JIDR Journal of Intellectual Disability Research
Published on behalf of mencap and in association with IASSID

Journal of Intellectual Disability Research doi: 10.1111/j.1365-2788.2011.01416.x

VOLUME 55 PART 7 pp 623–635 JULY 2011

Attention-deficit/hyperactivity disorder among children with and without intellectual disability: an examination across time

C. L. Neece,[1] B. L. Baker,[1] J. Blacher[2] & K. A. Crnic[3]

1 *Department of Psychology, University of California, Los Angeles, CA, USA*
2 *Graduate School of Education, University of California, Riverside, CA, USA*
3 *Department of Psychology, Arizona State University, Tempe, AZ, USA*

Abstract

Background Children with intellectual and developmental disabilities are at heightened risk for mental disorders, and disruptive behaviour disorders appear to be the most prevalent. The current study is a longitudinal examination of attention-deficit/hyperactivity disorder (ADHD) among children with and without intellectual disability (ID) across ages 5 to 8.

Method We assessed 228 5-year-old children, 87 with ID and 141 with typical development (TD), for clinical diagnoses using a structured interview. These interviews were conducted with mothers annually from child age 5 to 8.

Results Attention-deficit/hyperactivity disorder was over 3 times as prevalent in the ID group as in the TD group across ages 5, 6, 7 and 8. The diagnosis of ADHD tended to emerge earlier and was more stable in the ID group; however, the total number and relative frequency of ADHD symptoms endorsed appeared to be similar within the two groups across time. With respect to the developmental course, the trajectories of ADHD inattentive and hyperactive/impulsive symptoms over time were similar in the two groups.

Discussion Children with ID appear to be at heightened risk for ADHD and they may experience a longer and more persistent course of the disorder. These findings highlight the need for making interventions available for early treatment of this condition in children with ID.

Keywords attention-deficit/hyperactivity disorder, behaviour problems, children, intellectual disability, longitudinal studies

Correspondence: Ms Cameron Neece, Department of Psychology, UCLA, 405 Hilgard Avenue, Los Angeles, CA 90095, USA (e-mail: cneece@ucla.edu).

Author note: This paper was based on the activities of the Collaborative Family Study, supported by the Eunice Kennedy Shriver National Institute of Child Health and Human Development, Grant number: 34879-1459 (Drs Bruce L. Baker, Jan Blacher and Keith Crnic PIs). We are indebted to our staff and doctoral student colleagues.

Introduction

Children and adolescents with intellectual disability (ID) are at high risk for mental disorders. Epidemiological studies of youth with ID have reported clinically significant emotional and behaviour problems and/or diagnosable mental disorders in one-third to

a half of cases (Dekker & Koot 2003; Emerson 2003; Emerson & Einfeld 2010). When studies included a comparison group with typical cognitive development, about 2.5 to over 4 times as many children with ID had serious behaviour/emotional problems as those with typical development (TD) (Dekker *et al.* 2002; de Ruiter *et al.* 2008; Emerson *et al.* 2010). Studies that report specific symptoms or diagnoses generally find that disruptive behaviour disorders are among the most prevalent co-occurring disorders among children with ID (Dekker & Koot 2003; Emerson 2003; Voigt *et al.* 2006).

Studies have indicated that children with ID are at heightened risk for attention-deficit/hyperactivity disorder (ADHD). However, what is still unclear is whether the ADHD diagnosis has the same meaning in the presence of ID as it does for typically developing children. Is ADHD a valid diagnosis for children with ID? Some have argued that the apparent risk for ADHD in children with ID is simply due to their developmental delay, citing research showing that ADHD symptoms (e.g. inattentiveness, overactive/impulsive behaviour) are characteristic of individuals with low cognitive functioning (Reiss & Valenti-Hein 1994; Tonge *et al.* 1996; Gjaerum & Bjornerem 2003). However, other studies provide support for ADHD as a valid psychiatric diagnosis for children with ID. Handen *et al.* (1998) examined a sample of children with ID with and without elevated levels of ADHD symptoms and found differences in terms of activity level and attention difficulties, even after controlling for intellectual functioning (Handen *et al.* 1998). Fee *et al.* (1994) found no significant differences between children with ID and ADHD and children with ADHD alone in terms of their psychological characteristics. In our own lab, we found that the ADHD diagnosis appeared to be reached in the same way in children with or without developmental delay (Baker *et al.* 2010). The current study expands on these studies investigating the validity of ADHD as a diagnosis for children with ID by comparing the developmental course of ADHD in typically developing children and children with ID.

We previously reported findings pertaining to mental disorders at age 5 from a longitudinal sample of children with ID or TD (Baker *et al.* 2010). Every disorder assessed was more prevalent in the ID group than in the TD group, but the per cent of children meeting criteria for ADHD most highly differentiated the two groups (risk ratio 3.21 to 1). The present report extends the analyses of Baker *et al.*'s (2010) sample across early and middle childhood (ages 5 to 8) focusing on ADHD. Beyond examining ID versus TD differences in diagnostic rates, three key developmental questions are addressed regarding the age of onset of ADHD diagnosis, stability of diagnosis and developmental course of ADHD symptoms between these two groups. We reason that children with ID are at increased risk for ADHD in part due to impairments in cognitive functioning, specifically deficits in working memory and executive functioning (e.g. inhibitory control, set shifting, planning) (Alloway 2010; Schuchardt *et al.* 2010). Given this increased risk, we expected that children with ID will have an earlier age of onset of ADHD, a more stable diagnosis and perhaps higher levels of ADHD symptoms over time.

