Early identification of autism by the CHecklist for Autism in Toddlers (CHAT)

Simon Baron-Cohen PhD Sally Wheelwright MSc Antony Cox FRCPsych[1] Gillian Baird FRCPCH[1]
Tony Charman PhD[2] John Swettenham PhD[3] Auriol Drew MA[1] Peter Doehring PhD[4]

J R Soc Med 2000;**93**:521–525

The CHecklist for Autism in Toddlers (CHAT) is a screening instrument that identifies children aged 18 months who are at risk for autism. This article explains how the CHAT was developed and how it should be used. First we offer a brief introduction to autism.

WHAT IS AUTISM?

Autism, first described by Kanner in 1943[1], is one of a family of 'pervasive developmental disorders[2]. The most severe of the childhood psychiatric conditions, it is characterized by a triad of impairments—in socialization, communication and flexible behaviour. The exact cause is unclear but family and twin studies suggest a genetic basis[3–5]; molecular genetic studies are underway[6]. Altered central nervous system function is evident in several different brain regions including the medial prefrontal cortex[7] and the amygdala[8–10]. Autism occurs in about 1 per 1000 children[11].

The general view is that autistic conditions exist in a spectrum, with classic autism at the extreme. In *DSM–IV* this is referred to as autistic disorder, and in *ICD–10* as childhood autism. To qualify for this diagnosis, the difficulties in social interaction, communication, and flexible behaviour must have begun before the age of three years. Atypical autism and 'pervasive developmental disorder not otherwise specified' (PDD-NOS) also lie on the autistic spectrum, but children with these conditions do not meet criteria for autism because of late age of onset, atypical symptoms, symptoms which are not very severe, or all of these. Asperger's syndrome is thought to be another condition on the autistic spectrum: individuals with this syndrome have the social interaction difficulties and restricted patterns of behaviour and interests but their IQ is normal and there is no general delay in language. A final subtype are individuals with 'high functioning autism' (HFA), who are diagnosed when all the signs of Asperger's syndrome are present, together with a history of language delay (defined as not using single words by two years old or phrase speech by three years old).

University of Cambridge, Departments of Experimental Psychology and Psychiatry, Downing Street, Cambridge CB2 3EB; [1]Newcomen Centre, UMDS, Guy's Hospital, London SE1 9RT; [2]Behavioural Sciences Unit, Institute of Child Health, London WC1N 1EH; [3]Department of Human Communication and Science, University College London, London WC1N 1PG, UK; [4]Delaware Autistic Program, 144 Brennan Drive, Newark DE 19713, USA

Correspondence to: Simon Baron-Cohen. E-mail: sb205@cus.cam.ac.uk

EARLY DETECTION

Until recently, autism was seldom detected before the age of three years. This is not surprising since it is a relatively uncommon condition and can have subtle manifestations. No specialized screening tool exists and most primary healthcare professionals have little training in the detection of autism in toddlers. However, the earlier a diagnosis can be made, the sooner family stress can be reduced; moreover, intervention can improve outcome[12]. In addition, early professional recognition of parental concerns may prevent secondary difficulties developing. The challenge is to identify a cost-effective method of detecting the early signs.

Which behaviours might be important?

Parents of children with autism often report that they first suspected that their child was not developing normally around the age of eighteen months[13]. At this age, certain behaviours are present in the normally developing child that are lacking or limited in older children with autism. Two of these are *joint attention*[14,15] and *pretend play*[11,16].

Joint attention refers to the ability to establish a shared focus of attention with another person via pointing, showing or gaze monitoring (e.g. glancing back and forth between an adult's face and an object of interest or an event)[17]. Joint attention allows children to learn through others—both learning what words refer to[18,19], and what to pay attention to in the environment ('social referencing')[20]. Joint attention is seen as the earliest expression of the infant's 'mind-reading' capacity, in that the child shows a sensitivity to what another person is interested in or attending to[21]. Pointing to share interest (or declarative pointing) can be distinguished from a simpler form of pointing (pointing to request, or imperative pointing). This distinction comes from child language research[22]. It is the declarative form which is of particular importance simply because in this type of pointing mind-reading may be the driving force ('*Look at*

Box 1 **The CHAT**

Section A: Ask parent

1. Does your child enjoy being swung, bounced on your knee,etc.? Yes No
2. Does your child take an interest in other children? Yes No
3. Does your child like climbing on things, such as up stairs? Yes No
4. Does your child enjoy playing peek-a-boo/hide-and-seek? Yes No
5. Does your child ever PRETEND, for example, to make a cup of tea using a toy cup and teapot, or pretend other things? Yes No
6. Does your child ever use his/her index finger to point, to ASK for something? Yes No
7. Does your child ever use his/her index finger to point, to indicate INTEREST in something? Yes No
8. Can your child play properly with small toys (e.g. cars or bricks) without just mouthing, fiddling or dropping them? Yes No
9. Does your child ever bring objects over to you (parent) to SHOW you something? Yes No

