Psychological Markers in the Detection of Autism in Infancy in a Large Population

SIMON BARON-COHEN, ANTONY COX, GILLIAN BAIRD, JOHN SWETTENHAM, NATASHA NIGHTINGALE, KATE MORGAN, AURIOL DREW and TONY CHARMAN

Background. Investigation to see if there are key psychological risk indicators for autism in a random population study of children at 18 months of age, and to assess how well these discriminate children who receive a diagnosis of autism from other forms of developmental delay.

Method. Sixteen thousand children in the southeast of England were screened for autism by their health visitor or GP, during their routine 18-month-old developmental check-up, using the CHAT (Checklist for Autism in Toddlers). From a previous high-risk study we predicted that children at 18 months of age who failed three items ('protodeclarative pointing', 'gaze-monitoring', and 'pretend play') would be at risk for receiving a diagnosis of autism. From other evidence, we further predicted that those 18-month-olds who failed one or two of the key items (either pretend play, or protodeclarative pointing and pretend play) would be at risk for developmental delay without autism.

Results: Twelve children out of the total population of 16,000 consistently failed the three key items. Of these, 10 (83.3%) received a diagnosis of autism. Thus, the false positive rate was 16.6% (2 out of 12 cases), and even these 2 cases were not normal. When the 10 children with autism were reassessed at 3.5 years of age, their diagnosis remained the same. Thus the false positive rate among the cases diagnosed with autism was zero. In contrast, of 22 children who consistently failed either protodeclarative pointing and/or pretend play, none received a diagnosis of autism, but 15 (68.2%) received a diagnosis of language delay.

Conclusions. Consistent failure of the three key items from the CHAT at 18 months of age carries an 83.3% risk of autism; and this pattern of risk indicator is specific to autism when compared to other forms of developmental delay.

Autism is regarded as the most severe psychiatric disorder of childhood. It is rarely diagnosed before 3 years old, and usually considerably later than this, despite the fact that in the majority of cases it has an onset during infancy (Gillberg, 1990). When examined at school-age, children with autism are impaired in three behaviours that are normally universally present by 14 months of age.

Protodeclarative pointing (PDP) (Bates et al., 1979): the normal 9-14-month-old infant points at an object in order to direct another person to look at the object, as an end in itself. This form of the pointing gesture is absent or severely impoverished in school-age children with autism (Wing, 1976; Baron-Cohen, 1989, 1995). This is a specific deficit, in that a related form of the pointing gesture (protoimperative pointing) in which the normal infant points at an object (usually out of reach) in order to try to obtain it, is not thought to be specifically impaired in autism.

Gaze-monitoring (GM) (Scaife & Bruner, 1975): the normal 9-14-month-old infant turns to look in the same direction that an adult is looking in. This behaviour is also absent in school-age children with autism. Both PDP and GM are aspects of 'joint attention behaviours', which result in the convergence of the infant's and the adult's attentional foci onto the same object or event (Bruner, 1983).

Pretend play (PP): defined as play involving object-substitution, and/or the attribution of absent properties to objects or situations (Leslie, 1987). Across different cultures, it makes its earliest appearance in simple form by about 14 months of age (Bretherton, 1984). Again, in autism the deficit in pretend play is highly specific, in that functional play, in which the normal toddler uses a toy according to its conventional function, is not specifically impaired (Wing, 1977; Baron-Cohen, 1987).

If these three key behaviours are normally present by 14 months of age, and yet are absent or significantly impaired in school-age children with autism, they might serve as important indicators for the early detection of autism. Currently, none of
these key behaviours are checked during routine developmental check-ups at 18 months of age. In an earlier study we therefore developed a new checklist, to test these predictions. The Checklist for Autism in Toddlers (CHAT)  {see Fig. 1) was administered to a group of 41 children of 18 months of age, selected for being at raised genetic risk of developing autism. Of these, only 4 failed on all three of the key items (PDP, GM, and PP) and at follow-up 12 months later, all 4 of these children had received a diagnosis of autism. None of the other 37 children failed more than one key item on the CHAT, and none developed autism. Equally, of 50 randomly selected 18-month-olds in a control group, none failed more than one key item, and none developed autism (Baron-Cohen et al., 1992).

We aimed to replicate the finding from the earlier study, and test the CHAT and the predictions on a random population study, in order to examine the generalisability of the earlier findings. In addition, since a delay in PDP or PP is associated with specific language or general developmental delay (Tomasello, 1988; Signan et al., 1986), we aimed to test if absence of PDP or absence of both PDP and PP, would distinguish children with developmental delay from autism.

### Method

The overall design of the study involved screening a large general population of children at 18 months of age, identifying those consistently failing the CHAT (on two administrations), and then rescoring the whole population at age 3.5 years, to determine the sensitivity and specificity of the CHAT as a screening instrument. This paper is concerned with findings from the screen at 18 months.

