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Published

2016

Journal Title

Child: Care, Health and Development

Version

Accepted Manuscript (AM)

DOI

10.1111/cch.12346

Comparison of parental estimate of developmental age with measured IQ in children with neurodevelopmental disorders

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Grant sponsor: Clothworkers' Foundation, brokered by Research Autism

Grant number: R011217 Autism M10 2011/12

Short title: Parental estimate of developmental age

ABSTRACT

Background Formal IQ tests are an important part of the diagnostic and needs-based assessment process for children with neurodevelopmental disorders. However, resources for such assessments are not always available. It has been suggested that parental estimates of their child's developmental age could serve as a proxy IQ when formal measures are unavailable.

Method Parental estimates of their child's developmental age were converted to a developmental quotient (DQ) in 197 children with Autism Spectrum Disorder (ASD) aged 4-9 years, and 108 children with ADHD and intellectual disability (ADHD+ID) aged 7-15 years. Formal IQ assessments were then conducted. Parents completed the Social Communication Questionnaire ((SCQ), a measure of autism symptomatology), and a demographic questionnaire.

Results In the ASD sample, 58% of parent estimates were within 15 points (i.e., one standard deviation) of the child's measured IQ score. Lower measured IQ and lower SCQ total score predicted higher parental accuracy. In the ADHD+ID sample, 74% of parental estimates were within 15 points of measured IQ. In this group, higher child IQ predicted greater parental accuracy. Parents in the ADHD+ID group were more likely to overestimate children's ability level than parents in the ASD group.

Conclusions In this study, the majority of parents of children with ADHD and ID were able to estimate their child's intellectual ability level with some accuracy. Parents of children with ASD were less accurate but this may be because these parents were focussing more on children's level of adaptive functioning, which is known to be typically lower than cognitive ability in ASD.

Key Messages.

Within this study of two groups of children with neurodevelopmental disorders:

- parents of children with ADHD and intellectual disability were able to provide relatively accurate estimates of developmental level.
- parents of children with ASD were less accurate in estimating developmental level. This may be because parents were focussing on adaptive function rather than IQ.

INTRODUCTION

In clinical services for children with developmental disorders, formal cognitive (IQ) assessments are important to aid diagnosis, and to inform educational and therapeutic needs. However, standardised IQ testing requires resources that are not always available. These include costly test materials, the need for trained professionals to administer the tests and interpret the results, and the length of time required to complete assessments. Furthermore, validity of the assessment can depend on the appropriateness of the test for the child's age and ability, and on the degree of engagement by the child; indeed, detailed IQ testing may not be possible for many children with severe intellectual disability (Madhavaram, 2011).

Limited access to detailed psychometric assessments can be a particular problem in busy paediatric settings and for this reason asking parents to estimate their child's developmental age is common clinical practice. Previous studies of children in mainstream schools have suggested that parents' estimates of their child's developmental age may be a useful proxy for assessing intellectual ability when formal measures are unavailable. For example, a study of 70 elementary school children found that 80% of mothers were able to estimate their child's IQ to within one standard deviation (Delgado-Hachey and Miller, 1993). And, in a sample of 141 five to 15 year olds, Furnham and Bunclark (2006) found parental estimates of children's overall intelligence correlated moderately with measured IQ scores (r=.44). However, other studies suggest that parents tend to overestimate their children's ability (Miller et al., 1991); accuracy also seems to vary according to child's age (Chamorro-Premuzic et al., 2008) and gender (Furnham and Bunclark, 2006; Furnham et al., 2002).

Accuracy of parental estimate has also been investigated in studies of children with developmental and physical disabilities (Ewert and Green, 1957; Schulman and Stern, 1959; Keshavan and Narayana, 1983; Tew et al., 1974; Coplan, 1982), generally indicating good agreement between parents' estimates and measured developmental age (Pulsfier et al., 1994). For example, in a study of 46 children, aged 2 to 5 years with known or suspected developmental disabilities, Coplan (1982) found a correlation of .85 between mothers' estimates of their children's developmental level and formal

developmental assessments (FDQs). Parental estimates (categorized as </>70) displayed 75% sensitivity and 100% specificity in identifying children with a FDQ of <70. However, there was a slight tendency for mothers to overestimate their child's abilities. This was also noted in an earlier study (Tew et al., 1974) of children with spina-bifida, where parents of children with borderline IQ to mild intellectual impairments were particularly likely to overestimate ability.