Section B: general practitioner or health visitor observation

i. During the appointment, has the child made eye contact with you? Yes No

ii. Get child's attention, then point across the room at an interesting object and say '*Oh look! There's a [name of toy]!*' Watch child's face. Does the child look across to see what you are pointing at? Yes No*

iii. Get the child's attention, then give child a miniature toy cup and teapot and say '*Can you make a cup of tea?*' Does the child pretend to pour out tea, drink it, etc.? Yes No†

iv. Say to the child '*Where's the light?*', or '*Show me the light*'. Does the child POINT with his/her index finger at the light? Yes No‡

v. Can the child build a tower of bricks? (If so how many?) (No. of bricks: . . . . . .) Yes No

*To record Yes on this item, ensure the child has not simply looked at your hand, but has actually looked at the object you are pointing at.
†If you can elicit an example of pretending in some other game, score a Yes on this item.
‡Repeat this with '*Where's the teddy?*' or some other unreachable object, if child does not understand the word light. To record Yes on this item, the child must have looked up at your face around the time of pointing.

Box 2 **Key and non-key items**

CHAT key items	***CHAT non-key items***
Section A	
A5: Pretend play	A1: Rough and tumble play
A7: Protodeclarative pointing	A2: Social Interest
	A3: Motor development
	A4: Social play
	A6: Protoimperative pointing
	A8: Functional play
	A9: Showing
Section B	
Bii: Following a point	Bi: Eye contact
Biii: Pretending	Bv: Tower of bricks
Biv: Producing a point	

that! Do you see what I see?'), whereas in imperative pointing this may not be required ('*I want that! Get me that!*').

Pretend play is a second behaviour to be distinguished. It involves the attribution of imaginary features to people, objects or events[23]. Some theorists view it as signalling the emergence of symbolic ability[24] as well as mind-reading. Pretence is symbolic in that one object is treated as if it represents something different, and it may involve mind-reading by requiring the child to appreciate that the person pretending (oneself or another person) is imagining something. Generally, pretend play is distinguished from simpler forms of play (functional, where the child uses objects appropriately, and sensorimotor, where the child just explores objects for their physical qualities).

CHAT

The CHecklist for Autism in Toddlers is a screening instrument that was devised to test the prediction that those children not exhibiting joint attention and pretend play by the age of eighteen months might be at risk for receiving a later diagnosis of autism. The CHAT is shown in Box 1. It takes 5–10 minutes to administer and is simple to score. The order of the questions avoids a yes/no bias.

The nine questions in section A are asked of the parent by the health visitor or general practitioner, who then completes the five items in section B by direct observation. There are five 'key items' and these are concerned with joint attention and pretend play. The key items in section B are included to validate (by cross-checking) the parents' answers to the key items in section A. The remainder ('non-key') items provide additional information so as to distinguish an autism-specific profile from one of more global developmental delay (see Box 2). The non-key items also provide an opportunity for all parents to answer 'yes' to some questions.

Those children who fail all five key items (A5, A7, Bii, Biii, and Biv) are predicted to be at the greatest risk for autism. In Box 3, we call this the 'high risk for autism group'. Children who fail both items measuring proto-declarative pointing, but who are not in the high risk for autism group, are predicted to be at medium risk. Children who do not fit either of these profiles are predicted to be at low risk.

High-risk (sibling) study

Our first study tested the effectiveness of the CHAT as a screening instrument in a high-risk sample[25]. We studied a group of 50 unselected eighteen-month-olds (group A) and a group of 41 eighteen-month-old siblings of children with autism (group B). The sibling group was selected because they have a raised genetic risk for autism compared with the general population. Even if we take the most generous

Box 3 **Risk assignment**

High risk for autism group	Fail A5, A7, Bii, Biii, Biv
Medium risk for autism group	Fail A7 Biv (but not in maximum risk group)
Low risk for autism group	Not in other two risk groups

estimate of the prevalence of autism spectrum conditions in the general population, 0.34%[26], this is still at least ten times less than the recurrence risk rate among siblings of children with autism (3%)[4]. So the likelihood of finding cases of undiagnosed autism in the sibling group was much higher than in the control group.

