Validation of the Social Communication Questionnaire in a Population Cohort of Children with Autism Spectrum Disorders

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ABSTRACT

Objective: To examine the properties of the Social Communication Questionnaire (SCQ; Rutter et al., 2003) in a population cohort of children with autism spectrum disorders (ASDs), and in the general population.

Method: SCQ data were collected from three samples: The Special Needs and Autism Project (SNAP; Baird et al., 2006) cohort of 9 to 10-year-old children with special educational needs (SEN) with and without ASD and two similar but separate age groups of children from the general population (n=411 and n=247). Diagnostic assessments were completed on a stratified sub-sample (n=255) of the SEN group. A sample weighting procedure enabled us to estimate characteristics of the SCQ in the total ASD population. Diagnostic status of cases in the general population samples were extracted from Child Health Records.

Results: The SCQ showed strong discrimination between ASD and non-ASD cases (sensitivity=0.88; specificity=0.72) and between autism and non-autism cases (sensitivity=0.90; specificity=0.86). Findings were not affected by child IQ or parental education. In the general population samples, between 4-5% of children scored above the ASD cut-off including 1.5% who scored above the autism cut-off. While many of these high scoring children had an ASD diagnosis, almost all (~90%) had a diagnosed neurodevelopmental disorder.

Conclusions: This study confirms the utility of the SCQ as a first-level screen for ASD in at risk samples of school-age children.

Keywords: Autism, Autism Spectrum Disorders, Pervasive Developmental Disorders, Screening, Identification, SNAP cohort

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INTRODUCTION

The prevalence of autism spectrum disorders (ASDs), the common clinical term for the pervasive developmental disorders (PDDs) described in the psychiatric classification systems (DSM-IV-TR, 2000; ICD-10, 1993), is now recognized to be between 60 and 116 per 10,000, depending on the strictness with which the diagnostic criteria are applied (Baird et al., 2000, 2006; Chakrabarti and Fombonne, 2001, 2005; Green et al., 2005; Honda et al., 2005). Diagnosis requires careful history-taking and observation. However, screening questionnaires can help highlight a group requiring more in-depth diagnostic assessment. The Social Communication Questionnaire (SCQ; Rutter et al., 2003) is a recently developed screening tool for ASD, based on the Autism Diagnostic Interview-Revised (ADI-R; Lord et al., 1994) and is increasingly widely-used in clinical research and practice. In the initial validation study the SCQ discriminated well between ASD and non-ASD cases with a sensitivity of 0.85 and a specificity of 0.75 (Berument et al., 1999). The ability of the SCQ to discriminate between ASD and non-ASD cases in two samples of 3-to-6-year-old children has recently been reported. Eaves and colleagues found reduced sensitivity (0.71) in one study (Eaves et al., 2006a) and reduced specificity (0.54) in the second (Eaves et al., 2006b). Several other first-level screens for identifying potential cases of ASD have also been recently published, including the Social and Communication Disorders Checklist (SCDC; Skuse et al., 2005) and the Social Responsiveness Scale (SRS; Constantino and Gruber, 2005).

However, the initial validation study of the SCQ (Berument et al., 1999) had a number of limitations on the generalisability of its findings: the study was carried out with samples that had previously completed the ADI-R thus introducing potential response bias; the samples were recruited from a number of different research studies and clinical sources; and

many participants with autism were adults but the non-ASD participants were predominantly children.

The first aim of the present study was to examine the instrument properties of the SCQ in a population cohort of children with special educational needs (SENs) with and without ASD. The second aim was to explore how the SCQ performed in samples of similar age children from the general population, with whom the SCQ has not previously been used.

METHOD

The study was approved by the South East Multicentre Research Ethics Committee (REC) (00/01/50), East Sussex Local REC (04/Q/1905/6) and West Kent Local REC (153/8/02).

Social Communication Questionnaire (SCQ)

Screening of all children was carried out using the SCQ (Rutter et al., 2003). The SCQ is a parent-report questionnaire asking about characteristic autistic behaviour at the age of 4-5 years and currently. Total scores can range from 0 to 39. It is based on the Autism Diagnostic Interview-Revised (ADI-R; Lord et al., 1994) and has established validity with the ADI-R and a diagnosis of autism (Berument et al., 1999).

Samples

SCQ data were collected from three different samples: (i) *Special Needs and Autism Project (SNAP) sample*: a cohort of children 'at risk' for ASD due either to having received a local clinical ASD diagnosis or by having a Statement of Special Educational Needs (SEN) (Baird et al., 2006). A Statement of Special Educational Needs is a legal document issued by the UK local educational authority when children require significant additional support in school due to any learning and/or behavioural problems; (ii) a group of non-Statemented children from mainstream schools (*School sample*); and (iii) and a group of children living in one postal district in the same geographic area (*General population sample*).

