly elevated in participants than comparisons at FU18 (e.g., alcohol SUD was excluded as a predictive variable as it was not more frequent among participants than controls at FU18^{16,17}). For intercorrelations among predictors, see Table S1, available online.

Outcomes in Adulthood. Trained clinicians who were blind to all previous data conducted clinical interviews at each follow-up^{1-3,16-18}.

Overall Function. Clinicians rated participants' overall functioning during the past six months using the Global Assessment Scale (GAS)²⁷ (ICCs >.90).

Educational and Occupational Attainment and Function. Educational attainment was defined as years of education. At each follow-up, participants reported details of their occupational history and job functioning. Best job ever held was rated according to Hollingshead and Redlich's²⁸ scale (range, 1 to 8), to ease interpretation of findings, scoring was modified so

that high values reflect higher occupational level (8=higher executives to 1=unemployed, consistent with other FU41 variables). Clinicians rated participants' occupational functioning on a 6-point scale (1=poor, 2=fair, 3=average, 4=good, 5=very good, 6=superior) based on participants' responses to questions about job stability, job problems (e.g., firings, complaints from employer, lateness or absenteeism), and accolades (e.g., promotions, merit-based salary increases), and independently of job ranking.

Social Functioning. At each follow-up, participants were asked about friendships and the frequency in which they socialized, their recent dating history (i.e., presence of a partner(s) and relationship length), and their participation in social activities (e.g., involvement in groups, sports, travel, preference for solitary activities). Qualitative responses were coded by the clinician into quantitative ratings with well-defined response categories (e.g., for friendship history, responses were categorized in a 9-point scale, ranging from 1=at least three close friends seen/spoken with regularly, and known for several years, to 9=no close friends or acquaintances). Clinicians used all the information available to make a global assessment of the participants' degree and quality of interpersonal interactions, using the same 6-point rating as the one used for occupational functioning.

Data Analyses

Linear regressions tested relationships between characteristics in childhood and in adolescence and functional outcomes at FU41 (GAS, educational and occupational attainment). To build these models, we selected predictors whose univariate relationship with outcome reached $p's \leq .10$, to reduce the probability of Type II errors while enforcing parsimony. Predictors were entered hierarchically in two blocks, following a developmental sequence: block one included childhood predictors, and block two, predictors in adolescence (at FU18). We

applied the Benjamini-Hochberg procedure²⁹ within each step in the hierarchical models to account for multiple comparisons. We consider variables for which the association with the outcome yielded a p value $<.05$ but did not retain significance post adjustment ones that are potentially meaningful and warrant future investigation.

Because information on occupational and social functioning was collected systematically at each follow up, we could estimate the association between each predictor and both (a) level of functioning at one point in time (e.g., adulthood), and (b) change over time. We used participants' social and occupational functioning at each follow-up to fit multilevel models²⁷ that examine the relationship between early predictors and trajectories of functioning while taking into account that multiple observations are nested within individuals and are not independent. To examine how social and occupational functioning varied over time, we first fitted an unconditional growth model³⁰ with only "time" as a predictor, representing the timing of assessment. We subsequently entered substantive predictors to test their association with overall level of functioning over time. We also tested for interactions between predictors and time that indicate whether the strength of the associations changed with time.

We examined occupational functioning at three age periods: (a) age 18 to age at FU25, (b) age 25 to age at FU41, and (c) current, at FU41. Therefore, we defined times 1, 2, and 3 as the participant's: (a) midpoint age between age 18 and age at FU25 (mean=21.6±0.7), (b) midpoint age between age 25 and age at FU41 (mean=33.2±1.4), and (c) age at FU41. Social functioning was evaluated for the periods: (a) "during High School" or "since High School," depending on the participant's age, (b) from age 18 to age at FU25, and (c) currently, at FU41.

Results

Sample Description

Mean and median values of predictors are noted in Table 2. As expected, childhood ADHD ratings were elevated ($M=2.3\pm 0.4$, 0-3 scale), and conduct problems were low (0.8 ± 0.4 , 0-3 scale).