### Subjects

Nine districts in the southeast Thames Health Region took part in this study. Sixteen thousand children were screened using the CHAT, administered by health visitors or GPs. The mean age of the sample at screening was 18.7 months (s.d. = 1.1 month). The sex ratio of the total population was 1:0.5:1 (m:f). The social class distribution of the main caregiver of these children was broadly representative of the UK (Economic Activity of Great Britain, 1981). Children with severe developmental delay were not included, since such children are already clearly identified by 18 months of age, and because health visitors were reluctant to give additional assessments to parents whose children were likely to fail almost all items on the CHAT.

### Screening

Each subject was screened using the CHAT (see Fig. 1), as close to their 18 month ‘birthday’ as was possible. In the majority of cases (n = 12,688, or 79.3%), this was administered by the family health visitor. In a proportion of cases (n = 771, or 4.8%) this was administered by the family GP. Finally, in another subgroup of cases (n = 2541, or 15.9%), the CHAT was administered by the main caregiver.

The CHAT form for each child was then sent back to our research centre, where all responses were entered into a computer database. The construction of the CHAT is described in detail elsewhere (Baron-Cohen et al., 1992). In structure, the CHAT has 2 sections: Questions in section A assess areas of development via parental report. In section B, the clinician checks the child’s actual behaviour against the parental report given in section A. Like

---

1. In this latter subgroup, items Bii and Biv were omitted, since these would have been simply repeating items A5 and A7.
most screening tests in public health surveillance, a positive case is identified if a child consistently fails on initial test and on a subsequent retest. In all cases, retest with the CHAT was done as soon as possible after the initial CHAT, and on average this was one month later. Our interest was only in those children who were consistently failing the key items, since this was likely to be due to significant developmental causes rather than situational causes (such as the child’s current physical state), or very mild developmental delay. We searched for children whose scores met criteria for one of three risk groups:

(i) Autism risk group: Children who failed on PDP, GM, and PP (CHAT items A5, A7, Bii, Bii, and Biv). Note that a failure on Bii validated a fail on A5, and failure on Biv validated a fail on A7. Thus, children in this risk group failed 3 key items.

(ii) Developmental delay (without autism) risk group (henceforth developmental delay risk group): Children who failed PDP (A7 and Biv), or failed PDP and PP (A5, A7, Bii, and Biv). Critically, children in this group had to pass GM (Bii). Thus, children in this risk group failed either 1 or 2 key items.

(iii) Normal group: Children who passed all three key items; PDP, GM, and PP (A5, A7, Bii, Bii, and Biv).

Diagnostic groups

Children who met criteria for each of the risk groups were invited to our clinic in London for developmental and diagnostic assessments. These children were then given one of three diagnoses. These were:

(i) Autism; children who met criteria for autism on at least 2 out of the following 3 diagnostic methods: (i) the Autism Diagnostic Interview – Revised (ADI-R); Lord et al, 1994

(ii) ICD–10 criteria (World Health Organization, 1994) from interaction during assessment with the child in the clinic; and (ii) ICD–10 criteria as rated from videotapes of all 50 subjects. These three sets of diagnostic judgements were all strictly independent of each other, conducted by five independent judges (AC, GB, KM, AD, and SBC), and in all cases the judges were blind as to which of the three risk groups any given child was in. All judges were clinicians with considerable experience in the field of autism. The ADI–R was not used on its own, as it has not been used with this age-group before.

(2) Developmental delay: children who had (i) equal to or less than 5 words, according to parental report, as ascertained in the ADI. This is on the basis that less than 5% of children at 20-months-old have five or fewer words (Fenson et al, 1993); and/or (ii) a delay on the Griffiths Scale of Infant Development (Griffiths, 1986) of equal to or more than 4 months. This was administered by a psychologist in our team who remained blind to the autism diagnostic information. Given that children with severe developmental delay were not included in the population we screened, our aim was to assess if autism could be distinguished from mild to moderate developmental delay in language or cognition (without autism).

(3) Normal: those children who did not fall into the above two categories, and were free of other clinical diagnoses.

Following Wing & Gould (1979), we predicted that approximately 4 in 10 000 children in the population would have classic autism (Kanner, 1943), and as many as one per 1000 might have some form of autism (Gillberg, 1990). We therefore estimated there would be between 6 and 16 cases in a population of 16 000. We predicted that all of these cases would come from the autism risk group, as defined above. In contrast, we predicted that cases of developmental delay would come from the developmental delay risk group.

Results

From the total population of 16 000, just 12 children met criteria for the autism risk group (Failed A5, A7, Bii, Bii and Biv), 44 children met criteria for the developmental delay risk group (Passed Bii, but either failed A7 and Biv, or A7, Biv, A5 and Bii). Finally, more than 99.6% of the total

2. The Autism diagnosis actually contains 2 subgroups: Autism (without any developmental delay), and Autism + Developmental Delay.