Paediatricians without access to psychological testing often rely on parental estimates of ability in children with developmental disorders, but how accurate are such estimates? In the present study we investigated accuracy of parental estimates of IQ in two convenience samples of children, aged 4-16 years, with neurodevelopmental disorders: Autism Spectrum Disorder (ASD) and Attention Deficit Hyperactivity Disorder (ADHD),

METHODS

Participants and Procedure

Table 1 about here

ASD sample

ASD participants were part of the QUEST cohort, a study assessing emotional and behavioural problems in young children with ASD (Salazar et al., 2015; Chandler et al., 2015). The study was approved by Guy's Hospital Research Ethics Committee (08/H0804/37) and Bromley and Lewisham Local Research Ethics Committees (RDLEWBR 428).

The target sample included all children living in two London boroughs who were born between 01/09/2000 and 01/09/2004 (aged 4-8 years at time of recruitment) and had a formal diagnosis of ASD made by the local multidisciplinary team (details of diagnostic measures, Salazar et al., 2015; Chandler et al., 2015). The boroughs represented individuals across a broad spread of socio-economic and ethnic groups (total n=447). Eligible families were mailed information sheets, invitations to participate, and consent forms. Non-responders were telephoned. Consenting families were then mailed a questionnaire pack and arrangements were made to conduct children's cognitive assessments in school.

Responses were received from 362 (81%) eligible families (see Figure 1). Parental questionnaires were completed on 277 (62%) but 80 children were excluded from the present analysis due to missing data (no measured IQ: n=15; no parental estimate: n=61; neither: n=4), resulting in a total of 197 with both a parental estimate and measured IQ. Included and excluded cases did not differ in terms of autism symptomatology (SCQ totals = 19.7 vs 21.1, p = .16); school placement (77% of the included and 83% of the excluded group in mainstream education, p = .24), or parental education (55% of included parents had A-levels or above vs 45% of the excluded group p =.16). However, excluded children were slightly older at entry to the study than those included (7 years, 1 month vs 6 years, 8 months, $t(275)=3.06$, p = .002). Mean age of the final sample when assessed was 6 years 10 months (range 4-9 years). Most children (77%, n=151) attended mainstream school/nursery; 40 (20%) were in special school; five (2.5%) were in special units attached to mainstream schools, one was home-schooled. Ethnicity data indicated that 48% of families were white; 30% were black African/Caribbean; 22% were "Other".

ADHD and intellectual disability sample (ADHD+ID)

ADHD+ID participants were part of a randomised controlled trial of stimulant medication in children with ADHD and intellectual disability (ID) (Simonoff et al., 2013). The study was approved by the Southeast Multi-Centre Research Ethics Committee (MREC +04/01/013).

Participants were recruited through clinical referrals and community screening across the south-east of England. Inclusion criteria were: age 7-15 years; full-scale IQ 30-69[a]; clinical diagnosis of ICD-10 hyperkinetic disorder. Diagnosis of hyperkinetic disorder was subsequently confirmed using the Child and Adolescent Psychiatric Assessment (CAPA; Angold et al., 1995). Of 890 children assessed for eligibility (full details, Simonoff et al., 2013), 122 met trial criteria and were recruited (see Figure 2). Written informed consent was obtained from parents/legal guardians, with assent from children as appropriate for their level of understanding. Fourteen children were excluded

[a] During final data-cleaning, one participant's full-scale IQ was recoded from 69 to 71; these data were not excluded from analysis as the participant met all other study criteria.

due to missing data (child unable to complete IQ test due to very low ability: n=1; no parent-estimated DQ: n=13) resulting in 108 cases with both parent estimated DQ and a measured IQ. Included and excluded cases did not differ in terms of SCQ (mean totals =16.8 vs 18.9, p =.36); proportion in mainstream education (21% vs. 14%, p=.54) or age (11 years, 1 month vs 10 years, 4 months, p=.34), although a smaller proportion of parents in the included group was educated to A-level (22% vs. 50% of excluded group; X^2 (1)= 5.17, p=.023). Mean age of the group at assessment was 11 years, 0 months (range = 7 years, 0 months – 15 years, 10 months). Twenty three children (21%) were in mainstream education; 79 (73%) attended special schools; six (6%) attended special units attached to mainstream schools. Ethnicity data were not available for this group. Summary characteristics of the groups are provided in Table 1.

Measures

IQ was measured using either the Wechsler Intelligence Scale for Children (WISC-IV; Wechsler, 2003), Wechsler Preschool and Primary Scale of Intelligence (WPPSI-III; Wechsler, 2002), or Mullen Scales of Early Learning (MSEL; Mullen, 1995), depending on age and developmental level. Ratio IQs were employed when the MSEL was used out of age range (to avoid floor effects in participants of low ability). In the ASD group, 46 completed the WISC-IV, 122 the WPPSI-III, 39 the MSEL. In the ADHD+ID group, 66 completed the WISC-IV, 40 the WPPSI-III, 2 the MSEL.