At FU41, the average GAS score was 63.5 ± 13.6 (modes=60 and 70), which reflects mild symptoms or some difficulty, but relatively good functioning. Mean years of education was 13.3 ± 2.1 . The average Hollingshead occupational rating for best job ever held was 3.9 ± 1.6 , where 8=higher executives and 1=unemployed. Mean occupational functioning was in the “3=average” to “4=good” range: 3.2 ± 1.2 at age 17, 2.8 ± 1.0 at mean age 25, 3.3 ± 1.3 at mean age 33, and 3.6 ± 1.3 at mean age 41 (modal values=3, 3, 2, and 4, respectively). Average levels of social functioning at FU18, 25, and 41 were: 3.6 ± 1.3 , 2.9 ± 0.7 , and 3.2 ± 1.2 , respectively (modes=4, 3, and 3, respectively).

Predicting Functional Outcomes in Adulthood

Table 3 presents the results for overall function, educational attainment, and occupational ranking.

Overall Function. Conduct problems in childhood were associated with worse overall function in adulthood [$b(SE)=-6.53(2.91)$, $p=.03$]. In contrast, high educational goals in adolescence was associated with better functioning [$b(SE)=3.20(1.16)$, $p=.007$].

Educational Attainment. As expected, higher SES [$b(SE)=0.48(0.20)$, $p<.05$], IQ [$b(SE)=0.06(0.02)$, $p=.002$], and reading achievement [$b(SE)=0.03(0.01)$, $p<.05$] in childhood predicted better educational attainment in adulthood. Conduct problems in childhood were associated with lower ultimate educational attainment [$b(SE)=-0.96(0.48)$, $p<.05$]. Similarly, antisocial behaviors in adolescence predicted low educational attainment [$b(SE)=-0.13(0.04)$, $p=.002$]. No other adolescent characteristic was predictive.

Occupational Ranking. Higher IQ in childhood was the only significant predictor of occupational ranking in adulthood [b(SE)=0.06(0.01), $p<.001$].

Occupational Functioning. Occupational functioning improved slightly over time [b(SE)=0.01(0.01), $p<.05$]; further, childhood IQ was associated with a better trajectory [b(SE)=0.01(0.01), $p<.01$], whereas severity of conduct problems in childhood was associated with lower occupational functioning across time [b(SE)=-0.40(0.18), $p<.05$] (Table 4). Occupational functioning was higher among those with better social functioning in adolescence [b(SE)=0.18(0.06), $p=.002$]. None of the interactions between predictors and occupational functioning were significant (available upon request).

Social Functioning. Across individuals, level of social functioning worsened over time [b(SE)=-0.01(0.01), $p<.05$]. IQ was the only significant childhood predictor of social functioning [b(SE)=0.01(0.01), $p<.05$]: those with higher IQ were more socially adept than those with lower IQ (see Table 4). Job functioning [b(SE)=0.13(0.05), $p=.008$] in adolescence was positively related to social functioning over time. The relationships between predictors and occupational functioning did not vary significantly across time (available upon request).

Discussion

We have previously reported that children with ADHD prospectively followed through adulthood have deficits in multiple domains, relative to non-ADHD peers³. However, outcomes vary substantially, warranting investigation of their early precursors. This study was designed to explain variation in functional outcomes of ADHD among children followed through adulthood (at mean age 41), when participants had reached functional independence. A summary of our findings is presented in Table 5.

Contrary to expectations, we identified very few factors that contributed meaningfully to multiple aspects of adult outcome. This finding is congruent with the extant literature on adult outcome of children with ADHD^{6,11-13,31,32}, which, with the exception of severity of ADHD and comorbid conduct disorder^{31,32}, has not been able to identify many common predictors of later outcome.

In terms of the variety of outcomes predicted, childhood IQ emerged as the most meaningful contributor. It was positively associated with higher educational attainment, occupational ranking, occupational functioning, and social functioning. This relationship is striking insofar as we excluded children with IQ's below 85, indicating the contribution of IQ even within the average range of intellectual functioning. Evidence for the relationship between IQ and functional outcomes has been less equivocal (although significant associations are not always found) than its influence on other outcomes^{6,11,13,31,32}. For example, in the Multimodal Treatment Study of Children with ADHD (MTA), IQ was predictive of several aspects of young adult functioning¹¹, but it was not found to be a meaningful predictor of persistence of ADHD into adulthood³³. It is likely that different characteristics in childhood are relevant for different aspects of adult outcome. Two other features, parental socioeconomic status and child reading level, both correlated with IQ, were also associated with higher educational attainment. These results suggest that childhood ADHD does not interfere with the well-documented concurrent associations among IQ, reading ability, and family SES⁹, nor with their ultimate relationship with attainment.