The ADHD diagnostic criteria in Diagnostic and Statistical Manual of Mental Disorders IV: Text Revision (DSM-IV-TR) (American Psychiatric Association 2000) require that symptoms be present and cause impairment before age 7. This age of onset criterion has been criticised, with opponents citing studies showing that children who met the symptom count and impairment criteria for ADHD but did not meet the age of onset criteria did not differ from, or in some cases had worse outcomes than, children who met full criteria for ADHD (Applegate *et al.* 1997; Waschbusch *et al.* 2007). Furthermore, the age of onset for ADHD may differ by subtype. The limited research in this area suggests that the inattentive subtype of ADHD has a significantly older age of onset than the hyperactive/impulsive subtype (Applegate *et al.* 1997; Waschbusch *et al.* 2007). No study, to our knowledge, has examined the age of onset of ADHD among children with ID.

With regard to the stability of ADHD diagnosis across development, diagnostic retention studies have produced varied estimates. A meta-analysis by Hill & Schoener (1996) found that the rates of ADHD decreased by 50% every 5 years starting at age 9, providing support that ADHD is a childhood disorder and prevalence decreases across development. However, other studies find that a substantial percentage of children who meet criteria for ADHD

continue to meet criteria many years later (80% diagnostic retention rate at 12-year follow-up reported in Claude & Firestone 1995). Some studies find lower diagnostic retention rates (e.g. 40% in Biederman *et al.* 2000) but note that the majority of people diagnosed with ADHD as children continue to report sub-threshold symptoms and significant functional impairment into young adulthood (90% in Biederman *et al.* 2000). It is likely that differences in diagnostic retention rates across studies are partially explained by age of assessment, length of follow-up period, assessment method (e.g. self-report vs. diagnostic interview) and sampling (e.g. clinic samples vs. community samples) (Willoughby 2003). We are not aware of studies that have examined the stability of ADHD diagnoses in children with ID.

Like age of onset, the developmental course of ADHD symptoms in children with TD appears to vary by subtype. Hyperactivity and overactivity are generally more pronounced in pre-school and these symptoms tend to decline with time, whereas problems with inattention tend to emerge later in development and become more pronounced with age (Applegate *et al.* 1997; von Stauffenberg & Campbell 2007). No study, to our knowledge, has examined ADHD symptom trajectories among children with ID or evaluated whether the developmental course of ADHD is similar among children with and without ID.

The present study, then, followed children with ID or TD from ages 5 through 8 years and addressed four primary questions. First, does the presentation of ADHD (i.e. prevalence, sex difference, co-morbidity and symptom endorsement) differ between the two status groups? Second, does the age of onset of ADHD (i.e. year of first meeting diagnostic criteria) differ between the two status groups? Third, what is the stability of ADHD diagnosis in the two status groups? Fourth, what are the trajectories of inattentive and hyperactive/impulsive symptom across early and middle childhood and do they differ between the two status groups?

Method

Participants

Participants were 228 families in a longitudinal study of young children, with samples drawn from Southern California (78%) and Central Pennsylvania (22%). This Collaborative Family Study has been based at three universities: University of California, Los Angeles; University of California, Riverside; The Pennsylvania State University (Baker *et al.* 2003). The present sample was comprised of all families for whom data were available on the primary measures at child age 5 years.

Families of children with developmental delays at age 3 years were recruited primarily through agencies that provide and purchase diagnostic and intervention services for persons with intellectual and developmental disabilities. In California, practically all families with young children with ID register for services with one of a network of regional centres. Children who had an autism diagnosis at the initial evaluation were excluded from the longitudinal study. Families of children with typical development were recruited primarily through local pre-schools and day care programmes. Further selection criteria were that the children score in the range of normal cognitive development and not have been born prematurely or have any developmental disability. In recruiting participants, school and agency personnel mailed brochures describing the study to families who met selection criteria and interested parents contacted the research centre.

Based on the Stanford-Binet IV (Thorndike *et al.* 1986) at age 5 years, children were classified as ID (IQ = 70 or lower, $n = 76$), or borderline intellectual functioning (BIF; IQ = 71–84, $n = 11$), if their scores on the Vineland Adaptive Behavior Scales were also below 85 (Sparrow *et al.* 1984). Children were classified as typically developing if their IQ was 85 or higher ($n = 141$).

Table 1 shows demographic characteristics. In the combined sample, there were more boys (58.4%) than girls. Child race/ethnicity was 60.4% White non-Hispanic, 15.9% Hispanic, 7.9% African American, 2.6% Asian American and 13.2% classified by parents as 'other'. Recruitment had initially focused on intact families, so 80.6% of participants were married (defined here as legally married or living together at least 6 months). The average socio-economic status was moderately high; 56.4% of families had an annual income above $50 000 and the average years of schooling was 3 years of college for mothers and fathers. There were no significant differences between status groups in child

Table 1 Demographic characteristics for child, mother and family at age 5 ($n = 228$)

	Intellectual disability ($n = 63$)	Borderline ($n = 24$)	Typically developing ($n = 141$)	χ^2 or F
Child				
Gender (% boys)	57.1	79.2	56.7	$\chi^2 = 4.43$
Race/ethnicity (% White non-Hispanic)	61.3	54.2	61.0	$\chi^2 = 0.43$
Health (SD)†	3.10 (0.69)[a]	3.21 (0.59)[a]	3.56 (0.55)[b]	$F = 14.26$***
Stanford-Binet IQ	51.8 (11.3)[a]	76.7 (4.0)[b]	103.5 (11.4)[c]	$F = 504.32$***
Mother and family				
Marital status (% married)	79.0	66.7	83.7	$\chi^2 = 3.94$
Mother's race/ethnicity (% White non-Hispanic)	59.7	54.2	67.4	$\chi^2 = 2.20$
Mother's education (mean grade in school) (SD)	14.4 (2.0)[a]	14.5 (2.5)[ab]	15.5 (2.4)[b]	$F = 5.83$**
Mothers' mean age in years (SD)	35.0 (6.6)	35.5 (6.4)	36.1 (5.8)	$F = 0.73$
Mothers' health (SD)†	2.8 (0.8)[a]	3.2 (0.8)[ab]	3.2 (0.7)[b]	$F = 4.15$*
Family annual income (% >$50 000)	46.8	50.0	61.7	$\chi^2 = 4.35$

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

† Health items rated (1) poor, (2) fair, (3) good, (4) excellent.