Autism symptomatology was measured using the parent rated Social Communication Questionnaire Lifetime version (SCQ; Rutter et al., 2003). The SCQ comprises 39 items scored 0 or 1; a cut-off of $\geq$15 is recommended for identifying potential ASD cases.

Data on ethnicity (ASD sample only), parental education, number of children and number of other children with special educational needs (SEN) in the home, and type of school attended by the child were collected by questionnaire.

Parental estimate of developmental quotient (DQ)

Parents in the ASD sample were asked: *"It is always helpful to know at what age you think your child is behaving; at what age do you think your child is functioning overall?*" Parents in the ADHD+ID sample were asked: *"At what developmental age do you think*

your child is functioning?". In both samples, this question preceded IQ testing. Parental estimates of developmental age were then used to derive a developmental quotient (DQ) [DQ = (developmental age/chronological age) x100].

Analysis

Difference scores (i.e. the difference, both positive and negative, between parent-estimated DQs and measured IQs) were calculated and used in a multiple linear regression analysis with the difference score as the dependent variable, and measured IQ, SCQ total, child's age and gender as the predictors. A factorial ANOVA was used to explore the effect of background factors (school placement, presence of other children/other SEN children at home, parental education and, for the ASD sample only, ethnicity) on difference scores. Difference scores were banded according to whether parental estimates were within 15 points (1 test SD), 16-30 points (2 test SDs) or more than 30 points (>2 SDs) of measured IQ. Multinomial logistic regression was used to explore factors associated with parental accuracy using "within 15 points" as the baseline category. X^2 and Fisher's Exact tests were used to explore whether any factors were associated with differences in direction of parental estimates (i.e. over- vs under-estimations). As the analysis was largely exploratory, significance level was set at $p<.05$. Analyses were undertaken separately for the two samples.

RESULTS

ASD group

Table 2 & Figure 3a and 3b about here

Although there was a strong positive correlation between parent-estimated DQs and measured IQs ($r(197) = .71$, $p<.0001$; see Figure 3a), the mean measured IQ score was significantly higher (M=72.6, SD=27.7) than the mean parent-estimated DQ (M=68.9, SD=23.2; , $t(196)$=-2.68, $p = .008$). Difference scores ranged from -77 (parental under-estimation) to + 46 (parental over-estimation), with a mean of -3.99 (SD=13.1). Table 2 presents mean difference scores broken down by child and background factors.

Multiple regression showed lower difference scores (ie. parental under-estimates) were associated with higher measured IQ (β=.-.37, p <.001) and SCQ score (β = -.38, p=.011); no association was found between difference scores and child's age (p = .59) or

gender (=.28). A factorial ANOVA indicated a significant effect for school placement on difference score ($F(1, 186) = 18.6$, p<.0001), with lower difference scores among the mainstream group (see Table 2); no other background factors (presence of other children/presence of other children with SEN at home, parental education, ethnicity) were significant (all p>.08). Fifty-eight percent of parental estimates were within 15 points of measured IQ (22% within 0-5 points; 18% within 6-10 points and 18% within 11-15 points); 92% were within 30 points. Multinomial regression showed poor parental accuracy (estimates >30 points from measured IQ, relative to estimates within 15 points) was associated with higher child IQ (Wald (1) =4.40, p<.05). Higher SCQ scores were also associated with less accurate estimates (16-30 points from measured IQ, relative to estimates within 15 points; Wald (1) = 5.02, p<.05). Direction of parental estimates varied with IQ, school placement and ethnicity. Thus, parents of children with IQ≥70 were more likely to under-estimate their child's level (72% under-estimated); parents of children with IQ<70 were more likely to over-estimate (72% over-estimated, X^2 (1) = 35.4, p<.001). Parents of children in mainstream education were also more likely to under-estimate (64% under-estimated), while parents of children in specialist settings were more likely to over-estimate (65% over-estimated; X^2 (1) = 11.9, p<.05). Parents of white Caucasian children were more likely to under-estimate (66% under-estimated) whereas parents of children of other ethnicities over- and under-estimated in almost equal measure (49% under-estimated, 51 over-estimated, X^2 (1) = 5.35, p<.05). Other background factors (gender, presence of other children/other SEN children at home, parental education) were not associated with direction of parental estimation (all p >.2).