'At risk' (SNAP) cohort

As part of a prevalence study of ASD, within a total population cohort of 56,946 children born between July 1st 1990 and December 31st 1991 (Baird et al., 2006) all those with a current clinical diagnosis of PDD (n=255) or considered 'at risk' for being an undetected case by virtue of having a Statement of SEN (n=1,515) were screened. A total of 1,066 SCQs were returned completed (mean return rate 60.2%), 31 families declined further participation, leaving 1,035 (return rate 58.5%) who returned the SCQ and opted in for further assessments (see Figure 1 for sample ascertainment). Mean (SD) age at screening in this SEN/ASD sample was 10.3 (0.4) years.

Figure 1 about here

A stratified subsample (by coincidence also n=255) received a comprehensive diagnostic assessment including standardized clinical observation (Autism Diagnostic Observation Schedule – Generic (ADOS-G); Lord et al., 2000) and parent interview assessments of autistic symptoms (Autism Diagnostic Interview-Revised (ADI-R); Lord, et al., 1994), language and IQ, psychiatric comorbidities and a medical examination. The age at which participants were assessed ranged from 9.8 to 14.5 years. The team used ICD-10 research criteria to derive a clinical consensus diagnosis of childhood autism (n=81) and other ASDs (n=77) (see Baird et al., 2006; for details). Of the 77 cases meeting criteria for 'other ASDs'; 3 met ICD-10 criteria for 'atypical autism' due to late onset; 3 met ICD-10 criteria for 'atypical autism' due to an insufficient number of areas of abnormality; 61 met ICD-10 criteria for 'atypical autism' due to sub-threshold symptomatology; 7 met ICD-10 criteria for 'PDD unspecified' due to lack of information (incomplete assessment, adopted children for whom early history was not available); and 3 met ICD-10 criteria for overactive disorder

associated with mental retardation and stereotyped movements. 97 children did not meet clinical consensus diagnosis for autism or other ASD. 96 of the non-ASD children were assigned ICD-10 diagnoses following assessment; these included intellectual disability (DSM-IV-TR 'mental retardation') and learning disabilities (n=56), language delay (n=12), hyperkinetic and/or conduct disorder (n=14) and a variety of other medical, sensory and developmental diagnoses (n=15). One child had had a statement of SEN but did not meet ICD-10 criteria for any developmental disorder.

For 36 randomly selected cases project consensus diagnoses were compared to those of 8 internationally recognised experts using ICD-10 criteria (usually 2 experts independently rated ADI, ADOS, psychometric findings and a clinical vignette for each case. Quadratic weighted agreement between project consensus and expert autism/ASD/no-ASD diagnostic categories was 93% with kappa 0.77 (see Baird et al. 2006; for details).

The following child characteristics relevant to identification by the screen were also collected: IQ, severity of autism symptoms measured by ADI-R and ADOS-G algorithm total scores and parent report of emotional and behavioural problems. A total count of ICD-10 symptoms (0-12) was systematically completed as part of the diagnostic review process of every case. Adaptive behaviour was assessed using the Vineland Adaptive Behavior Scales (VABS; Sparrow et al, 1984).

IQ was measured using the Wechsler Intelligence Scale for Children (WISC-III- UK; Wechsler, 1992), Raven's Standard Progressive Matrices (SPM) or Coloured Progressive Matrices (CPM; Raven, 1990a,b), depending on the child's ability. For the 35 cases where SPM or CPM but not WISC full scale IQ's were available, imputed full-scale IQ's were obtained using the regression relationship of full scale IQ to SPM/CPM IQ within each diagnostic group. For the 11 cases where no direct cognitive testing was possible 9 cases had Adaptive Behaviour Composite on the VABS below 20 and these cases were assigned an IQ

score of 19 to reflect their profound level of mental retardation; 2 cases had no VABS data and were excluded from analysis involving IQ. The (weighted) mean (SD) full scale IQ of the total ASD sample was 69.4 (24.1) and the range was 19 to 136. 55% of all children with an ASD and 73% of the most narrowly defined autism cases had IQ<70 (Baird et al., 2006).

Parents completed the Strengths and Difficulties Questionnaire (SDQ; Goodman, 1997). Each subscale has 5 questions that are rated 'not true', 'somewhat true' and 'certainly true' and score 0-2 with higher scores indicating higher pathology. A 'total problem score' derived from the hyperactivity/inattention, conduct problems and emotional problems subscale scores was used in the present analysis. Information on parental education was also collected (defined by the highest academic qualification of either parent: 0=none, 1=O level (school leaving exam age 16 years), 2=NVQ (technical qualification), 3=A level (school leaving exam age 18 years), 4=graduate, 5=postgraduate).

Low risk School and General population samples

School sample: The SCQ was sent to 936 families with children attending mainstream schools in a predominately middle income town in the South East of the UK. An initial mailing was followed by a reminder letter. 411 SCQs were returned, a rate of 43.9%. Mean age of the children was 12.0 years (SD 0.3), and none had a Statement of SEN.

General population sample: Children were recruited from one postal district in a mixed low-to-middle income town on the South coast of the UK. Every family with a child born within an 18-month cohort was sent the SCQ (n=582). An initial mailing was followed by a posted reminder, then a telephone call, and then a home visit. 247 SCQs were returned, a response rate of 42.4%. Mean age of children was 11.5 (SD 0.6). 16 (6.5%) parents reported their child as having a Statement of SEN.