Means sharing the same superscript are not significantly different from each other (Tukey's honestly significant difference, $P < 0.05$).

gender or race/ethnicity, or in parents' age, race/ethnicity, income, health or marital status. However, TD children were reported to have better physical health compared to children with ID and BIF. Furthermore, mothers of children with TD had completed significantly more years of school and had better physical health compared to mothers of children with ID. Demographic variables that differed by child status group were covaried in analyses if they also were significantly related to the dependent variable.

Procedures

Procedures were approved by the Institutional Review Boards of the three universities. Children at age 5 and their mothers came into the child study centre. After reviewing procedures and obtaining informed consent, trained research assistants administered the Stanford-Binet to children while their mothers completed demographic and diagnostic interviews. The remaining data used in this study came from diagnostic interviews that were conducted in the family homes, when the children were 6, 7 and 8 years old. At each time point, parents received an honorarium for their participation. Teachers also completed a battery of measures at child ages 6–8 years, and they, too, received an honorarium.

Measures

Stanford-Binet IV (Thorndike et al. *1986)*

The Stanford-Binet IV, a widely used assessment instrument with sound psychometric properties, was administered to assess children's cognitive abilities. The Stanford-Binet IV yields an IQ score with a normative mean = 100 and SD = 15. It is particularly well suited to the evaluation of children with delays, because the examiner adapts starting points according to the child's developmental level.

Vineland Adaptive Behavior Scales (Sparrow et al. *1984)*

Child adaptive behaviour was examined using the Vineland Adaptive Behavior Scales, a semi-structured interview assessing the adaptive behaviour of individuals with or without disabilities. In the present study, mothers were informants and reported on behaviours that their children usually do. Three sub-scales were used: *communication*, *daily*

living skills and *socialisation*. These were combined to form an Adaptive Behaviour Composite score with an alpha coefficient of 0.93.

Diagnostic Interview Schedule for Children (Costello et al. *1985)*

The Diagnostic Interview Schedule for Children (DISC), administered to mothers at child ages 5, 6, 7 and 8, is a highly structured diagnostic interview covering current DSM criteria for child psychiatric disorders. Respondents were asked about the presence of symptoms that fall under the major diagnostic categories. In the present study, we used an alternative way of administering the DISC (Edelbrock *et al.* 1999; Baker *et al.* 2010). We selected six modules appropriate for younger children: Social Phobia, Separation Anxiety, Major Depressive Disorder, Dysthymic Disorder, Attention-Deficit/Hyperactivity Disorder and Oppositional Defiant Disorder (ODD). The interviewer began by reading a brief summary of the criteria for each diagnosis and then asked the mother to select the first diagnostic area to be covered. Standard administration of modules was followed. After the first module, the mother was asked to select the next diagnostic area. This was continued until there was no other area the mother considered relevant and further review of the diagnostic criteria with the mother confirmed that the child did not have any problems represented in the remaining modules. This administration procedure has been found to take less time, increase reliability, decrease attenuation (reporting fewer symptoms for disorders assessed later in the interview and on retest) and be more interesting for parents than the standard procedure of administering all areas in a fixed order (Edelbrock *et al.* 1999; Jensen *et al.* 1999).

Teacher Report Form Ages 6–18 (Achenbach & Rescorla 2001)

The Teacher Report Form Ages 6–18 (TRF) is a teacher report of child behaviour problems. It is included here to give an indication of ADHD-related behaviour problems in the school context. It is used extensively with school-aged children and each TRF item indicates a child problem. Teachers completed this measure at ages 6, 7 and 8 through the mail and for each item the respondent indicated whether it is 'not true' (0), 'somewhat or sometimes true' (1) or 'very true or often true' (2), now or within the past 2 months. The TRF yields a total problem score, broadband externalising and internalising scores and seven narrowband scales (of which attention was used in the present analyses), as well as six DSM-IV-oriented scales (of which the ADHD scale was used). The TRF yields *t*-scores for the total and broadband scores, with the mean set at 50 and a standard deviation of 10. Total score alpha for the present sample was 0.94.

Results

Descriptive analyses

Rates of attention-deficit/hyperactivity disorder in intellectual disability, borderline and typical development groups

Rates of ADHD were examined for children who met criteria for any subtype of ADHD. Subtype comparisons (inattentive, hyperactive/impulsive and combined) across groups were not possible because of small cell sizes. Rates of ADHD were significantly higher in the ID and borderline group compared to the TD group at every time point, while there were no differences in the rates of ADHD between the ID and borderline groups. These differences are shown in Table 2 as risk ratios. Because the ID and borderline groups did not differ on any demographic variable or on prevalence of ADHD diagnosis at any age, these two groups were combined in subsequent analyses in order to increase statistical power. For the remainder of the paper, the ID group ($n = 87$) includes the children who met criteria for ID as well as BIF. Additionally, for further analyses, we compared children who met ADHD DISC criteria (ADHD group) with those children who did not meet criteria for any disruptive behaviour disorder (No-DBD group). This, in effect, eliminated children meeting criteria for ODD from the comparison group, in order to have an entirely non-overlapping comparison group.