ADHD + ID group

Table 3 about here

In the ADHD+ID group there was only a weak correlation between parent-estimated DQs and measured IQs (r (108) = .29, p =.002; see Figure 3b) and measured IQ scores were significantly lower than parent-estimated DQs (IQ M=53.4, SD=10.1 vs DQ M=57.2, SD=11.8; t (107) = -3.02, p =.003). In contrast to the ASD group, parents in the ADHD+ID group were more likely to overestimate their child's developmental level (58% overestimated vs. 43% in the ASD sample, z = 2.39, p<.05). The mean difference

score in the ADHD+ID group was +3.80 (SD 13.1, range =-26-+33) compared with -3.99 in the ASD group (SD 18.2, t (107) = 6.19, p<.001). Table 3 presents ADHD+ID mean difference scores broken down by child and background factors.

As with the ASD group, multiple linear regression showed difference scores were predicted by measured IQ (β = -.71, p<.001) and SCQ score (β=-.32, p<.05), but not by child's age (p=.53) or gender (p=.62). A factorial ANOVA found no significant effects for any background factors (school placement, other children/other SEN children at home, parental education) on difference scores (all p>.2). Seventy-four percent of ADHD+ID parental estimates were within 15 points of measured IQ (32% within 0-5 points; 24% within 6-10 points; 18% within 11-15 points); 97% were within 30 points. Multinomial regression found no child or background factors to be associated with the different levels of accuracy (within 15 IQ points, 16-30+ points; multinomial regression, all p>.3). However, parents of children with a greater degree of ID (IQ <50) were more likely to over-estimate their child's level (80%) than parents of children with an IQ between 50 and 71 (48%; Fisher's Exact, p=.003**).**

DISCUSSION

This study investigated the accuracy with which parents of children with ASD and parents of children with ADHD+ID were able to estimate their child's cognitive ability. In both groups, the mean group difference between estimated DQ and measured IQ score was relatively small (-3.99 and +3.80 for the ASD and ADHD+ID samples respectively) but the range of difference scores, both positive and negative, was very wide, particularly in the ASD sample. In this group, although the correlation between parental estimates and measured scores was high (r=.71), only 58% of parental estimates were within 1 SD of measured IQ. In the ADHD +ID group, in contrast, the correlation between estimated and actual scores was much lower (r=.29) but almost three quarters of parental estimates were within 15 points of measured IQ. The truncated IQ range (31-71) in the ADHD+ID group will have reduced the variance between parental estimates and measured IQs and this may have contributed both to the weak correlation between parent-estimates and measured IQ, and to the higher proportion of estimates within 15 points of measured IQ. The fact that ADHD+ID parents all knew that their children had an intellectual disability

may also have improved their accuracy. Furthermore, the ADHD+ ID group was older than the ASD sample and, as children get older, parents may become more aware of their learning problems and the gap between them and "typical" children. Importantly, these findings indicate that the strength of correlation between measures does not necessarily reflect the degree of agreement between ratings.

In neither group was parental accuracy related to child's age or gender, parental education or the presence of other children at home. However, in the ASD group there was a moderate association between parental accuracy and autism severity. In both groups IQ was related to the discrepancy between estimated and actual scores but, whereas in the ASD sample accuracy was greater for children of lower measured ability, in the ADHD+ID group the opposite trend was found, i.e. parental accuracy was greater for children of higher IQ

One explanation for this finding may be that measured full scale IQ is not a robust measure of functional ability (adaptive skills) in autism. For example, cognitive profiles in ASD are typically very uneven, with often significant discrepancies between verbal and performance IQ scores (Charman et al., 2011). Adaptive behaviour scores also tend to be lower than IQ scores, particularly in children with ASD of average intelligence (Charman et al., 2011; Bolte and Poustka, 2002). In this cohort, higher levels of autism symptomatology (as measured by the SCQ) were associated with a greater tendency for parents to underestimate their children's cognitive level and this may reflect the extent to which the severity of autistic symptoms limits functional competence:.

Discrepancies between measures of adaptive functioning and IQ have also been found for children with ADHD (Roizen et al., 1994) but as the discrepancy tends to be greater in children of higher IQ this is less likely to have influenced parental estimates within our group of children with ADHD and intellectual disability. In fact, in this sample, parental accuracy increased with higher measured IQ. It is also worth noting that whilst both the ASD and ADHD+ID groups were asked about their child's "functioning" (which could be interpreted as including cognitive and non-cognitive abilities such as adaptive functioning), the ADHD+ID group were explicitly asked about "developmental age", whereas for the ASD group the question was preceded by a statement about "age of behaving" followed by "overall function" which may have led them to view their child's abilities in global behavioural rather than cognitive terms.

The present study has a number of strengths. Sample size was large; similar assessment protocols were completed for both the ASD and ADHD+ID groups; formal IQ measures as well as parental estimates of ability were collected on over 300 children, and the ASD sample comprised children across a wide IQ and age range. However, there are also several methodological issues that may affect the findings.