Statistical Analysis

SNAP sample. Stratification of the ASD/SEN sample was based on whether or not a child had a locally recorded ASD diagnosis (yes/no) and 4 levels of SCQ score (low score (<8), moderately low score (8-14), moderately high score (15-21), high score (≥22); see Baird et al., 2006 and Figure 1 for details). Use of weights allowed all statistics such as proportions, means, group differences and screen performance measures to be presented as target population estimates, taking account not only of the differences in sampling proportions according to SCQ score and local ASD diagnosis, but also the differential response to the SCQ associated with a prior local ASD diagnosis, health district and child's sex. Wald test statistics (adjusted t and F-tests) and p-values were calculated using the linearisation version of the robust parameter covariance matrix as implemented by the svy procedures of Stata 9 (Stata, 2005). Confidence intervals for signal detection statistics such as sensitivity, that compare the screen with a gold standard, or area-under-curve (AUC), that compare the screen with another test measure, were obtained by bootstrap resampling. Statistics presented for the *School* and *General population samples* are unweighted, as no stratified sampling was performed.

RESULTS

SNAP sample. The mean SCQ score in the 'at-risk' sample was 15.2 (SD 8.6) and the sample scored across nearly the full range of the possible scores (0-39). Figure 2 shows the distribution of SCQ scores for the 255 cases seen for a research diagnostic assessment, stacked by consensus diagnosis. The bimodal distribution is due to the stratified sample design of the prevalence study (see Baird et al., 2006; for details). Figure 2 shows exact frequencies. However, all subsequent analyses on the on the 'at-risk' sample are weighted to take the sampling proportions and differential response into account.

Figure 2 about here

The weighted mean (SD) SCQ scores for non-ASD, other ASD and childhood autism cases were 10.8 (+/-6.1), 19.6 (+/-6.6), and 26.6 (+/-4.4), respectively. SCQ scores were highly correlated with ASD symptom severity as measured by the ADI-R (total algorithm score: r=.79, p<.001) and consensus ICD-10 symptom count (r=.71, p<.001), although more moderately correlated with ADOS total algorithm score (r=.42, p<.001). SCQ scores were moderately negatively correlated with VABS composite scores (r=-.38, p<.001) but the correlation between SCQ scores and IQ was negligible (r=.-05, ns).

Discriminating between ASD and non-ASD cases in the at-risk SNAP sample

A receiver operating characteristic (ROC) analysis was performed to assess the discriminant power of the SCQ in distinguishing ASDs (including autism) cases from non-ASD cases (Dunn, 2000; Hanley and McNeil, 1982). The area under the curve (AUC) was 0.88 (95% CI 0.82 to 0.93), indicating very strong discriminant ability. At the recommended cut-off of =>15 sensitivity (Se) was 0.88 (95% CIs=0.78 to 0.95), specificity (Sp) 0.72, (95% CIs=0.57 to 0.85), positive predictive value (PPV) was 0.64 (95% CIs=0.50 to 0.78), and negative predictive value (NPV) was 0.91 (95% CIs=0.82 to 0.97). In order to determine whether the ability of the SCQ to discriminate between ASD and non-ASD cases varied depending on IQ or parental education, the ROC analysis was repeated for cases with low (FSIQ<70) vs. high (FSIQ=>70) IQ and high (3-5) vs. low (0-2) parental education. The AUC was >=0.87 for both these subgroup comparisons. Figure 3 shows the ROC curves for the SCQ (with labels for each score between 0-39) compared to that for the ADI-R total algorithm score. The AUC was high for both instruments.

Figures 3 and 4 about here

Child and family characteristics relevant to being a true case 'missed' by the cut-point (that is, being a 'false negative' (FN) compared to being a 'true positive' (TP)) and to being a non-case 'falsely identified' by the cut-point (that is, being a 'false positive' (FP) compared to being a 'true negative' (TN)) were examined. We considered that IQ, total algorithm scores on the ADI-R and ADOS-G, ICD-10 total symptom count and SDQ 'total problem score' were relevant child characteristics and that parental education was a relevant background variable that might influence screen performance. FN cases had lower ADI-R algorithm scores (mean=32.2 (SE=3.13)) than TP cases (40.9 (+/-2.2); Z=1.98, p <.05). FP cases had higher ADI-R algorithm scores (20.3 (+/-1.6) vs. 8.5 (+/-1.0); Z=3.05, p <.01) and higher SDQ total problem scores (14.3 (+/-2.2) vs. 12.1 (+/-0.8); =2.06, p<.05) than TN cases. FP cases did show a moderate level of ASD symptoms with a mean (SE) ICD-10 total symptom score of 3.2 (+/-0.5). However, only 1.2% had received an ASD diagnosis from their local teams. All were given a non-ASD ICD-10 diagnosis following assessment in the following (weighted) proportions: learning disability/mental retardation 61.6%, language disorder 7.7%, hyperkinetic disorder/ADHD 25.2% and other medical conditions 5.5%.