A valid diagnosis of ADHD ideally should be based on the child meeting diagnostic criteria in two more contexts (American Psychiatric Association 2000). While we could not administer the DISC to teachers, we did obtain the TRF of child

Table 2 Diagnostic status children classified as ID, borderline intellectual functioning and TD, ages 5–8 years

Variable	ID (% ADHD)	Borderline (% ADHD)	TD (% ADHD)	Overall χ^2	χ^2 (ID vs. TD)	Relative risk (ID vs. TD)	χ^2 (bord vs. TD)	Relative risk (bord vs. TD)	χ^2 (ID vs. bord)	Relative risk (ID vs. bord)
Age 5	42.9	37.5	12.1	26.21***	24.42***	3.54:1	10.00**	3.10:1	0.21	1.13:1
Age 6	50.9	47.6	11.7	35.16***	31.84***	4.35:1	16.36***	4.07:1	0.07	1.07:1
Age 7	40.8	40.0	12.0	20.33***	17.65***	3.40:1	9.96***	3.33:1	0.00	1.02:1
Age 8	35.3	28.6	8.8	15.25***	14.36***	4.01:1	4.94*	3.25:1	0.20	1.23:1

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.
ID, intellectual disability; TD, typical development; ADHD, attention-deficit/hyperactivity disorder.

behaviour problems. To assess whether teachers were reporting more ADHD-like behaviours in children classified by the parent DISC as ADHD, independent *t*-tests were conducted on TRF scores with each status group (ID, TD) for the ADHD group children versus No-DBD group children. We examined Total Behaviour Problems, Externalising Behaviour Problems, Attention Problems and the ADHD scale. Table 3 shows teacher ratings at child age 6, the first point when school measures were obtained. For ID group children, teacher TRF scores were significantly higher for the ADHD group on all four scales examined; three means were in the borderline clinical range (60–63) and the fourth just missed it. For the TD group, the same magnitude of differences was found, although the *t*-scores were lower for both groups and the small number of TD children with ADHD and teacher measures limited statistical power. All comparisons in both status groups (ID and TD) had medium to large effect sizes according to the conventions for Cohen's *d* (Cohen 1988).

Rates of attention-deficit/hyperactivity disorder by child sex

There were no significant differences in rates of ADHD diagnosis by child sex at any age. However, at age 6, the rates of ADHD were marginally higher in boys than girls in the TD group ($\chi^2 = 3.56$, $P = 0.06$). Chi-squares ranged from 0.08 to 3.56 in the TD group and from 0.31 to 1.52 in the ID group.

Co-morbidity with attention-deficit/hyperactivity disorder

The co-morbidity of ADHD and other mental disorders in this sample was consistently higher in the ID group. At ages 5, 6, 7 and 8, the per cent of TD group children who met criteria for ADHD and one or more additional disorders was 7.1%, 4.2%, 7.7% and 3.5%. In the ID group, the per cents were 28.6, 23.8, 22.4 and 19.2%. Chi-squared analyses of co-morbidity in ID versus TD groups were conducted at each time point; χ^2 ranged from 7.30 to 18.37, all at least $P < 0.01$. The two disorders that were most highly co-morbid across times were ADHD and ODD. Rates of ADHD/ODD co-morbidity at ages 5, 6, 7 and 8 were 6.4%, 4.2%,

Table 3 Continuity of child behaviour across reporters: DISC classifications and teacher report TRF scores at age 6

	Intellectually disabled				Typically developing			
Teacher TRF scales	**No DBD**	**ADHD**	***t*-value**	**Cohen's *d***	**No DBD**	**ADHD**	***t*-value**	**Cohen's *d***
Total behaviour problems	55.9 (9.0)	62.1 (7.2)	2.56*	0.75	45.2 (8.7)	53.5 (5.1)	2.62*	1.17
Externalising behaviour problems	53.7 (7.7)	59.7 (8.4)	2.40*	0.75	46.8 (6.9)	53.2 (5.8)	2.51*	1.01
Attention problems	57.9 (5.5)	62.5 (7.8)	2.16*	0.69	51.7 (3.7)	55.2 (5.0)	2.38*	0.80
ADHD scale	57.6 (5.8)	63.0 (8.3)	2.22*	0.75	52.4 (4.4)	55.5 (5.4)	1.79†	0.63

† $P < 0.10$, * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.
DISC, Diagnostic Interview Schedule for Children; TRF, Teacher Report Form; DBD, disruptive behaviour disorder; ADHD, attention-deficit/hyperactivity disorder.

6.8% and 3.5% in the TD group and 28.6%, 23.8%, 22.4% and 17.8% in the ID group (χ^2 ranged from 8.55 to 20.09, all at least $P < 0.01$).

Symptom endorsement

Symptom presentation for ADHD was similar among children with TD and ID across time. Baker *et al.* (2010) found that, among children who met criteria for ADHD at age 5, the two groups did not differ significantly in the number of inattentive, hyperactive/impulsive or total ADHD symptoms endorsed. The present analyses showed this finding to be consistent at ages 6, 7 and 8; at no time point did the ID and TD groups differ significantly in number of symptoms endorsed. Further replicating the analysis conducted in Baker *et al.* (2010), we then examined if the specific ADHD symptoms were endorsed at the same relative frequency in the TD and ID groups. We ranked the symptoms in each status group by the per cent of respondents who endorsed them. A Spearman's rank correlation coefficient on the endorsement frequency between items for the two samples was moderately high at age 5 ($\rho = 0.64$, $P < 0.001$), age 6 ($\rho = 0.58$, $P < 0.05$), age 7 ($\rho = 0.51$, $P < 0.05$) and age 8 ($\rho = 0.44$, $P = 0.07$), indicating that symptoms were endorsed at similar relative frequencies within the two samples across time. There was one symptom that was endorsed differentially. Mothers of ID sample children who met criteria for ADHD more frequently endorsed that their child 'often has trouble keeping his/her mind on what he/she is doing for more than a short period of time', compared to mothers of TD children at each time point (ages 5 and 8 $P < 0.05$, ages 6 and 7 $P < 0.10$).