The principal limitation is the absence of a formal adaptive behaviour measure (e.g. Vineland Adaptive Behavior Scales, Sparrow et al., 2005), which may have been a more appropriate metric against which to compare parental accuracy, especially in the ASD group. Secondly, in the ASD group, participants were not reassessed using standard diagnostic measures although clinical records of any child with a low score on the SCQ score (i.e. total < 10; n=28) were checked with local clinicians and diagnosis was confirmed by the clinical team in all cases. Thirdly, slight differences in the wording of the question to parents in the two groups about their child's estimated level of ability may have influenced the findings, although we cannot be sure how, or to what extent

Finally, different IQ assessments were used, depending on children's age and level of functioning. While the majority (87%) was assessed using the WPPSI-III or WISC-IV, for a small number of very low ability children who could not score on the Wechsler tests it was necessary to use the Mullen scales. Mullen scores were significantly lower than Wechsler test scores (M = 30.2, SD = 10.1 vs M=71.3, SD=21.3 t-test p<.001).The discrepancy between parent estimate and measured IQ was greater in the Mullen subgroup, reflecting our overall finding that, across both cohorts, parents of children with increased ID were more likely to overestimate their child's ability. Consistent with this, the mean difference between parent estimate and measured IQ for the Mullen group was +8.84 (SD = 14.2), indicating overall overestimation, whereas for the Wechsler group the mean difference was -2.80 (SD = 16.8), indicating overall underestimation.

In conclusion, our findings indicate that, among children with hyperkinetic disorder and intellectual disability, parental estimates of functioning can provide a good estimate (within 15 points) of measured IQ. In children with ASD, however, parental estimates of developmental age should be used with caution, especially among children of higher cognitive ability. We suggest that, in ASD, parental estimates of IQ may be influenced by children's autism severity and/or their relatively lower levels of adaptive

behaviour, and thus be of more value in assessing overall functional competence than intellectual ability.

Acknowledgements

We thank Lewisham Autism Support and the Complex Communication Diagnostic Service in Bromley for their support. We thank all the families and schools who participated. This paper represents independent research part funded by the National Institute for Health Research (NIHR) Biomedical Research Centre at South London and Maudsley NHS Foundation Trust and King's College London and Research Autism. The views expressed are those of the author(s) and not necessarily those of the NHS, the NIHR or the Department of Health.

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Table 1. Sample characteristics

	ASD sample N=197	ADHD+ID sample N=108
Mean age at test (SD)	6.8 (1.3) years	11.1 (2.3) years
Range	4.3 – 9.7 years	7.0 – 15.8 years
% male	81% (n=159)	68% (n=73)
Mean measured IQ (SD)	72.8 (27.4)	53.4 (10.1)
Range	19-129	31-71
Mean parent-estimated DQ (SD)	68.8 (23.8)	57.2 (11.8)
Range	13-125	27-86
Mean SCQ total (SD)	19.7 (7.6)	16.8 (8.1)
Range	1-37	0-33
School placement	77% in mainstream	21% in mainstream
Parental education	55% with A-levels	22% with A-levels
Child ethnicity	49% white Caucasian	No data

Table 2. ASD difference scores in relation to child and other background factors.

	Difference score[a] Mean (SD)	Difference score range
Child under 7 years (n=100)	-3.48 (18.0)	-77 to +28
Child over 7 years (n=97)	-4.51 (18.4)	-53 to +46
Boys (n=159)	-4.35 (18.6)	-28 to +46
Girls (n=38)	-2.49 (16.6)	-39 to +26
IQ<70 (n=68)	7.65 (13.9)**	-32 to +46
IQ≥70 (n=129)	-10.13 (17.1)**	-77 to +28
SCQ <15 (n=50)	-2.78 (16.2)	-39 to +31
SCQ ≥15 (n=147)	-4.40 (18.8)	-77 to +46
Not in mainstream (n=46)	-6.97 (17.9)**	-31 to +46
In mainstream (n=151)	5.81 (15.6)**	-77 to +31
No other children in household (n=9)	-2.94 (17.3)	-30 to +23
Other children in household (n=188)	-4.01 (18.2)	-77 to +46
No other SEN children (n=176)	-4.21 (18.1)	-77 to +31
Another SEN child at home (n=21)	-2.14 (18.9)	-32 to +46
Parental education: below A-level (n=86)	-2.67 (18.1)	-77 to +31
Parental education: A-level and above (n=105)	-5.61 (18.1)	-26 to +33
(6 missing parental education data)		
Child ethnicity: white Caucasian (n=94)	-8.41 (17.8)*	-77 to + 31
other (n=99)	-.18 (17.5)*	-45 to +46
(4 missing ethnicity)		

[a]Difference score = Parent estimated DQ – measured IQ
SEN = special educational needs
Note: negative difference scores indicate an underestimation by parents, and positive scores an overestimation.