Discriminating autism cases from non-autism cases in the at-risk SNAP sample

A further ROC analysis, examining the ability of the SCQ to differentiate between childhood autism and non-childhood autism cases (combining the 'other ASD' and non-ASD groups) at the recommended cut-off of =>22 also indicated strong discrimination (AUC=0.93 (95%CI = 0.90 to 0.96); Se=0.90 (95% CIs=0.83 to 0.96); Sp=0.86 (95% CIs=0.80 to 0.90), PPV=0.47 (95% CIs=0.36 to 0.57), NPV=0.98 (95% CIs=0.97 to 0.99)). For the high and low IQ and high and low parental education subgroups all AUCs were >=0.90. Figure 4 shows the ROC curves for the SCQ and ADI-R and, once again, the AUC was high for both instruments.

There were no differences between FN and TP cases in IQ, ADI-R and ADOS-G algorithm scores, ICD-10 total symptom count, total SDQ score or parental education. FP

cases (38.9 (+/-2.0)) had higher ADI-R algorithm scores than TNs (14.6 (+/-1.5); Z=6.02, p<.001). FP cases showed a high level of ASD symptoms with a mean (SE) ICD-10 total symptom score of 5.6 (+/-0.4), although the clinical consensus diagnosis for these cases was not childhood autism. 21.4% had received an ASD diagnosis from their local teams, although 70.6% of the FPs at the 22 cut-point received a consensus diagnosis of 'other ASDs'. All other FPs were given a non-ASD ICD-10 diagnosis following assessment in the following (weighted) proportions: learning disability/mental retardation 52.0%, language disorder 27.8%, hearing impairment 4.7%, hyperkinetic disorder/ADHD 14.3% and other medical conditions 1.1%.

Distribution of SCQ scores in the low-risk School and General population samples

The distribution of SCQ scores in the School and General population samples was strongly negatively skewed. The mean (SD) SCQ score for the School sample was 4.1 (+/-4.7), and the mean SCQ score for the General population cohort was 4.7 (+/-5.0).

4.4% of the School sample obtained an SCQ score of 15 or above. The majority of these cases (16/18, 88.9%) had a neurodevelopmental diagnosis recorded, e.g. intellectual disability/mental retardation, language disorder, ADHD; although only 2/18 (11.1%) of cases scoring above at/above 15 had an ASD diagnosis recorded locally. 6 cases scored at/above 22 and one (16.7%) of these had an ASD diagnosis recorded locally. The 5 others had other neurodevelopmental diagnoses recorded locally.

5.3% of the General population sample scored at 15 or above on the SCQ. 12/13 (92.3 %) of these cases had a neurodevelopmental diagnosis recorded locally, of which 7/13 (53.8 %) of cases had an ASD diagnosis recorded locally. Four (out of 13) cases scored at/above 22 and each had an ASD diagnosis recorded locally.

There was one false-negative among the School sample based on locally recorded diagnosis; this child has an SCQ score of 7. There were two false-negative cases within the

General population cohort based on locally recorded diagnosis; one had an SCQ score of 9, and the other had an SCQ score of 12.

DISCUSSION

Properties of the SCQ in the 'at risk' SNAP sample

Within the population weighted SNAP sample the SCQ discriminated well between children with and without ASD at the established cut-point of >=15. The sensitivity (0.88) and specificity (0.72) were similar to that in the initial validation study (Se=0.85; Sp=0.75; Berument et al., 1999) and also compare well with those of two other recently published screening instruments for ASD (Social and Communication Disorders Checklist (SCDC); Se=0.90; Sp=0.69; Skuse et al., 2005; Social Responsiveness Scale (SRS); Se=0.85; Sp=0.75; Constantino and Gruber, 2005). Two recent studies used the SCQ in younger samples of 3-to-6-year-old children and found reduced sensitivity (0.71) in one study (Eaves et al., 2006a) and reduced specificity (0.54) in the other (Eaves et al., 2006b; see also Allen et al., in press). Reduced sensitivity in a younger sample is consistent with the fact that not all autism symptoms enquired about on the SCQ will necessarily have emerged in 3 year-olds with an ASD (e.g. repetitive routines or imaginative games with peers; Charman et al., 2005; Cox et al., 1999) or not sufficiently for parents to have identified them as noteworthy.

When discriminating between autism and non autism cases (including 'other ASDs') at the cut-point of >=22 the sensitivity (0.90) and specificity (0.86) remained high. Note that these figures cannot be directly compared to those reported in Berument et al. (1999) who used the 22 cut-point to discriminate between autism and 'other ASD' cases. We report data for the autism vs. non-autism (including cases with an ASD but not a childhood autism diagnosis) discrimination as this is more likely to reflect the use of the screen in clinical practice; where a sample will likely consist of children with autism, children with other ASDs and children who do not have an ASD. The ROC analysis showed that the SCQ discriminated

between ASD and non-ASD a little less well and autism and non-autism cases almost as well as the ADI-R. For diagnostic assessment a full parental interview regarding current and past development and behaviour, and structured observation of the child, preferably including a peer-group setting, is essential. Our study demonstrates that for some clinical and research purposes the SCQ can be an efficient first-level screen to identify children with likely ASD or autism.