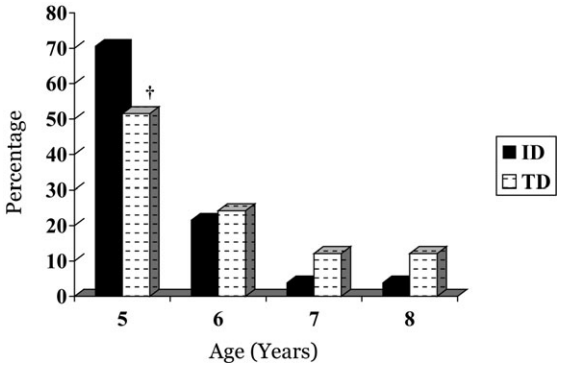

Figure 1 Age first meeting Diagnostic Interview Schedule for Children diagnostic criteria for attention-deficit/hyperactivity disorder among children with intellectual disability (ID) or typical development (TD). †$P < 0.10$.

Age of onset

Of the children who met criteria for ADHD at any time from age 5 to 8, the majority did so at age 5 (63.1%). In the ID group, 70.6% of the children had their first diagnosis at age 5 compared to 51.5% in the TD group ($\chi^2 = 3.13$, $P = 0.08$, OR = 2.26, CI = 0.91–5.61). Figure 1 shows the per cent of children in each group who received their first ADHD diagnosis at age 5, 6, 7 and 8.

Stability of diagnosis

Stability of ADHD diagnosis was evaluated by creating three stability groups. The 'early onset/stable'

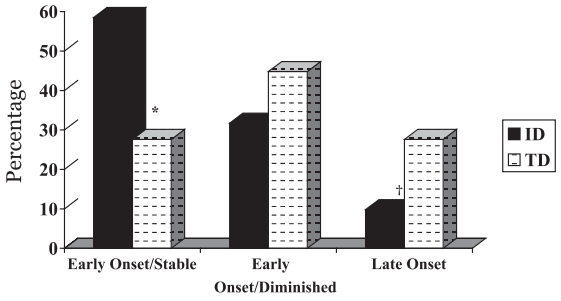

Figure 2 Stability of attention-deficit/hyperactivity disorder diagnosis among children with intellectual disability (ID) or typical development (TD). †$P < 0.10$, *$P < 0.05$.

group included children who met criteria for ADHD at three out of four or at all four time points ($n = 32$). The 'early onset/diminished' group consisted of children who met criteria for ADHD at age 5 and/or 6, but did not meet criteria for ADHD at age 7 or 8 ($n = 26$). Finally, the 'late onset' group consisted of children who first met criteria for ADHD at age 7 or 8 ($n = 12$). Of the children who met criteria for ADHD, children in the ID group were significantly more likely to be in the 'early onset/stable' group compared to the TD children (ID=58.5%, TD = 27.6%, $\chi^2 = 6.56$, $P < 0.05$, OR = 3.71, CI = 1.33–10.32). Additionally, there was a trend suggesting that children in the TD group were more likely to be in the 'late onset' group compared to children with ID (ID = 9.8%, TD = 27.6%, $\chi^2 = 3.80$, $P = 0.05$, OR = 0.28, CI = 0.08–1.06). Figure 2 shows the per cent of children in each group.

Attention-deficit/hyperactivity disorder subtype trajectories

To examine the trajectories of inattention and hyperactive/impulsive symptoms over time, multilevel growth model analyses were conducted using hierarchical linear modelling (Raudenbush & Bryk 2002). All children who were administered the ADHD module of the DISC were included in these analyses (in contrast to just those meeting ADHD criteria in our previous analyses). To assess significant change over time, we examined unconditional growth models including only an intercept (representing the dependent variable at Time 1) and slope (representing the linear rate of change of the dependent variable across ages 5–8). The variable used to represent time ranged from 0 to 3, because there were four yearly time points, from child age 5 through age 8 years; child age 5 was set = 0. Table 4 shows results of the unconditional growth models. Child inattention symptoms yielded a significant intercept and a non-significant slope parameter, indicating that the initial level of ADHD inattentive symptoms in the combined sample was significantly different from zero (intercept) and that there was not a significant increase or decrease in these symptoms over time (slope). Hyperactive/impulsive symptoms showed significant intercept and negative slope parameters, meaning that the initial level of ADHD hyperactive/impulsive symptoms in the combined sample was significantly different from zero (intercept) and the levels of hyperactive/impulsive symptoms decreased significantly from age 5 to 8 (slope).

Conditional growth models were run to test whether the trajectories were different in the two status groups (TD and ID). Table 4 and Fig. 3 show the results of these models. The conditional models differed from the unconditional model in that the conditional models included status group as a predictor of the dependent variable intercept and slope. The conditional models also included relevant demographic covariates. Variables that had a significant relationship ($P < 0.05$) with the independent variable (child intellectual status) *and* the dependent variable (inattention or hyperactive/impulsive symptom count) were included as covariates in these analyses. For both models, child developmental status (TD vs. ID) was specified so that the TD group was set to 1 and the ID group to 0. Similar to the unconditional models, there was no significant change in inattentive symptoms over time (slope was non-significant); however, there was a significant decrease in hyperactive/impulsive symptoms from age 5 to 8 ($g_{10} = -0.23$, $P < 0.05$). In both the inattention symptoms and the hyperactive/impulsive symptom models, child developmental status did not predict the slope, suggesting that changes over time, or lack thereof, were similar in the TD and ID groups.

Discussion

To our knowledge, the present study is the first longitudinal investigation of ADHD among children

Table 4 Results of multilevel models

Variable	ADHD inattention symptoms	ADHD hyperactive/impulsive symptoms
Unconditional growth models		
Intercept parameter (g_{00})	3.84***	3.93***
Slope parameter (g_{10})	0.11	–0.22**
Intercept variance component (d_0)	4.90***	4.94***
Slope variance component (d_1)	0.07	0.05
Conditional growth models		
Intercept parameter (g_{00})	4.60***	4.39***
By status(g_{01})	–1.62**	–0.95*
By mother education (g_{02})	–0.15	–0.19*
By child health (g_{03})	–0.78*	–0.12
Slope parameter (g_{10})	0.09	–0.23*
By status (g_{11})	0.10	0.02
By mother education (g_{12})	0.13**	0.03
By child health (g_{13})	0.07	–0.02

† $P < 0.10$, * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.
ADHD, attention-deficit/hyperactivity disorder.

with ID. We examined the presentation, age of onset, diagnostic stability and developmental course of ADHD across early to middle childhood among children with ID or TD. The first question asked about the presentation across the 4 years in these two groups. Results indicated a high continuity in the presentation of ADHD across time, with children in the ID group exhibiting consistently higher rates of ADHD (over 3 times as high) from age 5 to 8 as those in the TD group.