The toddlers in both groups were assessed with the CHAT. None of the children in group A failed all five key items whilst 4 of the children in group B failed all five key items. A year later, when the children were thirty months old, a follow-up was arranged. None of the children in group A had autism. The 4 children in group B who had failed the five key items were all diagnosed as having autism. This strongly confirmed the prediction that absence of joint attention and pretend play at eighteen months of age is a marker that a child is highly likely to receive a diagnosis of autism.

Population screening study

After the preliminary success of the CHAT in detecting children at risk for autism in the sibling group, a more stringent test of the CHAT was set up in a population screening study[27]. 16 235 children aged eighteen months were screened with the CHAT from April 1992 to April 1993 by health visitors or GPs and parents. These were all children born in the South Thames Region of the UK. 38 children matched the high risk for autism profile and 369 the medium risk profile, with the remainder at low risk by the criteria in Box 3. One month later, all 38 of the high risk for autism group were re-screened by a psychologist in our research team, and 12 continued to meet this profile. Limited resources meant that only about half of the medium risk group could be re-screened: 22 met the criteria on the second CHAT, 2 of whom did not continue to participate in the project. 16 children were selected at random from the low risk group to receive a second CHAT and continued to match this profile. Thus 12 children in the high risk for autism group, 20 children in the medium risk for autism group and 16 children in the low risk for autism group were assessed clinically at twenty months and forty-two months. The diagnoses made at twenty months were provisional since this is earlier than the age at which children have usually been seen for diagnostic assessment and there is little evidence about the accuracy and stability of childhood autism and PDD diagnoses made in infancy. Substantive diagnoses were made at the forty-two month clinical assessment. We were able to diagnose children with childhood autism reasonably accurately at twenty months of age, in that most were thought to have either autism or PDD at that time.

By forty-two months, 10 of the 12 children in the high risk for autism group had received a diagnosis on the autistic spectrum. The eleventh child was clinically normal and the twelfth child had language delay. In the medium risk for autism group, half the children were diagnosed with autism spectrum conditions (childhood autism, Asperger's syndrome, or PDD), 2 received no diagnosis and the rest had language or learning difficulties. In the low risk for autism group, although 1 child was diagnosed with language delay, the other 15 were normal. Figure 1 summarises how the diagnoses in each group changed between twenty and forty-two months. Full details of diagnostic methods can be found elsewhere[28].

KEY ISSUES IN ANY SCREENING PROGRAMME

To be appropriate for screening, a condition should meet the following criteria[29]: (1) It should be serious; (2) treatment given early (before symptoms are fully developed) should be more beneficial in terms of reducing morbidity or mortality than treatment given later; and (3) the prevalence of the condition should be high among the population screened. Autism meets all three of these criteria. In addition a screening test should ideally be inexpensive, easy to administer, and cause negligible discomfort. The CHAT meets these too.

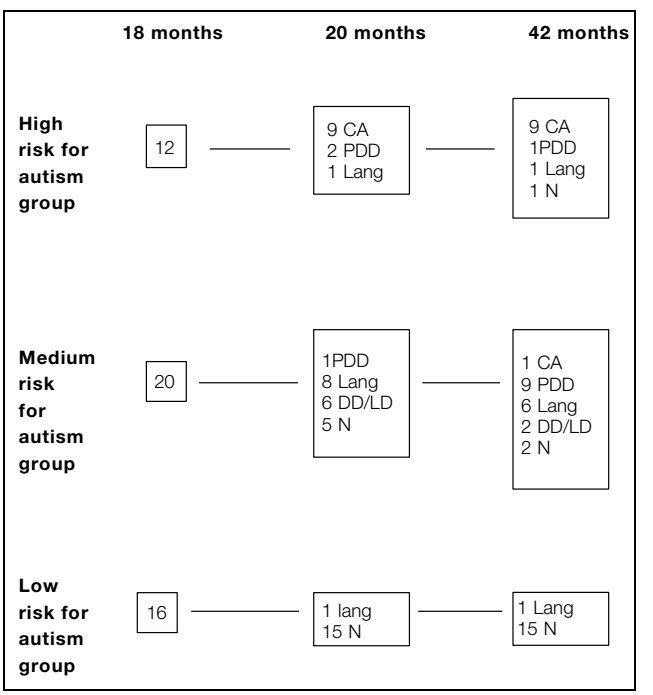

Figure 1 **Summary of changing diagnosis.** A=Childhood autism; DD/LD=developmental delay/learning difficulties; Lang=language disorder; N=normal; PDD=pervasive developmental disorder

Sensitivity and specificity are two measures of the validity of a screening test. Sensitivity is defined as the probability of being test positive and having the condition. As the sensitivity of a test increases, the number of people with the condition who are missed by being incorrectly classified as test-negative (false negatives) will decrease. Specificity is defined as the probability of being screen negative and truly not having the condition. Obviously, it is desirable to have a screening test that is both highly sensitive and highly specific. Usually that is not possible, and there is a trade-off between sensitivity and specificity. As regards the number of cases detected by a screening programme, one measure that is commonly considered is the predictive value of the screening test. Predictive value positive is the probability that a person actually has the condition given that he or she tests positive. Predictive value negative is the probability that an individual is truly condition-free given a negative screening test.