At both cut-points, sensitivity and specificity in this sample were similar for the high and the low IQ subgroups and the correlation between SCQ score and IQ was close to zero. This contrasts with the study by Eaves et al. (2006b) who reported that SCQ scores were negatively correlated with IQ. Similarly, the ability of the SCQ to discriminate case and non-cases at both cut-points did not differ according to parental education. In different samples false positive and false negative cases might be explained by different child (IQ; age) and family factors (parental knowledge about autism; recognition of symptoms) and these need to be considered alongside the score on the SCQ when assessing whether a child might be a likely case of ASD.

As would be expected, screen false negatives scored lower than screen true positives, and conversely false positives scored higher than true negatives, on the ADI-R. The questions on the SCQ were closely modeled on ADI-R items and on both instruments parents are the respondents. In contrast to Berument et al. (1999), in our study parents completed the SCQ prior to completion of the ADI-R thus reducing response bias on the screening instrument (note that the diagnosis relied on global clinical consensus using all information and not just the ADI-R). False positives at both cut-points also had higher ICD-10 total symptom scores than true negatives (though lower scores than the screen true positives), reflecting the fact that many of the false positive cases identified by the screen had sub-threshold levels of ASD symptomatology. The majority of the false positives (~70%) at the 22 cut-point, which

identifies likely autism cases, had a study consensus diagnosis of ASD. However, only one-fifth had an ASD diagnosis from their local clinical team and very few of the false positives at the 15 cut-point did so. One finding from the SNAP study was that only 58% of cases meeting consensus diagnosis of childhood autism had received an ASD from their local clinical teams, and this fell to 23% of cases meeting consensus diagnosis for 'other ASDs' (Baird et al., 2006). Thus, reliance on local clinical diagnosis as the gold-standard would underestimate the true proportion with ASDs among the false positives at the autism cut-off.

Screen false positives (in the ASD vs. non ASD comparison) scored higher than screen true negatives on the total problem score of the SDQ. In response to questions on the SCQ that are meant to be measuring autism symptoms, some parents might rate their child's emotional, hyperactivity or conduct difficulties. One previous study has reported high scores on the SCQ for children with mood and anxiety disorder in whom a clinical diagnosis of PDD had been excluded (Towbin et al., 2005). Among false positives at both cut-points we found children meeting criteria for other ICD-10 neurodevelopmental conditions, including intellectual and learning disabilities, language delay, hearing impairment, hyperkinesis/ADHD and physical disability.

Properties of the SCQ in the School and General population samples

Similar to the findings with other screens in normal populations (Constantino and Todd, 2003; Posserud et al., 2006; Skuse et al., 2005), the distribution of SCQ scores in the School and General population was heavily skewed to low scores, and the distribution of scores was continuous. In both samples, approximately 4-5% of children scored above the SCQ cut-off (15) that discriminated well between children with and without ASD. Not all of these screen positive children had received a local clinical ASD diagnosis – 11% in the School sample and 54% in the General population sample. In both samples, approximately 1.5% of children scored above the SCQ cut-off (22) that discriminated well between children

with and without childhood autism. Half of these children had received a local clinical ASD diagnosis. If the findings of local under identification of ASD from the SNAP study apply to these samples from the same geographic region, then these might be underestimates of the number of actual cases of ASD in those who scored above the SCQ thresholds for ASD and autism (Baird et al., 2006). In both low-risk samples children with a locally recorded ASD diagnosis were rarely screen negative (less than 0.5% SCQ<15), though here local under-identification might under-estimate the rate of FNs. However, almost all children with an SCQ score of 15 or above (~90%) had ASD or another neurodevelopmental disorder, including learning difficulties, language delay and hyperkinetic disorder/ADHD.

Strengths of the present study

The strengths of the present study include: the generalisability of the findings due to the population weighting procedure; the calculation of confidence intervals around the instrument parameter estimates; the inclusion of children only in the sample (compared to Berument et al., 1999); and the inclusion of both low and high IQ children (compared to Skuse et al., 2005). The comprehensive diagnostic assessment and use of a clinical consensus decision-making process that was corroborated by independent expert rating (see Baird et al., 2006) are also strengths. We were also able to test whether child or family characteristics systematically related to false positive and false negative identification. Although the two studies investigating how the SCQ worked in unselected samples of same-age children were less methodologically rigorous, the present samples of children compare well in terms of size to other published studies (n=411 and n=247, respectively; compared to n=118 in Skuse et al., 2005).