We also conducted descriptive analyses examining ID/TD differences in ADHD by child sex and co-morbidity across time. Consistent with findings at age 5 (Baker *et al.* 2010), no differences in rates of ADHD between boys and girls emerged from ages 6 to 8 in either sample. These gender findings are notably different from most studies with TD samples, where rates of disruptive behaviour disorders are usually higher among boys than girls. ADHD, for example, is reported in the DSM-IV to have a 4:1 boy to girl ratio (American Psychiatric Association 2000). However, our gender finding is consistent with several studies of behaviour problems/mental disorder in children with ID (Hastings *et al.* 2005; de Ruiter *et al.* 2008).

The rates of co-morbid disorders with ADHD were high, more so for children with ID. ODD was the most common co-occurring disorder in both groups. This is consistent with our previous findings (Baker *et al.* 2010) as well as past research on TD children (Jensen *et al.* 2001).

We also examined whether the ADHD diagnosis appeared to be reached in the same way in children with or without ID. Similar to our findings at age 5 (Baker *et al.* 2010), the total number of ADHD symptoms endorsed did not differ between children meeting ADHD criteria in the ID and TD groups at any later time point and the individual symptoms were endorsed at similar frequencies in the two groups across development. However, there was an indication that difficulty with sustained attention may be particularly problematic for children with ID. This is consistent with research investigating neuropsychological functioning among people with ID as well as studies of ADHD, where deficits in attentional processes and working memory have been demonstrated (Pearson *et al.* 1996; Barkley 1997). This suggests that individuals with both ID and ADHD may face a kind of double jeopardy. The shared symptom of poor sustained attention in ID and ADHD raises the question of whether a diagnosis of ADHD in this case is simply reflecting ID attributes. While this may be so to a small degree, most of the other defining characteristics of ADHD are not part of the typical picture of ID.

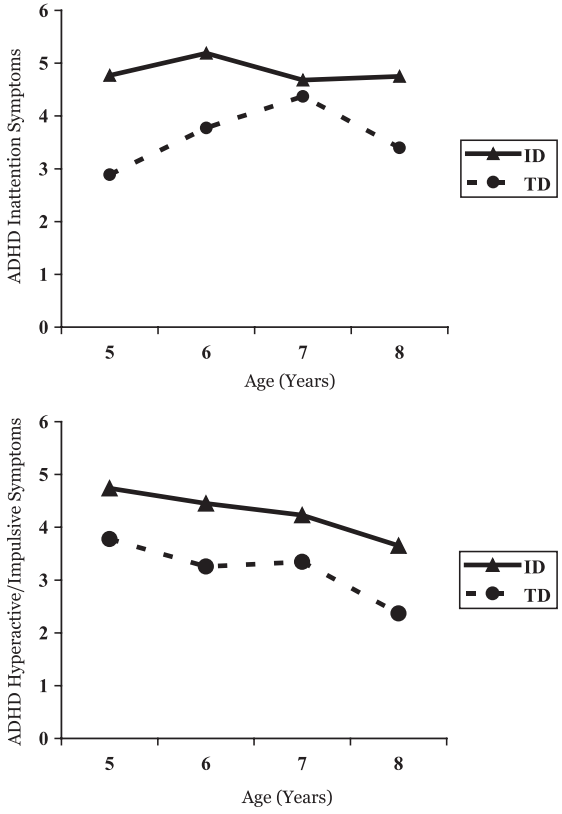

Figure 3 Trajectories of attention-deficit/hyperactivity disorder (ADHD) inattentive and hyperactive/impulsive symptoms among children with intellectual disability (ID) or typical development (TD).

The second question asked about the age of onset of ADHD. We found that the majority of the combined sample who would meet ADHD criteria sometime during the age 5–8 period did so by age 5, and this was more likely in the ID group. One explanation for the earlier onset of ADHD among children in the ID group is that these children exhibit more behaviour problems early in development (Baker *et al.* 2002), which heightens their risk for a later disruptive behaviour disorder diagnosis. Previous analyses with the current sample showed high continuity between externalising behaviour problems at child age 3 and meeting diagnostic criteria for ADHD at age 5 (Baker *et al.* 2010). Another explanation for the earlier evidence of ADHD in the ID group is that because parents, teachers and other service providers scrutinise these children more carefully (often via completion of assessment measures) than they do children who are typically developing, there may be increased recognition of symptoms.

The third question asked about the stability of the ADHD diagnosis among children with ID and TD. Results indicated that the diagnosis of ADHD is more stable across this period of childhood among children in the ID group than in the TD group. Environmental variables, particularly family variables, may help to explain this finding. Parenting difficulties as well as poor parental psychological health (e.g. depression, stress) have been linked to higher levels of ADHD symptomotology and conduct problems across development (Johnston & Mash 2001). Our previous work suggests that early parenting stress may be a particularly relevant risk factor for the development of ADHD symptoms among both groups of children (Baker *et al.* 2010). Therefore, among families of children with ADHD and ID, it may be that increased levels of parental stress and child behaviour problems are maintaining ADHD symptoms.