3. It should be noted however that with the judges who used the ADI-R (a parent-report measure only), criteria were slightly modified: To receive a diagnosis of autism, a child had to score above the traditional threshold on the first 2 axes (Reciprocal Social Interaction, and Communication), and score above a new threshold of 2 or more on the third axis (Repetitive Behaviour). This modification was made because many children scored above the traditional threshold on the first 2 axes, but just missed doing so on the third.
population met criteria for the normal group. (estimate based on retesting approximately 20 cases in this group at the initial CHAT).

The number of children from each of the three risk groups who were given one of the three diagnoses is shown in Fig. 2, and summarised in Table 1. The following results are worth highlighting:

(i) Ten out of 12 (83.3%) of children in the autism risk group received an autism diagnosis, whilst the risk of receiving an autism diagnosis for a child in the developmental delay risk group was 0% (or 0/22). This odds ratio difference is highly significant ($\chi^2 = 7.99, 1$ d.f., $P = 0.005$).

(ii) None of the children in the autism risk group were diagnosed as normal. That is, the 2 cases in the autism risk group who did not receive a diagnosis of autism nevertheless received a diagnosis of developmental delay. Thus, the false positive rate for detection of autism is 16.6% (2/12), but even these cases are not normal.

### Table 1

<table>
<thead>
<tr>
<th>Key items failed (risk group)</th>
<th>Autism (n=12)</th>
<th>Diagnosis Developmental delay (n=22)</th>
<th>Normal (n=16)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failed GP, PP, and PDP</td>
<td>10</td>
<td>$\hat{2}$</td>
<td>0</td>
</tr>
<tr>
<td>Failed PDP, or PDP and PP</td>
<td>0</td>
<td>$\hat{1}$</td>
<td>7</td>
</tr>
<tr>
<td>Fail 0 (n=16)</td>
<td>0</td>
<td>0</td>
<td>16</td>
</tr>
</tbody>
</table>

GM, gaze monitoring; PDP, protodeclarative pointing; PP, pretend play.

(iii) Thus, absence of PDP, GM, and PP in combination, carries a significant risk of autism (83.3%), while absence of PDP alone, or PDP plus PP, carries a zero risk of autism, when assessed at 18 months.

(iv) Absence of GP alone, or of PDP plus PP, carries a 68.2% risk of the child receiving a diagnosis of developmental delay (based on 15 out of 22 children who were so diagnosed in the developmental delay risk group). That is, less than half of the children in the developmental delay risk group were diagnosed as normal.

(v) The finding of 10 cases of autism in a population of 16 000 (or 0.625 per 10 000) is within expected prevalence levels, given previous epidemiological studies (Wing & Gould, 1979). Note though that the number of cases of autism in the population is likely to be even higher than this, since there may have been some who passed on the CHAT and were therefore not detected at 18 months. Our follow-up study of this population (forthcoming) will therefore establish the final prevalence figure.

(vi) Nine of the 10 children who received a diagnosis of autism also had developmental delay (either in terms of language, or language plus non-verbal cognitive level). This implies that one of the children with autism had no developmental delay, and might therefore be diagnosed as Asperger’s syndrome. However, we suspect Asperger’s syndrome is more common than this, and our current work focuses on how to improve the detection of this related condition.

### CHAT profile by diagnosis

CHAT scores for the children given each of the three diagnoses are shown in Table 2. Of the 10 cases of autism, A5, A7, Bii, Bi, Bii, and Biv were
failed by all of the group. Finally, 9 of the 10 cases also failed A6 (proteoimperative pointing), which was not predicted from current theories, although this has been previously noted clinically. Of the 17 cases of children with developmental delay, none failed GM (Bii) in combination with the other key items. This combination of failure is therefore a powerful discriminator of autism from developmental delay.

Follow-up of the 10 children with autism

Since the diagnosis of autism at 18–20 months using the ADI–R has never been attempted before, we invited all 10 children who had received an autism diagnosis to be reassessed at 3.5 years of age. They were again given the ADI–R, as well as a clinical assessment by two members of our team with considerable experience in this field. In all cases, the diagnosis of autism was confirmed. Thus, diagnosis of autism using the ADI–R at 18–20 months produces no false positives.

Discussion

We predicted that undiagnosed toddlers with autism at age 18 months would fail to show three key behaviours: protodeclarative pointing (PDP), gaze-monitoring (GM), and pretend play (PP). In the majority of cases, this prediction was confirmed. Sixteen thousand children were screened, and of 12 children who fell into this pattern of failure on two administrations of the CHAT, 10 of these (83.3%) received a diagnosis of autism. In contrast, of 22 children who failed PDP alone, or PDP and PP, none received a diagnosis of autism. This implies that absence of PDP, PP, and GM at 18 months carries a very high risk for autism. This study thus provides further evidence for the importance of these items in any screening method for the detection of autism at 18 months of age, and replicates earlier findings from a high-risk sample (Baron-Cohen et al., 1992).