Limitations

One limitation of the present study is that the age of the 'at risk' sample at the time of screening (9-10 years) is later than would be required for first-level screening of young

children, although it is still an age at which many children get referred for possible ASD. Other studies have begun to investigate how well the SCQ works in preschool children, so far with mixed findings (Eaves et al., 2006a,b). In comparison to our assessment of the SCQ in the 'at-risk' SNAP sample our attempt to screen children in the 2 low-risk samples had limitations: local clinical diagnoses of the unselected population sub-samples was not confirmed by direct or standard clinical assessment; uptake was moderate only and subject to (unknown) bias, reducing the generalisability of these findings. However they were considered worthwhile as nothing was known about how the SCQ performs outside of clinical samples, and screening instrument properties vary with sample prevalence and characteristics (Clark and Harrington, 1999).

Clinical implications

This study confirms the utility of the SCQ as a first-level screen for ASD in at risk samples of school-age children. In both our 'at risk' SNAP sample and in the low risk general population samples scoring above the cut-offs for autism (22) or ASD (15) was highly indicative that the child had childhood autism or ASD, respectively, or another neurodevelopmental condition that would warrant further assessment and likely support and intervention.

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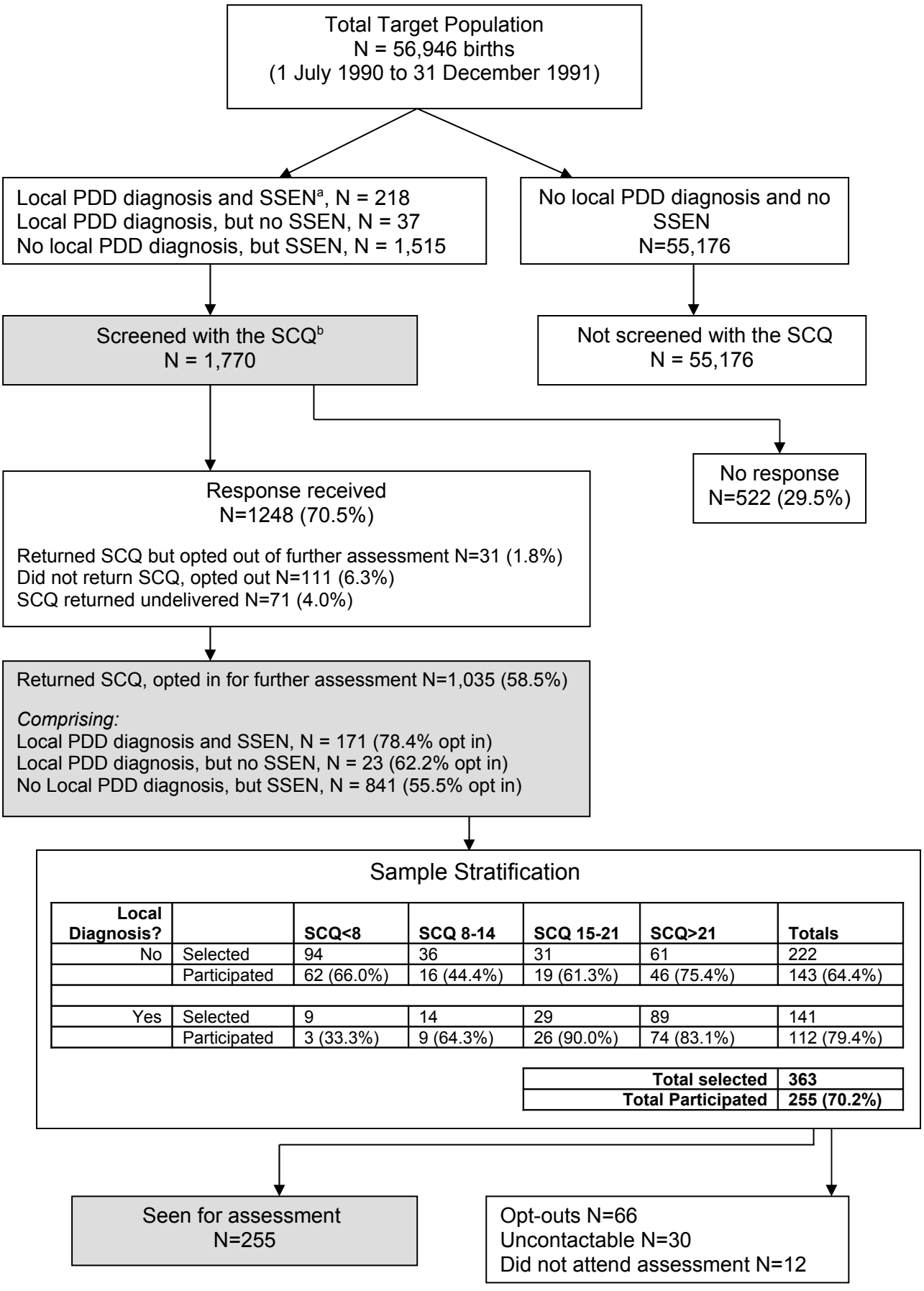
Figure 1: Case ascertainment SNAP sample

Figure 2: Distribution of SCQ scores in the SNAP sample by consensus diagnosis (showing cut-points of 15 and 22)

Figure 3: ROC curve for SCQ and ADI-R discriminating ASD vs. non-ASD (>=15)