So is the CHAT a good screening instrument?

After administration of the CHAT at eighteen months, a series of follow-up screening and surveillance procedures were conducted with the aim of identifying all the children from the population with an autism spectrum condition, so as to test the properties of the CHAT in terms of identifying false negatives among other autism spectrum subgroups. By use of these methods in a population of over 16 000, a total of 50 children (47 boys, 3 girls) were found who met *ICD–10* criteria for childhood autism; and 44 children (36 boys, 8 girls) with other pervasive developmental disorders were also identified. With administration of the CHAT in two stages, a total of 74 children who went on to receive some sort of autism spectrum diagnosis were not identified as being at risk.

For autism, the high risk criteria of the CHAT had a sensitivity of 18%, specificity 100%, positive predictive value 75%, negative predictive value 99.7%. For all PPDs, the medium and high risk criteria combined had a sensitivity of 21.3%, specificity 99.9% and positive predictive values 58.8%. Just as for autism, the CHAT clearly has excellent specificity for all PDDs, though again the sensitivity is low.

The implication is that failure on two administrations of the CHAT points to a high likelihood that a child will eventually receive a diagnosis on the autism spectrum. The CHAT is useful in picking up some children whose development is autistic. The high false-negative rate is not a serious drawback of the test, because the condition is not life-threatening. One reason for the high false-negative rate might be that some parents are (understandably) answering questions in section A in such a way as to put their child in the best possible light. Since to 'fail' on the CHAT a child needs to fail on both sections A and B, our team did not look closely at children who failed only on section B. A second possible reason is that to fail on the CHAT a child must have *never* produced the behaviour ('*Has your child ever pointed/pretended?*'). This is clearly going to pick up only the severe or extreme cases and will miss those who simply show a reduced rate of pointing or pretending. A third reason which could lead to a false negative is that a child has 'late onset' autism[30].

Who should use the CHAT and when?

The CHAT is designed to be administered by primary healthcare workers or clinicians in children's services. As a screening tool, it is convenient to administer at the eighteen-month developmental check-up. Administration of the CHAT to younger children is not recommended because of the increased risk of false positives. Administration of the CHAT to children older than eighteen months is possible, since if a child is still showing a high-risk profile at this age this is very likely to be a sign of an autism-spectrum condition. In some regions, developmental screening is carried out only at twenty-four months, which is why we consider this possibility. We do not yet know of any data on the use of the CHAT at this age, and suspect that the false negative rate will again be high. However, by 24 months of age the issue of delayed speech will be somewhat clearer.

What happens if a child fails the CHAT?

In the population screening study[27], the first CHAT was administered in the routine check-up at eighteen months. Those children who failed this CHAT were re-screened about one month later with the same questionnaire. As with any screening, a second CHAT is advisable so as to check that a 'fail' on a key item occurs for valid reasons. Thus, a child might fail on the first administration of the CHAT simply because he or she has slight developmental delay or is merely having 'a bad day'. Any child failing the CHAT a second time should however be referred to a specialist clinic for diagnosis. This underlines that the CHAT itself is *not* a diagnostic tool. More than half the children who fail on the first administration of the CHAT lose their risk status after the second CHAT; and the risk group a child is assigned to does not represent a statement of diagnosis.

CONCLUSION

The CHAT is primarily a screening tool for clinical use. If a child meets criteria for the high risk group, he or she will almost certainly go on to be diagnosed as having autism or PDD. Of the medium risk group, about half will be so diagnosed, whilst most of the remainder will have other developmental delay conditions. The low false-positive rate means that few parents will be unnecessarily alarmed.

Acknowledgments We are grateful to the Medical Research Council for support through project grants to SBC, AC and GB. Carol Brayne gave us valuable feedback.