Conduct problems in childhood were associated with lower levels of overall functioning, lower educational attainment, and lower occupational functioning. Comorbid conduct *disorder* in childhood had been consistently identified as a risk factor for a range of adverse outcomes

among children with ADHD^{31,32}. Our finding in the 5th decade of life extends what Roizen¹³ previously reported in this cohort: even mild conduct problems in childhood had significant associations with overall functioning, educational attainment, and social functioning in young adulthood (mean age, 25). This finding is noteworthy given that, by design, none of the children with ADHD had comorbid conduct disorder. Thus, even low levels of conduct problems place children at risk for maladaptive outcomes later in life. Other prospective studies that did not exclude conduct disorder at recruitment, however, had not identified associations between conduct problems in childhood and adult functioning^{6,12}.

To our knowledge, this study is the first to examine the relevance of a young person's future goals. Adolescents who reported more concrete, positive, educational goals had relatively better overall function. Its association with social functioning and occupational rank was not robust to adjustment for multiple comparisons, however, it shows potential for further examination. It is possible, that other features, especially SES and IQ, could have accounted for the relationship between educational goals and overall function. However, the adolescents' educational goals were not significantly related to IQ, reading level, nor parental SES. Should this relationship be replicated, factors that influence adolescents' vision of their future, an important aspect of development, deserve further study.

The adequacy of job functioning and social functioning during adolescence were related to better adult occupational and social functioning, respectively. It is not surprising that being socially skillful provides an advantage for the quality of occupational adjustment. Because both social and occupational functioning in late adolescence were correlated with educational goals, it is possible that they all reflect overall positive adjustment and mutually reinforce the likelihood

of positive outcomes. However, these associations, though significant, were not strong ($r=.27$ and $.28$, respectively).

Unexpectedly, the severity of ADHD symptoms in childhood was not associated with any of the outcomes examined, despite there being support for their relevance for future outcome^{6,11,32}. Similarly, ADHD symptom severity in adolescence was not significantly related to adult functioning after adjusting for multiple comparisons. This finding is somewhat surprising as others had found significant associations between early ADHD symptom severity and later outcome^{6,11,12}, but even in such studies, associations were often found with some outcomes but not others. The lack of association with outcome here might be related to the long time in between the assessment of ADHD symptoms and outcomes. Hechtman et al.⁹ found that adult functioning 16 years after a childhood diagnosis of ADHD was significantly worse among those for whom ADHD symptoms persisted. At FU41, 33 years after initial assessment, only 22% of adults with ADHD in childhood met criteria for ADHD³. It is possible then, that persistence of ADHD symptoms beyond adolescence is a more meaningful indicator of adult outcome than early ADHD symptoms, especially considering the variability in course of ADHD into adulthood³².

Our findings have clinical implications, and point to areas for future research. Difficulties identifying early predictors of functional outcomes across different domains represent a challenge for clinicians working with children with ADHD. However, our finding that conduct problems in children with ADHD (who were free of conduct disorder) may be indicative of future risk and suggests that even mild levels of conduct problems should not be overlooked. A previous investigation using the same sample found that many of the children developed conduct or antisocial personality disorder later on, which in turn was related to

substance use disorder and criminality³⁴. Even though this study cannot speak to the significance of predictors for later outcome of females with ADHD in childhood, the significance of conduct problems in childhood for overall function later in life has also been established for females³⁵. Together, findings underscore the need to address conduct problems early on, before they escalate. The significant contribution of reading level for the long-term functional outcome of children with ADHD gives hope that providing children with ADHD cognitively stimulating environments might increase their likelihood of success later in life. Our finding that the contribution of characteristics in childhood and adolescence to adult functioning did not vary over time is encouraging, as it suggests that early interventions can have lasting effects.