*p<.05 (t-test)
** *p*<.001 (t-test)

Table 3. ADHD+ID difference scores in relation to child and other background factors

	Difference score[a] Mean (SD)	Difference score range
Child under 11 years (n=60)	2.38 (11.5)	-20.0 to +31.9
Child over 11 years (n=48)	5.57 (14.7)	-26.0 to +33.0
Boys (n=73)	2.78 (12.8)	-17.0 to +32.8
Girls (n=35)	5.92 (13.5)	-26.0 to +33.0
IQ<50 (n=35)	11.5 (12.3)**	-15.0 to +33.0
IQ≥50 (n=73)	0.10 (11.7)**	-26.0 to +32.8
SCQ<15 (n=43)	4.81 (13.7)	-18.0 - +32.8
SCQ ≥15 (n=59) (6 missing SCQ data)	2.64 (12.8)	-26.0 - +33.0
Not in mainstream (n=23)	2.45 (11.0)	-14.1 to +32.8
In mainstream (n=85)	4.16 (13.6)	-26.0 to +33.0
No other children in household (n=10)	0.76 (8.27)	-11.0 to +33.0
Other children in household (n=74) (24 missing data on other children)	3.98 (13.6)	-26.0 to +33.0
No other SEN children (n=65)	3.07 (13.2)	-26.0 to +33.0
Another SEN child at home (n=19) (24 missing data on other children)	5.39 (13.2)	-16.0 to +30.0
Parental education: below A-level (n=82)	4.05 (13.1)	-26.0 to 33.0
Parental education: A-level and above (n=23) (3 missing parental education data)	2.79 (13.8)	-20.0 to 31.9

[a]Difference score = Parent estimated DQ – measured IQ
SEN = special educational needs
Note: negative difference scores indicate an underestimation by parents, and positive scores an overestimation.