The final question examined the trajectory of ADHD subtype scores from age 5 to 8 in the two groups of children. We found similar patterns of symptom trajectories. Children in the ID group had higher levels of both inattentive and hyperactive/impulsive symptoms across time, but we observed similar changes in symptoms over time. In both groups, hyperactive/impulsive symptoms decreased significantly from age 5 to 8, while inattentive symptoms remained fairly stable. The decrease in hyperactive/impulsive symptoms is consistent with de Ruiter *et al.*'s (2008) finding of decreased externalising symptoms across childhood.

A primary question when investigating the prevalence and picture of mental disorders in youth with ID is whether a given disorder (e.g. ADHD) is the same disorder in an ID versus TD population. Although some researchers have questioned the diagnostic validity of ADHD for children with ID, our results show a similar symptom picture and developmental course of ADHD symptoms for young children with and without ID, which is consistent with the position that ADHD is the same disorder regardless of disability status. The lack of sex differences, however, is at odds with the usual

finding for TD children and certainly requires more study.

It is useful to consider the results of this study within the context of methodological challenges and opportunities. The relatively small cell sizes limited our capacity to investigate the longitudinal questions by ADHD subtypes. This is an important direction for future research, given that previous studies with TD children have found differences in age of onset and stability of diagnosis by subtype (Applegate *et al.* 1997; Willoughby 2003; Waschbusch *et al.* 2007; Todd *et al.* 2008). The diagnostic interview was only administered to mothers. Multiple informants are called for in the DSM, but rarely employed in studies. We added a teacher measure of behaviour problems to increase the validity of the diagnoses, but future studies could include actual diagnostic measures from other sources. In order to understand the validity of the ADHD diagnosis for children with ID better, future studies also might address aetiological correlates and associated outcomes. Finally, future research must extend such analyses into later childhood and adolescence in order to get a complete picture of the development of ADHD among children with and without ID. Regardless, the present findings are concerning given the widespread impairment associated with ADHD as well as the high cost of this disorder to society (Jensen *et al.* 2005).

The present findings indicate that children with ID are at heightened risk for the development of ADHD and that they are more likely to have an earlier onset and more persistent course of the disorder. These findings have strong implications for intervention. Research examining the treatment of ADHD among children with ID is limited; however, the existing literature suggests that empirically supported treatments for typically developing children with ADHD, specifically stimulant medication and behavioural modification interventions, may also be effective in treating children with ID. Moreover, this research indicates that the combined use of stimulant medication and behavioural interventions can be beneficial for children with ID (Johnson *et al.* 1995; Handen *et al.* 1996). Given the high prevalence of ADHD among children with ID, it is critical that future research continues to examine interventions for this population.

References

Achenbach T. M. & Rescorla L. A. (2001) *Manual for the ASEBA School-Age Forms and Profiles*. University of Vermont, Research Center for Children, Youth, and Families, Burlington, VT.

Alloway T. P. (2010) Working memory and executive function profiles of individuals with borderline intellectual functioning. *Journal of Intellectual Disability Research* **54,** 448–56.

American Psychiatric Association (APA) (2000) *Diagnostic and Statistical Manual of Mental Disorders, DSM-IV, Fourth Edition Text Revision*. American Psychiatric Association, Washington, DC.

Applegate B., Lahey B. B., Hart E. L., Biederman J., Hynd G. W., Barkley R. A. *et al.* (1997) Validity of the age-of-onset criterion for ADHD: a report from the DSM-IV field trials. *Journal of the American Academy of Child and Adolescent Psychiatry* **36,** 1211–21.

Baker B. L., Blacher J., Crnic K. & Edelbrock C. (2002) Behavior problems and parenting stress in families of three-year-old children with and without developmental delays. *American Journal on Mental Retardation* **107,** 433–44.

Baker B. L., McIntyre L. L., Blacher J., Crnic K., Edelbrock C. & Low C. (2003) Pre-school children with and without developmental delay: behaviour problems and parenting stress over time. *Journal of Intellectual Disability Research* **47,** 217–30.

Baker B. L., Neece C. L., Fenning R., Crnic K. & Blacher J. (2010) Mental disorders in five year old children with or without intellectual disability: focus on ADHD. *Journal of Clinical Child and Adolescent Psychology* **39,** 492–505.

Barkley R. A. (1997) Behavioral inhibition, sustained attention, and executive functions: constructing a unifying theory of ADHD. *Psychological Bulletin* **121,** 65–94.

Biederman J., Mick E. & Faraone S. V. (2000) Age-dependent decline of symptoms of attention deficit hyperactivity disorder: impact of remission definition and symptom type. *The American Journal of Psychiatry* **157,** 816–18.

Claude D. & Firestone P. (1995) The development of ADHD boys: a 12-year follow-up. *Canadian Journal of Behavioural Science* **27,** 226–49.

Cohen J. (1988) *Statistical Power Analysis for Behavioral Sciences*, 2nd edn. Academic Press, New York.

Costello E. J., Edelbrock C. S. & Costello A. J. (1985) Validity of the NIMH diagnostic interview schedule for children: a comparison between psychiatric and pediatric referrals. *Journal of Abnormal Child Psychology* **13,** 579–95.

Dekker M. C. & Koot H. M. (2003) DSM-IV disorders in children with borderline to moderate intellectual disabil-

ity. I: prevalence and impact. *Journal of the American Academy of Child and Adolescent Psychiatry* **42,** 915–22.

Dekker M. C., Koot H. M., van der Ende J. & Verhulst F. C. (2002) Emotional and behavioral problems in children and adolescents with and without intellectual disability. *Journal of Child Psychology and Psychiatry* **43,** 1087–98.

Edelbrock C., Crnic K. & Bohnert A. (1999) Interviewing as communication: an alternative way of administering the diagnostic interview schedule for children. *Journal of Abnormal Child Psychology* **27,** 447–53.

Emerson E. (2003) Prevalence of psychiatric disorders in children and adolescents with and without intellectual disability. *Journal of Intellectual Disability Research* **47,** 51–8.