The findings show promise in the importance of goal setting and suggest a rationale for examining people's attitudes towards their own future. Setting specific, challenging goals motivates action and results in better performance than general, "do your best" goals¹⁵. Whether goals are self-directed or assigned by others makes little difference in terms of the outcome, as long as a rationale is provided for the goal¹⁵. Deficits in planned, goal-directed behavior are characteristic of children with ADHD, and often hinder a child's ability to succeed academically and otherwise. As a result, several behavioral interventions for children with ADHD have focused on developing skills that help children set and monitor goals and simplify assignments into more manageable tasks³⁶. Considering the importance of an individual's educational attainment for multiple aspects of life, supporting adolescents' formulation of concrete goals for their education may have lasting benefits. However, replication is need and future research should explore mechanisms linking educational goal setting and adult functioning among children with ADHD.

By design, we cannot determine whether findings generalize to women, individuals from other ethnic or racial backgrounds, or children with ADHD predominantly inattentive type. Some analyses may have been underpowered and may have prevented detecting significant associations. Such is clearly the case for parental psychopathology, for which rates were low, and has been identified as a significant predictor of a related adverse outcome of childhood ADHD (ADHD persistence)¹¹. Some associations were not robust to adjustments for multiple comparisons, however, they suggest areas for future inquiry. It is appropriate to note that even when single predictors were significantly related to outcome, these were mostly weak. At the same time, relatively weak significant findings may guide developmental theories of childhood ADHD, with the caveat that replication is essential. Notwithstanding these limitations, findings inform on a well-defined group of adults with ADHD in childhood, and have heuristic significance by providing a basis for complementary studies.

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Table 1. Summary of Findings From Follow-Up Studies Examining the Relationship Between Early Predictors of Adult Functional Outcomes Among Children With Attention-Deficit/Hyperactivity Disorder (ADHD)

Study	Predictors Examined by Functional Outcome at Follow-Up ^a			
	Overall Function	Educational Outcomes	Occupational Functioning	Social Functioning
Paternite, Loney, Salisbury, and Whaley (1999) ¹² ; Original N=121 (80.2% retained) Age at FU=Range, 21-23 (Mean NR)	<u>Childhood:</u> inattention/overactivity ($\beta=-.23$) <i>No relationship with:</i> aggression, interaction between inattention/overactivity and aggression, medication history <u>Adolescence:</u> none examined	<u>Childhood:</u> <i>No relationship with:</i> inattention/overactivity, aggression, interaction between inattention/overactivity and aggression, medication history <u>Adolescence:</u> none examined	<u>Childhood:</u> <i>No relationship with:</i> inattention/overactivity, aggression, interaction between inattention/overactivity and aggression, medication history <u>Adolescence:</u> none examined	<u>Childhood:</u> <i>No relationship with:</i> inattention/overactivity, aggression, interaction between inattention/overactivity and aggression, medication history <u>Adolescence:</u> none examined
Barkley, Murphy, and Fischer (2010) ⁶ Original N=158 (85% retained) Age at FU=(26.8 \pm 1.4), Range 22-31	<u>Childhood:</u> hyperactivity ($\beta=.22$, $r=.33$) <i>No relationship with:</i> IQ, no. problem settings, conduct problems <u>Adolescence:</u> <i>No relationship with:</i> ADHD, ODD, CD symptoms, life events scale	<u>Childhood:</u> WWPARS hyperactivity ($\beta=-.24$, $R=.53$), IQ ($\beta=.19$, $R=.58$), no. of problem settings ($\beta=-.18$, $R=.59$) <i>No relationship with:</i> hyperactivity and conduct problem scores <u>Adolescence:</u> WRAT math ($\beta=.19$, $R=.62$), no. CD symptoms ($\beta=-.20$, $R=.64$), no. of ODD symptoms ($\beta=.17$, $R=.65$) <i>No relationship with:</i> no. ADHD symptoms, WRAT reading and spelling scores, duration of stimulant treatment	<u>Childhood:</u> <i>No relationship with:</i> no. CD symptoms <u>Adolescence:</u> none examined	<u>Childhood:</u> none examined <u>Adolescence:</u> none examined
Roizen (2012) ¹³ Original N=103 (88% retained) Age at FU=(25.5 \pm 1.3), Range 22-30	<u>Childhood:</u> CD symptoms (OR=0.33), Freedom From Distractibility Factor (OR=1.10), Working Memory Index (OR=1.14) <i>No relationship with:</i> ADHD symptoms, ODD symptoms, Porteus Mazes (Quantitative IQ), Beery Visual Motor IQ, Beery Visual Motor	<u>Childhood:</u> IQ ($r=.22$), SES ($r=.31$), working memory ($B=0.09$), CD symptoms ($B=-1.01$) <i>No relationship with:</i> ADHD symptoms, ODD symptoms, Porteus Mazes (Quantitative IQ), Beery Visual Motor Integration, Visual Sequential Memory, Paired Associates Test,	<u>Childhood:</u> <i>No relationship with:</i> IQ, SES, ADHD symptoms, CD symptoms, ODD symptoms, Porteus Mazes (Quantitative IQ), Beery Visual Motor Integration, Visual Sequential Memory, Paired Associates Test, CPT Omission-, Freedom From Distractibility Factor, Working Memory Index,	<u>Childhood:</u> IQ ($r=.22$), SES ($r=.31$), CD symptoms ($B=-0.43$) <i>No relationship with:</i> ADHD symptoms, ODD symptoms, Porteus Mazes (Quantitative IQ), Beery Visual Motor Integration, Visual Sequential Memory, Paired Associates Test, CPT Omission-