**p<.0001 (t-test)

Figure 1. Target population and response rate for the ASD study

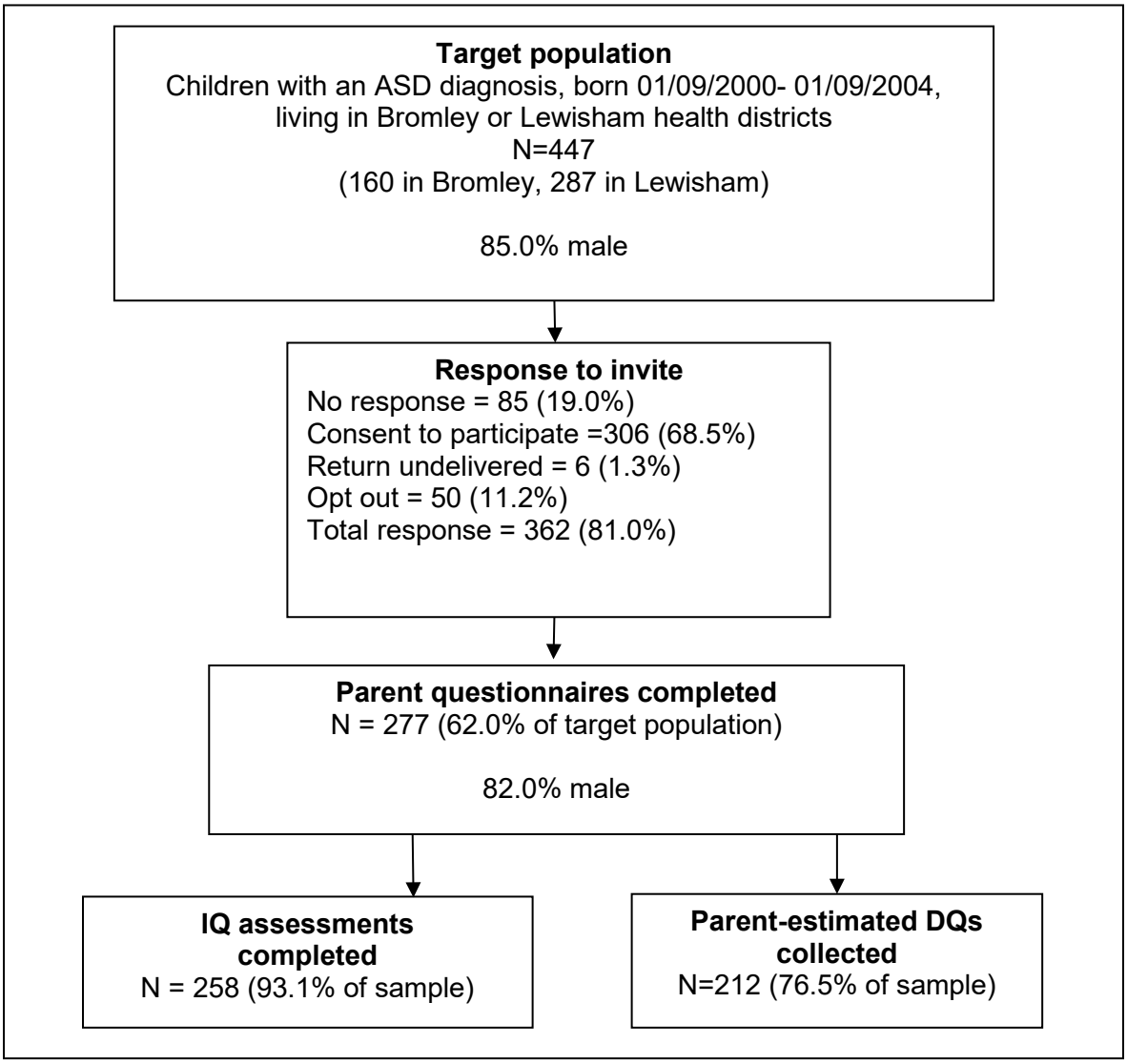

Figure 2. Participation and selection for the ADHD and ID study

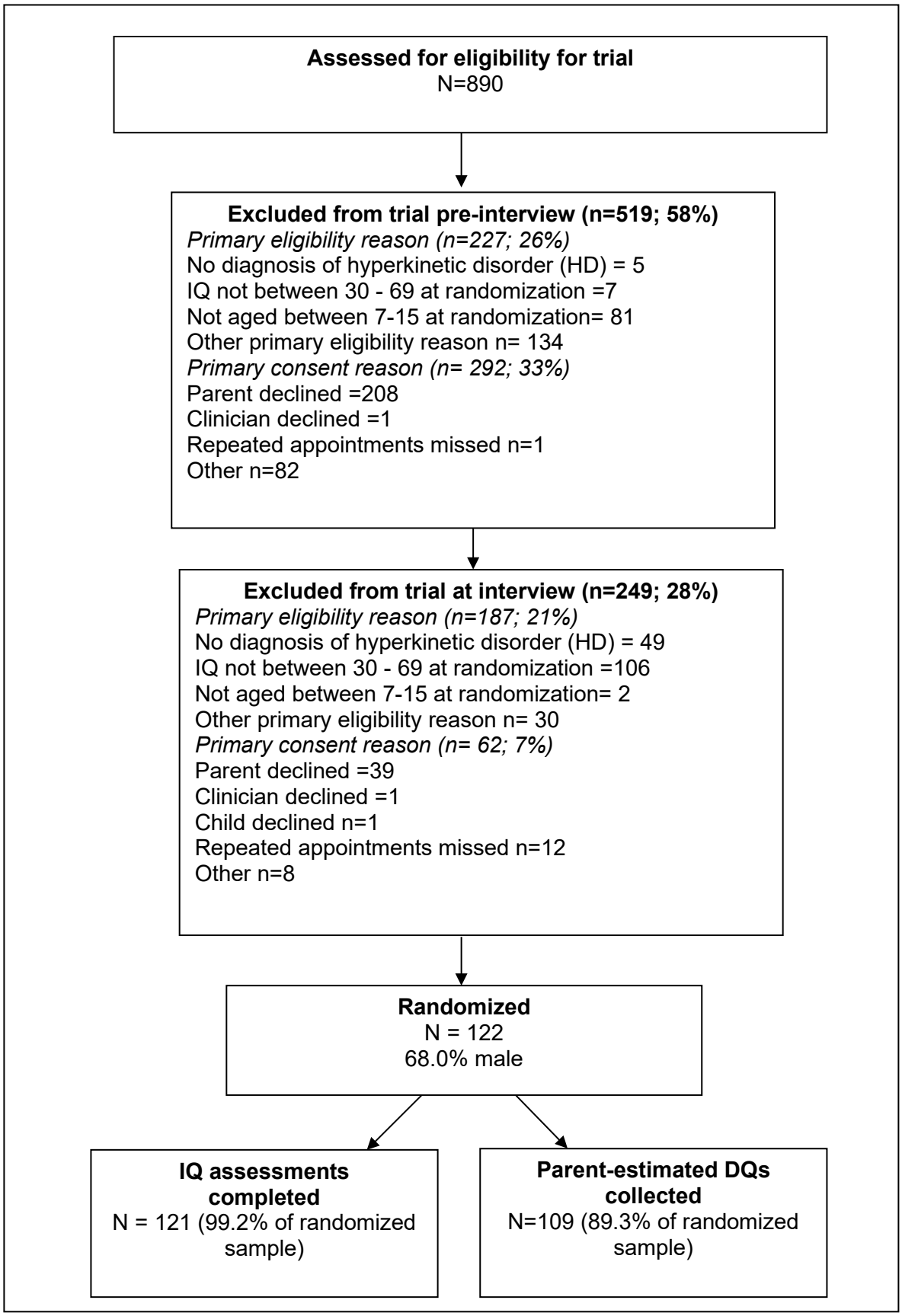