Figure 4: ROC curve for SCQ and ADI-R discriminating autism vs. non-autism (>=22)



Local Diagnosis?		SCQ<8	SCQ 8-14	SCQ 15-21	SCQ>21	Totals
No	Selected	94	36	31	61	222
	Participated	62 (66.0%)	16 (44.4%)	19 (61.3%)	46 (75.4%)	143 (64.4%)
Yes	Selected	9	14	29	89	141
	Participated	3 (33.3%)	9 (64.3%)	26 (90.0%)	74 (83.1%)	112 (79.4%)

Total selected	**363**
Total Participated	**255 (70.2%)**

a SSEN = Statement of Special Educational Need (see text)
b SCQ = Social Communication Questionnaire

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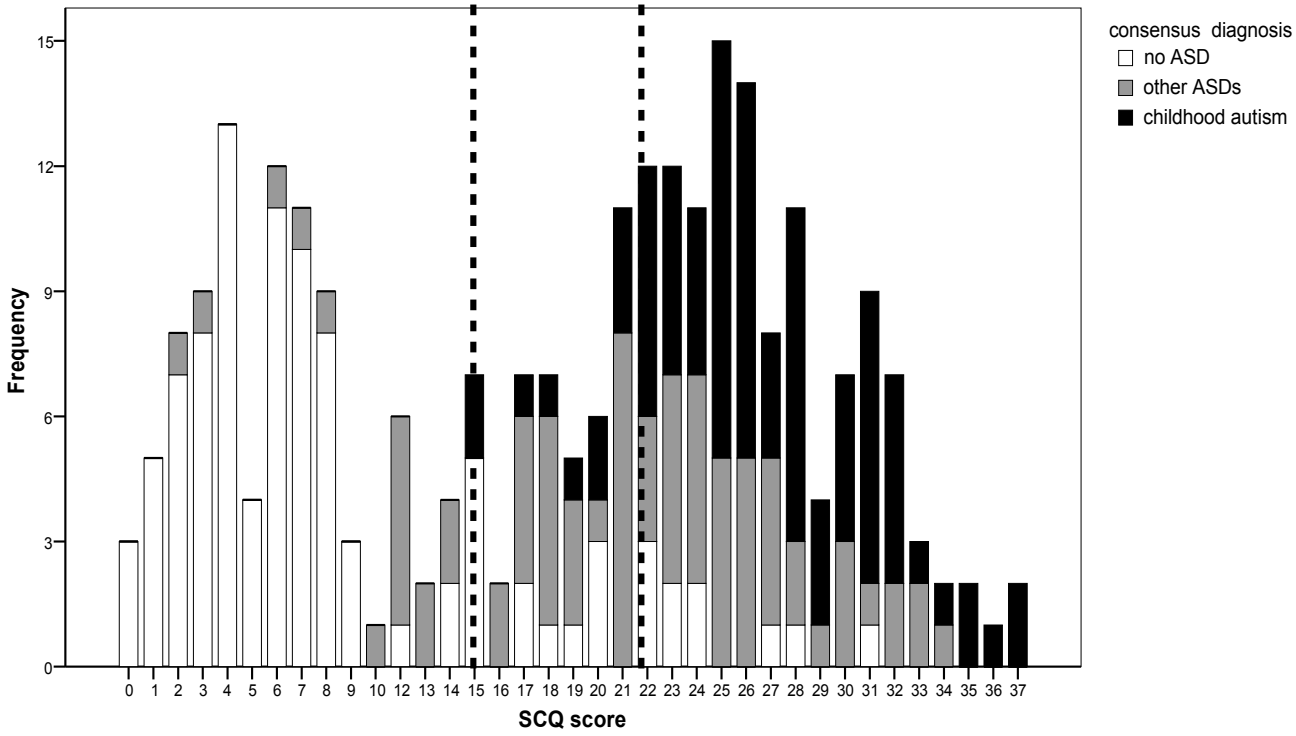
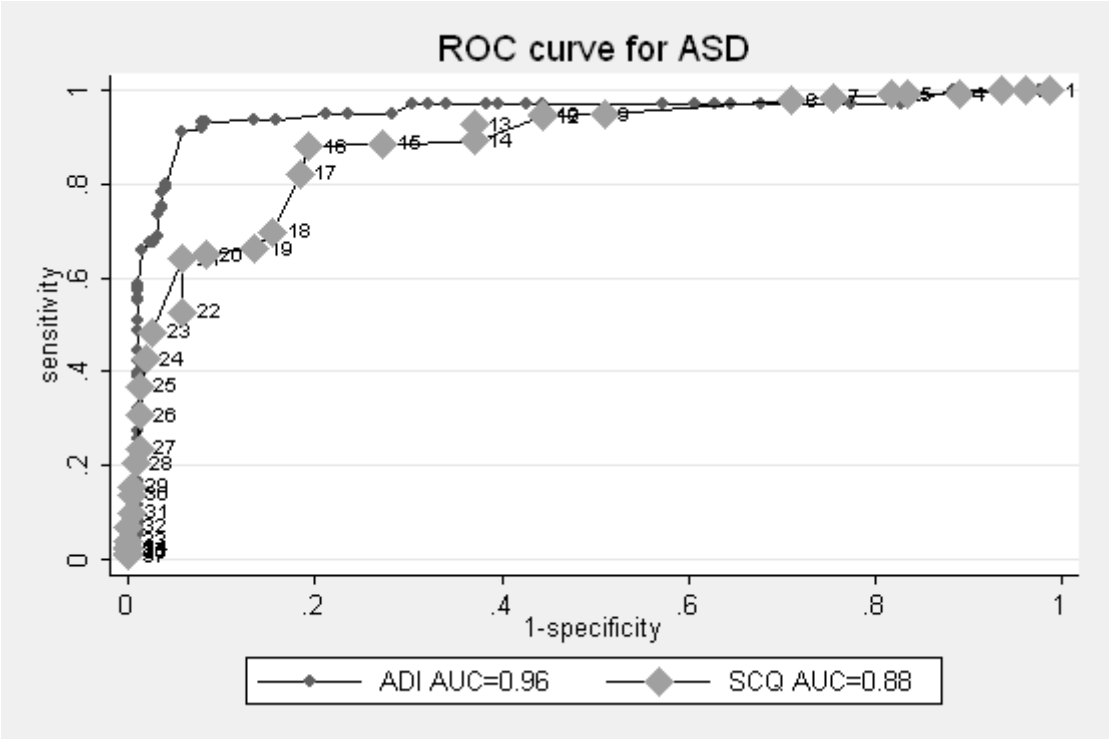
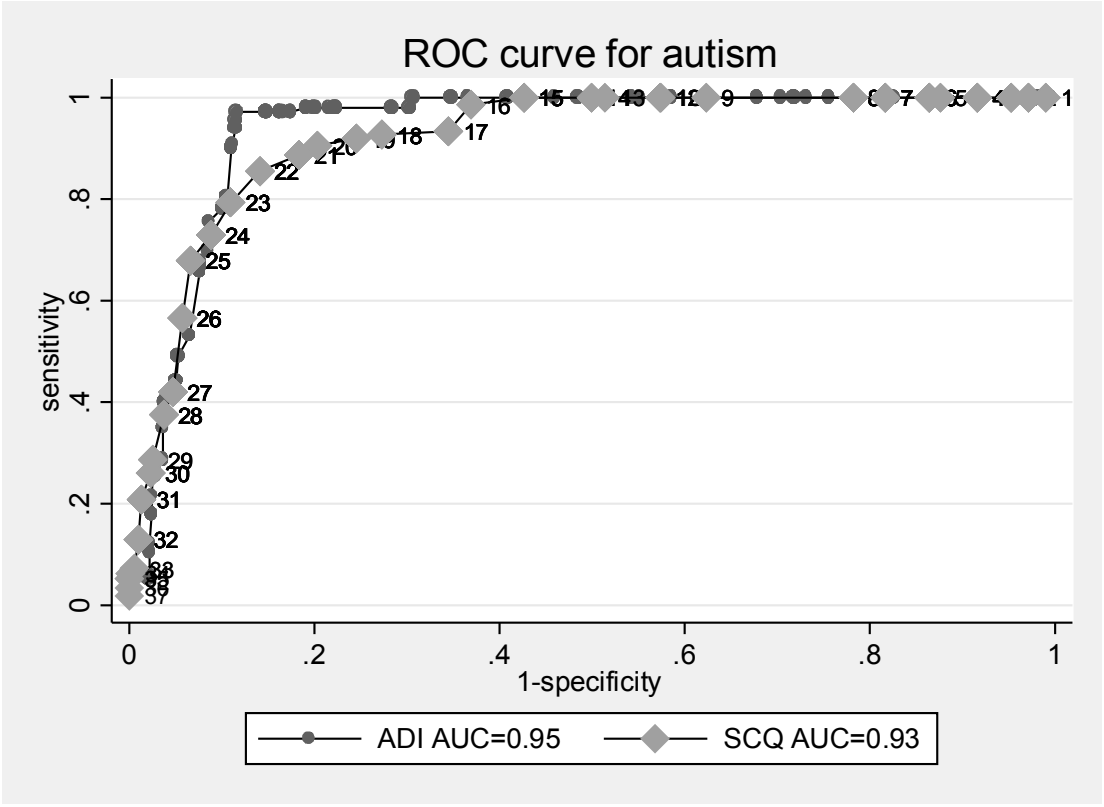

consensus diagnosis
no ASD
other ASDs
childhood autism
Frequency
SCQ score
0 1 2 3 4 5 6 7 8 9 10 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37
0 3 6 9 12 15


ROC curve for ASD
sensitivity
0
.2
.4
.6
.8
1
1-specificity
ADI AUC=0.96
SCQ AUC=0.88


ROC curve for autism
sensitivity
0
.2
.4
.6
.8
1
1-specificity
ADI AUC=0.95
SCQ AUC=0.93