	Integration, Visual Sequential Memory, Paired Associates Test, CPT Omission-Continuous Performance Test	CPT Omission- Continuous Performance Test, Freedom From Distractibility Factor, Working Memory Index	<u>Adolescence</u> : none examined	Continuous Performance Test, Freedom From Distractibility Factor, Working Memory Index <u>Adolescence</u> : none examined
Roy (2017) ¹¹	<u>Childhood</u> : none examined <u>Adolescence</u> : none examined	<u>Childhood</u> : parental education (OR=1.58), IQ (OR=1.02), symptom severity (OR=0.69), low monitoring and supervision (OR=0.71), parental marital problems (OR=0.75). <i>No relationship with</i> : household income, total household members, comorbidity, positive parenting, inconsistent discipline, harsh discipline, appropriate discipline, parental involvement, parent-child relationships (possessive and protective, affectionate and admiring, conflicting, nurturing and intimate, participating and involved) <u>Adolescence</u> : none examined	<u>Childhood</u> : IQ (OR=1.01), ADHD symptom severity (OR=1.20). <i>No relationship with</i> : household income, parental education, total household members, comorbidity, positive parenting, inconsistent discipline, low monitoring and supervision, harsh discipline, appropriate discipline, parental involvement, parent-child relationships (possessive and protective, affectionate and admiring, conflicting, nurturing and intimate, participating and involved), parental marital problems. <u>Adolescence</u> : none examined	<u>Childhood</u> : none examined <u>Adolescence</u> : none examined

Note: AOR = adjusted odds ratio; B = unstandardized regression coefficient; β = standardized regression coefficient; CD = Conduct Disorder; CPT = continuous performance test; FU = follow-up; IQ = intelligence quotient; NR = not reported; ODD = oppositional defiant disorder; OR = odds ratio; r = correlation coefficient; SES = socioeconomic status; WRAT = Wide Range Achievement Test-III; WWPARS = Werry-Weiss-Peters Activity Rating Scale.

^aIf more than one outcome was examined, we report the one that most closely resembles our measure to ease comparisons across studies.

^bThe two samples were combined in the analyses, but authors tested whether associations were consistent across groups.

^cOutcome data are based on the most recent assessment in adulthood (at 12, 14, or 16 years post baseline).

Table 2. Predictor Variables in Childhood (at Referral) and in Adolescence [at Follow-Up 18]

Childhood Predictors	Description	Scoring	<i>M</i> or n/N	SD or %	Median	Outcomes for which analyzed:
Parental SES	Hollingshead and Redlich ²⁶ (education and occupation)	1=lower class, 5=upper class	2.81	1.05	3	All
Full Scale IQ	Wechsler Intelligence Scale for Children ²⁰	Standard score	104.17	12.30	104	All
Reading Level	Wide Range Achievement Test ²²	Standard score	101.10	17.27	97	GAS, Edu, Occu Rank, Occu Func, Soc Func
ADHD Severity	Mean of 9 items on the Conners Teacher Rating Scale (CTRS) ²³	0=not at all, 3=very much	2.28	0.44	2.33	All
Conduct Problems	Mean of 4 items on the CTRS and 12 items on the Conners Parent Rating Scale (CPRS)	0=not at all, 3=very much	0.76	0.40	0.71	All
Oppositional Behavior	Mean of 8 items on the CTRS and 8 items on the CPRS	0=not at all, 3=very much	1.50	0.52	1.50	All
Eruptive Aggression	Psychiatrist diagnostic rating: “Unable to control response towards peers/adults. Physically aggressive, impulsive, often reacts to others before understanding the meaning or motives of their words or actions. Gets into numerous fights. Physically disruptive particularly in classroom where he may hit out at others with little or no provocation.”	0=absent, 1=present	55/113	49%	---	All