Figure 3: Scatterplots of parent-estimated DQs and measured IQs

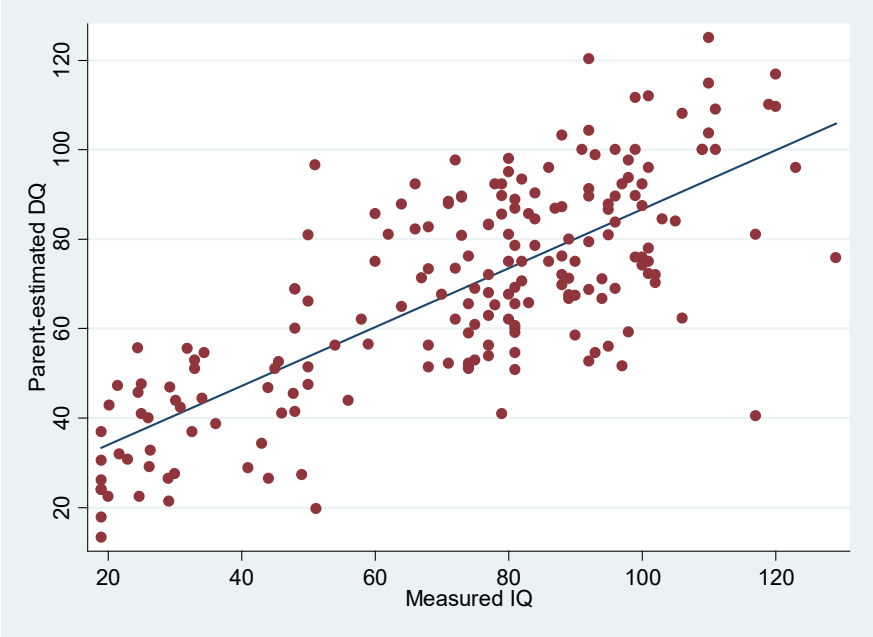

Fig. 3.a) ASD group

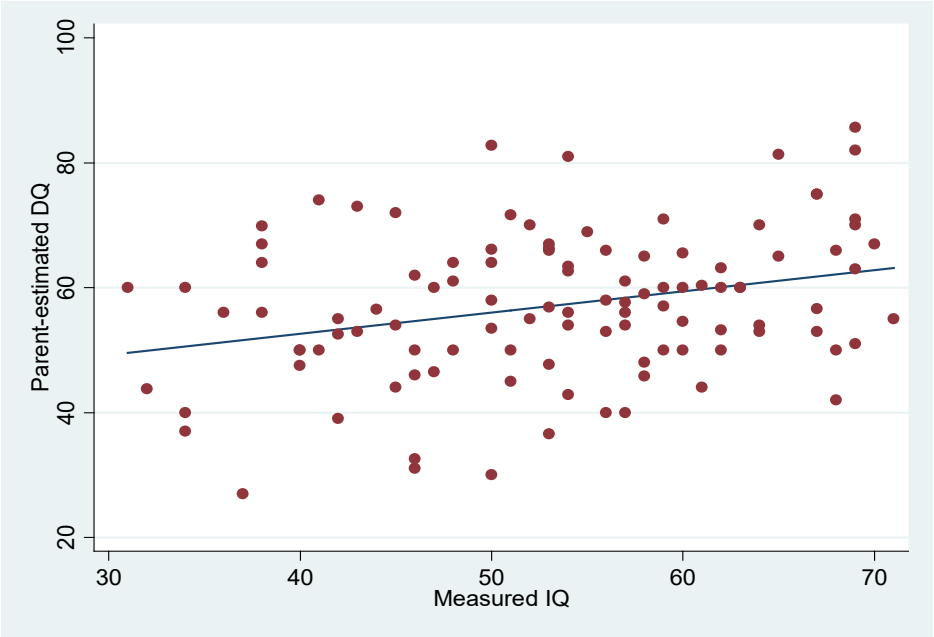

Fig. 3.b) ADHD+ID group