Emerson E. & Einfeld S. (2010) Emotional and behavioural difficulties in young children with and without developmental delay: a bi-national perspective. *Journal of Child Psychology and Psychiatry* **51,** 583–93.

Emerson E., Einfeld S. & Stancliffe R. J. (2010) The mental health of young children with intellectual disabilities or borderline intellectual functioning. *Social Psychiatry and Psychiatric Epidemiology* **45,** 579–87.

Fee V. E., Matson J. L. & Benavidez D. A. (1994) Attention deficit-hyperactivity disorder among mentally retarded children. *Research in Developmental Disabilities* **15,** 67–79.

Gjaerum B. & Bjornerem H. (2003) Psychosocial impairment is significant in young referred children with and without psychiatric diagnoses and cognitive delays: applicability and reliability of diagnoses in face of co-morbidity. *European Child & Adolescent Psychiatry* **12,** 239–48.

Handen B. L., McAuliffe S. & Caro-Martinez L. (1996) Stimulant medication effects on learning in children with mental retardation and ADHD. *Journal of Developmental and Physical Disabilities* **8,** 335–46.

Handen B. L., McAuliffe S., Janosky J., Feldman H. & Breaux A. M. (1998) A playroom observation procedure to assess children with mental retardation and ADHD. *Journal of Abnormal Child Psychology* **26,** 269–77.

Hastings R. P., Beck A., Daley D. & Hill C. (2005) Symptoms of ADHD and their correlates in children with intellectual disabilities. *Research in Developmental Disabilities* **26,** 456–68.

Hill J. C. & Schoener E. P. (1996) Age-dependent decline of attention deficit hyperactivity disorder. *The American Journal of Psychiatry* **153,** 1143–6.

Jensen P. S., Watanabe H. K. & Richters J. E. (1999) Who's up first? Testing for order effects in structured interviews using a counterbalanced experimental design. *Journal of Abnormal Child Psychology* **27,** 439–45.

Jensen P. S., Hinshaw S. P., Kraemer H. C., Lenora N., Newcorn J. H., Abikoff H. B. *et al.* (2001) ADHD co-morbidity findings from the MTA study: comparing co-morbid subgroups. *Journal of the American Academy of Child and Adolescent Psychiatry* **40,** 147–58.

Jensen P. S., Garcia J. A., Glied S., Crowe M., Foster M., Schlander M. *et al.* (2005) Cost-effectiveness of ADHD treatments: findings from the multimodal treatment study of children with ADHD. *The American Journal of Psychiatry* **162,** 1628–36.

Johnson C. R., Handen B. L., Lubetsky M. J. & Sacco K. A. (1995) Affective disorders in hospitalized children and adolescents with mental retardation: a retrospective study. *Research in Developmental Disabilities* **16,** 221–31.

Johnston C. & Mash E. J. (2001) Families of children with attention-deficit/hyperactivity disorder: review and recommendations for future research. *Clinical Child and Family Psychology Review* **4,** 183–207.

Pearson D. A., Yaffee L. S., Loveland K. A. & Lewis K. R. (1996) Comparison of sustained and selective attention in children who have mental retardation with and without attention deficit hyperactivity disorder. *American Journal on Mental Retardation* **100,** 592–607.

Raudenbush S. W. & Bryk A. S. (2002) *Hierarchical Linear Models: Applications and Data Analysis Methods*, 2nd edn. Sage, Newbury Park, CA.

Reiss S. & Valenti-Hein D. (1994) Development of a psychopathology rating scale for children with mental retardation. *Journal of Consulting and Clinical Psychology* **62,** 28–33.

de Ruiter K. P., Dekker M. C., Douma J. C. H., Verhulst F. C. & Koot H. M. (2008) Development of parent- and teacher-reported emotional and behavioural problems in young people with intellectual disabilities: does level of intellectual disability matter? *Journal of Applied Research in Intellectual Disabilities* **21,** 70–80.

Schuchardt K., Gebhardt M. & Mäehler C. (2010) Working memory functions in children with different degrees of intellectual disability. *Journal of Intellectual Disability Research* **54,** 346–53.

Sparrow S. S., Balla D. A. & Cicchetti D. V. (1984) *Vineland Adaptive Behavior Scales*. American Guidance Service, Circle Pine, MN.

von Stauffenberg C. & Campbell S. B. (2007) Predicting the early developmental course of symptoms of attention deficit hyperactivity disorder. *Journal of Applied Developmental Psychology* **28,** 536–52.

Thorndike R. L., Hagen E. & Sattler J. (1986) *The Stanford-Binet Intelligence Scale*, 4th edn (Technical Manual). Riverside Publishing, Itaska, IL.

Todd R. D., Huang H., Todorov A. A., Neuman R. J., Reiersen A. M., Henderson C. A. *et al.* (2008) Predictors of stability of attention-deficit/hyperactivity disorder subtypes from childhood to young adulthood. *Journal of the American Academy of Child and Adolescent Psychiatry* **47,** 76–85.

Tonge B. J., Einfeld S. L., Krupinski J. & Mackenzie A. (1996) The use of factor analysis for ascertaining patterns of psychopathology in children with intellectual disabilities. *Journal of Intellectual Disability Research* **40,** 198–207.

Voigt R. G., Barbaresi W. J., Colligan R. C., Weaver A. L. & Katusic S. K. (2006) Developmental dissociation, deviance, and delay: occurrence of attention-deficit-hyperactivity disorder in individuals with and without borderline-to-mild intellectual disability. *Developmental Medicine and Child Neurology* **48,** 831–5.

Waschbusch D. A., King S. & Gregus A. (2007) Age of onset of ADHD in a sample of elementary school students. *Journal of Psychopathology and Behavioral Assessment* **29,** 9–16.

Willoughby M. T. (2003) Developmental course of ADHD symptomatology during the transition from childhood to adolescence: a review with recommendations. *Journal of Child Psychology and Psychiatry* **44,** 88–106.

Accepted 1 March 2011