(continued)

Childhood Predictors	Description	Scoring	M or n/N	SD or %	Median	Outcomes for which analyzed:
Immature Behavior	Psychiatrist diagnostic rating: "Immature/inadequate behavior with poorly organized personality characteristics and coping techniques" ³⁷	0=absent, 1=present	36/115	31%	---	All
Social Factor Score	Mean of 4 CTRS items	0=not at all, 3=very much	1.99	0.73	2.00	All
Adolescent Predictors	Description	Scoring	M or n/N	SD or %	Median	Outcomes for which analyzed:
Dropped Out of School	Dropped out of Junior High or High School, even if later got GED	0=absent, 1=present	37/131	28%	---	GAS, Occu Rank, Occu Func, Soc Func
Severity of Inattention	Clinician rating, ages 16-18	1=none/mild, 5=extreme	2.54	1.46	3	All
Severity of Hyperactivity	Clinician rating, ages 16-18	1=none/mild, 5=extreme	2.23	1.44	2	All
Severity of Impulsivity	Clinician rating, ages 16-18	1=none/mild, 5=extreme	2.60	1.52	3	All
Number of Antisocial Behaviors	25 discrete antisocial behaviors at school, home, and other, from parent and adolescent interviews	Behaviors rated 0=absent, 1=present; range=0-25	10.51	6.42	11	All

(continued)

Adolescent Predictors	Description	Scoring	M or n/N	SD or %	Median	Outcomes for which analyzed:
Non-Alcohol Substance Use Disorder [n/N(%)]	Ongoing DSM-III diagnosis ^a	0=absent, 1=present	19/131	15%	---	All
Educational Goals	Clinician rating; Probe: "How do you see your future?" (educational)	1=has little/no idea, 4=has definite specific goals in mind	2.61	1.04	3	GAS, Edu, Occu Rank, Occu Func, Soc Func
Work Goals	Clinician rating; Probe: "How do you see your future?" (career)	1=has little/no idea 4=has definite specific goals in mind	2.83	0.99	3	GAS, Edu, Occu Rank, Occu Func, Soc Func
Global Job Functioning	Clinician rating, ages 16-18	1=poor, 6=superior	3.19	1.32	3	GAS, Edu, Occu Rank, Soc Func
Global Social Functioning	Clinician rating, during High School	1=poor, 6=superior	3.62	1.21	4	GAS, Edu, Occu Rank, Occu Func
Parental Alcohol or Non-Alcohol Substance Use Disorder [n/N(%)]	Lifetime diagnosis ^a based on the DIS or the SIS	0=absent, 1=present	24/114	21%	---	All

(continued)

Adolescent Predictors	Description	Scoring	<i>M</i> or n/N	(SD) or (%)	Median	Outcomes for which analyzed:
Parental Antisocial Personality Disorder [n/N(%)]	Lifetime diagnosis ^a based on the DIS or the SIS	0=absent, 1=present	12/114	11%	---	All

Note: ADHD = attention-deficit/hyperactivity disorder; CPRS=Conners Parent Rating Scale; CTRS=Conners Teacher Rating Scale; DIS=Diagnostic Interview Schedule; DSM= Diagnostic and Statistical Manual of Mental Disorders; Edu = educational attainment; GAS=Global Assessment Scale; GED = general equivalency diploma; IQ = intelligence quotient; Occu Func = occupational functioning; Occu Rank = occupational rank; SES = socioeconomic status; SIS = Spouse Interview Schedule; Soc Func = social functioning.