Secondly, we predicted that children who lacked PDP, or PDP plus PP, at 18 months of age, would be at risk for developmental delay (without autism). This prediction was also supported: 15 out of 22 children (68.2%) who unambiguously lacked one or both of these behaviours received a diagnosis of developmental delay (without autism).

Consistent failure on the CHAT at 18 months indicates an 83.3% risk of autism; and at this stage, expert diagnosis should be sought. We stress that the CHAT should not be used as a diagnostic instrument, but it can alert the primary health professional to the need for an expert child psychiatric or paediatric referral. A follow-up study will be essential to establish the rate of false negatives, and will be reported separately in a further paper.

Table 2

<table>
<thead>
<tr>
<th>Item</th>
<th>Autism (n=10)</th>
<th>Developmental delay (n=17)</th>
<th>Normal (n=23)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>A2</td>
<td>50</td>
<td>94</td>
<td>91</td>
</tr>
<tr>
<td>A3</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>A4</td>
<td>90</td>
<td>100</td>
<td>96</td>
</tr>
<tr>
<td>A5 (PP)</td>
<td>0'</td>
<td>53</td>
<td>100</td>
</tr>
<tr>
<td>A6</td>
<td>10</td>
<td>53</td>
<td>87</td>
</tr>
<tr>
<td>A7 (PDP)</td>
<td>0'</td>
<td>0</td>
<td>70</td>
</tr>
<tr>
<td>A8</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>A9</td>
<td>60</td>
<td>65</td>
<td>91</td>
</tr>
<tr>
<td>Bi</td>
<td>70</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Bi (GM)</td>
<td>0'</td>
<td>65</td>
<td>100</td>
</tr>
<tr>
<td>Bi (PP)</td>
<td>0'</td>
<td>65</td>
<td>100</td>
</tr>
<tr>
<td>Bi (PDP)</td>
<td>0'</td>
<td>0</td>
<td>70</td>
</tr>
<tr>
<td>Bv</td>
<td>90</td>
<td>82</td>
<td>91</td>
</tr>
</tbody>
</table>

1. This unique pattern identified 10 true positive cases of autism in 16,000, and 2 false positive cases of autism (they actually had developmental delay without autism).

Clinical implications

- Detection of autism is possible at 18 months of age.
- Early detection should lead to early support being available for families.
- Early detection should lead to treatment being started as soon after 18 months of age as possible.

Limitations of the study

- Until follow-up, the rate of false negatives will remain unknown.
- Diagnosis is not possible using the CHAT alone – only following a referral for expert assessment.
- Until early intervention studies have been tried and tested, the full value of early diagnosis will remain unknown.

Acknowledgements

This work was supported by a Project Grant from the Medical Research Council to the first 3 authors (1992–1995). SBC and JS were members of the Departments of Child Psychiatry and Psychology at the Institute of Psychiatry, London, during the
DETECTION OF AUTISM IN INFANCY

period of this work. We are very grateful to the 400 Health Visitors and 50 GPs in the following 9 Districts who took part in the screening: South Downs Health NHS Trust, Eastbourne and County Trust, Hastings and Rother, Thame Health, Mid Downs (Crawley and Chichester), and Mid Kent Health Care Trust. Additional support from the Waterhouse Staff Charities Committee made possible the inclusion of 2 districts by direct mailing to parents. Finally, we are grateful to Michael Rutter, Cathy Lord, Louis Sim and Andrew Pickles, for discussion of this work.

References


Simon Baron-Cohen, PhD, Departments of Experimental Psychology and Psychiatry, University of Cambridge; Antony Cox, MRCPsych, Gillian Baird, MRCP, Department of Child and Adolescent Psychiatry; John Swettenham, PhD, Department of Child and Adolescent Psychiatry, Bloomfield Clinic, and Departments of Experimental Psychology and Psychiatry, University of Cambridge; Natasha Nightingale, Kate Morgan, MRCPsych, Arulie Drew, BSc, Department of Child and Adolescent Psychiatry, Bloomfield Clinic and Newcomen Centre, Guy's and St Thomas' Hospital Medical School, St Thomas' Street, London SE1 9RT; Tony Charman, PhD, Department of Psychology, (Philips House), University College London, Gower Street, London WC1E 6BT

Correspondence: Dr Baron-Cohen, University of Cambridge, Department of Experimental Psychology, Downing Street, Cambridge CB2 3EB

(First received 21 March 1995, final revision 26 July 1995, accepted 18 August 1995)