Table 3. Childhood and Adolescent Predictors of Overall Function, Educational Attainment, and Occupational Ranking at Follow-Up 41

Predictors	Overall Function ^a					
	b	SE	<i>p</i>	B-H critical <i>p</i>	Significant?	R ²
Childhood						0.04
Conduct Problems	-6.53	2.91	.027	.050	Yes	
Adolescence (adjusted for above childhood predictors)						0.15
Dropped Out of School	-4.28	2.77	.125	.025	--	
Number of Antisocial Behaviors	0.08	0.21	.697	.038	--	
Educational Goals	3.2	1.16	.007	.013	Yes	
Global Job Functioning	-0.07	0.95	.937	.050	--	
Predictors	Educational Attainment					
	b	SE	<i>p</i>	B-H critical <i>p</i>	Significant?	R ²
Childhood						0.31
SES	0.48	0.20	.019	.025	Yes	
Full Scale IQ	0.06	0.02	.002	.013	Yes	
Reading Level	0.03	0.01	.019	.038	Yes	
Conduct Problems	-0.96	0.48	.049	.050	Yes	
Adolescence (adjusted for above childhood predictors)						0.47
Severity of Inattention	-0.27	0.14	.056	.019	--	
Severity of Hyperactivity	0.02	0.15	.924	.044	--	
Severity of Impulsivity	0.10	0.17	.560	.019	--	
Number of Antisocial Behaviors	-0.13	0.04	.002	.006	Yes	
Non-Alcohol SUD	0.137	0.58	.814	.031	--	
Job Functioning	-0.024	0.14	.867	.038	--	
Parental SUD	-0.23	0.47	.628	.025	--	
Parental APD	-0.03	0.66	.968	.050	--	
Predictors	Occupational Ranking					
	b	SE	<i>p</i>	B-H critical <i>p</i>	Significant?	R ²
Childhood						0.23
SES	0.31	0.16	.051	.033	--	
Full Scale IQ	0.06	0.01	.001	.017	Yes	
Reading Level	-0.01	0.01	.146	.050	--	

(continued)

Predictors	Occupational Ranking					R ²
	b	SE	<i>p</i>	B-H critical <i>p</i>	Significant?	
Adolescence (adjusted for above childhood predictors)						0.39
Dropped Out of School	-0.22	0.32	.504	.033	--	
Severity of Inattention	-0.23	0.09	.017	.008	--	
Educational Goals	0.35	0.15	.018	.017	--	
Job Functioning	0.07	0.11	.521	.042	--	
Social Functioning	-0.01	0.12	.923	.050	--	
Parental SUD	-0.65	0.33	.053	.025	--	

Notes. ^aGlobal Assessment Scale

APD = antisocial personality disorder; B-H = Benjamini-Hochberg; b = unstandardized regression coefficient; SE = standard error; SES = socioeconomic status, SUD = substance use disorder.

Predictors with $p < .10$ in univariate models were entered in hierarchical model.

Table 4. Childhood and Adolescent Predictors of Occupational and Social Functioning Over Time

Predictors	Occupational Functioning				
	b	SE	<i>p</i>	B-H critical <i>p</i>	Significant?
Childhood					
Full Scale IQ	0.01	0.01	.009	.025	Yes
Conduct Problems	-0.4	0.18	.027	.050	Yes
Adolescence (adjusted for above childhood predictors)					
Dropped Out of School	-0.03	0.17	.855	.050	--
Severity of Inattention	-0.11	0.05	.046	.017	--
Severity of Impulsivity	-0.04	0.06	.527	.033	--
Number of Antisocial Behaviors	-0.02	0.02	.208	.028	--
Non-Alcohol SUD	-0.47	0.22	.031	.011	--
Educational Goals	0.13	0.1	.166	.022	--
Work Goals	0.04	0.1	.649	.044	--
Social Functioning	0.18	0.06	.002	.006	Yes
Parental SUD	-0.10	0.16	.538	.039	--
Predictors	Social Functioning				
	b	SE	<i>p</i>	B-H critical <i>p</i>	Significant?
Childhood					
SES	0.09	0.06	.136	.100	--
Full Scale IQ	0.01	0.005	.015	.050	Yes
Adolescence (adjusted for above childhood predictors)					
Dropped Out of School	-0.18	0.14	.204	.025	--
Severity of Inattention	-0.05	0.04	.245	.033	--
Number of Antisocial Behaviors	0.004	0.01	.726	.050	--
Educational Goals	0.18	0.08	.027	.017	--
Work Goals	0.04	0.08	.621	.042	--
Job Functioning	0.13	0.05	.008	.008	Yes

Note: b = unstandardized regression coefficient; B-H = Benjamini-Hochberg; IQ = intelligence quotient; SE = standard error; SES = socioeconomic status; SUD = substance use disorder.

Table 5. Summary of Results Testing Associations between Predictors in Childhood and Adolescence and Functional Outcomes in Adults with Attention-Deficit/Hyperactivity Disorder (ADHD) in Childhood

Significant Predictors	Overall Function	Educational Attainment	Occupational Rank	Occupational Functioning	Social Functioning
Childhood					
Parental SES		+			
Full Scale IQ		+	+	+	+
Reading Level		+			
Conduct Problems	-	-		-	
Adolescence					
Number of Antisocial Behaviors		-			
Educational Goals	+				
Global Job Functioning					+
Global Social Functioning				+	

Note: IQ = intelligence quotient; SES = socioeconomic status; Sign (+ or -) indicates whether there was a positive or negative association between the predictor and the outcome. Associations were significant after adjusting for false discovery rate for multiple comparisons according to the Benjamini-Hochberg procedure.

Table S1. Inter-Correlations of Childhood and Adolescent Predictors (N=135)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
1 Parents' SES																					
2 Full Scale IQ	.2*																				
3 Reading Level	.1	.5*																			
4 Severity of ADHD	-.1	-.2*	-.2*																		
5 Conduct Problems	-.1	.0	.1	.2*																	
6 Oppositional Behaviors	-.2*	.0	.1	.3*	.7*																
7 Eruptive Aggression	.1	.1	.1	.1	.3*	.4*															
8 Immature Behavior	.2	-.1	.0	.1	.0	.1	.3*														
9 Social Factor Score	.1	.0	.0	-.2*	-.2*	-.2*	.0	.0													
10 Dropped Out of School	-.2*	-.2*	-.2*	.0	.1	.1	.1	-.1	.1												
11 Severity Inattention	.1	.0	.0	-.1	.0	.0	.1	.1	.1	.2*											
12 Severity Hyperactivity	.1	.1	.0	.0	.0	.0	.1	.0	.1	.2*	.5*										
13 Severity Impulsivity	.0	.1	.0	-.1*	.1	.0	.1	-.1	.1	.2*	.5*	.6*									
14 Number of Antisocial Behaviors	-.2*	.1	.1	.0	.3*	.2*	.2*	-.1	.0	.4*	.4*	.4*	.6*								
15 Non-Alcohol Substance Use Disorder	-.1	.1	.0	-.1	.0	.0	.0	-.1	.1	.3*	.2*	.2*	.3*	.5*							
16 Educational Goals	.1	.1	-.1	-.1	.0	-.1	.0	-.1	.0	-.1	-.1	.0	.0	-.2*	-.1						
17 Work Goals	.1	.0	-.1	-.2*	-.1	-.1	-.1	-.1	.1	-.1	-.1	.0	.0	-.2*	-.1	.7*					

(continued)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
18 Global Job Functioning	.1	.0	-.2*	-.1	-.2*	-.1	-.2*	-.1	-.1	-.2*	-.2*	-.1	-.2*	-.4*	-.2*	.3*	.3*			
19 Global Social Functioning	.1	.1	.0	-.1	-.1	.0	.0	-.1	.0	-.2*	-.1	.0	.0	-.2*	-.1	.3*	.2*	.4*		
20 Parental Alcohol or Non-Alcohol Substance Use Disorder	-.1	-.2*	.0	.0	.2	.1	.0	-.1	.1	.1	.1	.1	.1	.1	.1	-.1	-.1	-.1	-.1	
21 Parental Antisocial Personality Disorder	-.1	-.1	.0	.1	.3*	.2*	.2	.1	.0	.1	.1	.0	.0	.2*	.3*	-.1	-.1	-.1	.0	.4*

Note: ADHD = attention-deficit/hyperactivity disorder; ASP = antisocial personality disorder; IQ = intelligence quotient; SES = socioeconomic status; SUD = substance use disorder.

* $p < .05$