REFERENCES

1 Kanner L. Autistic disturbance of affective contact. *Nerv Child* 1943;**2**:217–50

2 American Psychiatric Association. *DSM–IV Diagnostic and Statistical Manual of Mental Disorders*. Washington DC: American Psychiatric Association, 1994

3 Bailey T, Le Couteur A, Gottesman I, *et al.* Autism as a strongly genetic disorder: evidence from a British twin study. *Psychol Med* 1995;**25**:63–77

4 Folstein S, Rutter M. Infantile autism: a genetic study of 21 twin pairs. *J Child Psychol Psychiatry* 1977;**18**:297–321

5 Folstein S, Rutter M. Autism: familial aggregation and genetic implications. *J Autism Devel Disord* 1988;**18**:3–30

6 Bailey A, Bolton P, Rutter M. A full genome screen for autism with evidence for linkage to a region on chromosome 7q. *Hum Molec Genet* 1998;**7**:571–8

7 Happe F, Ehlers S, Fletcher P, *et al.* ''Theory of mind'' in the brain. Evidence from a PET scan study of Asperger syndrome. *NeuroReport* 1996;**8**:197–201

8 Abell F, Krams M, Ashburner J, *et al.* The neuroanatomy of autism: a voxel-based whole brain analysis of structural scans. *Cogn Neurosci* 1999;**10**:1647–51

9 Baron-Cohen S, Ring H, Wheelwright S, *et al.* Social intelligence in the normal and autistic brain: an fMRI study. *Europ J Neurosci* 1999;**11**: 1891–8

10 Bauman M, Kemper T. Limbic and cerebellar abnormalities: consistent findings in infantile autism. *J Neuropathol Exp Neurol* 1988;**47**:369

11 Wing L, Gould J, Yeates SR, Brierley LM. Symbolic play in severely mentally retarded and in autistic children. *J Child Psychol Psychiatry* 1977;**18**:167–78

12 Lovaas O, Smith T. Intensive behavioural treatment for young autistic children. In: Lahey B, Kazdin A, eds. *Advances in Clinical Child Psychology*, vol. II. New York: Plenum, 1988

13 Wing L. *The Autistic Spectrum*. Oxford: Pergamon, 1997

14 Baron-Cohen S. Perceptual role-taking and protodeclarative pointing in autism. *Br J Devel Psychol* 1989;**7**:113–27

15 Sigman M, Mundy P, Ungerer J, Sherman T. Social interactions of autistic, mentally retarded, and normal children and their caregivers. *J Child Psychol Psychiatry* 1986;**27**:647–56

16 Baron-Cohen S. Autism and symbolic play. *Br J Devel Psychol* 1987;**5**: 139–48

17 Bruner J. *Child's Talk: Learning to use Language*. Oxford: Oxford University Press, 1983

18 Baldwin D. Understanding the link between joint attention and language acquisition. In: Moore C, Dunham P, eds. *Joint Attention: its Origins and Role in Development*. Hillsdale, NJ: Lawrence Erlbaum Associates, 1995

19 Tomasello M, Barton M. Learning words in nonostensive contexts. *Devel Psychol* 1994;**30**:639–50

20 Feinman S. Social referencing in infancy. *Merrill-Palmer Q* 1982;**28**: 445–70

21 Baron-Cohen S. Precursors to a theory of mind: understanding attention in others. In: Whiten A, ed. *Natural Theories of Mind*. Oxford: Blackwell, 1991

22 Bates E, Benigni L, Bretherton I, Camaioni L, Volterra V. Cognition and communication from 9–13 months: correlational findings: In: Bates E, ed. *The Emergence of Symbols: Cognition and Communication in Infancy*. New York: Academic Press, 1979

23 Leslie AM. Pretence and representation: the origins of ''theory of mind''. *Psychol Rev* 1987;**94**:412–26

24 Piaget J. *Dreams, Play and Imitation in Childhood*. London: Routledge and Kegan Paul, 1962

25 Baron-Cohen S, Allen J, Gillberg C. Can autism be detected at 18 months? The needle, the haystack, and the CHAT. *Br J Psychiatry* 1992;**161**:839–43

26 Ehlers S, Gillberg C. The epidemiology of Asperger syndrome. A total population study. *J Child Psychol Psychiatry* 1993;**34**:1327–50

27 Baron-Cohen S, Cox A, Baird G, *et al.* Psychological markers of autism at 18 months of age in a large population. *Br J Psychiatry* 1996;**168**: 158–63

28 Cox A, Klein K, Charman T, *et al.* Autism spectrum disorders at 20 and 42 months of age: stability of clinical and ADI-R diagnosis. *J Child Psychol Psychiatry* 1999;**40**:719–32

29 Hennekens C, Buring J. *Epidemiology in Medicine*. Boston: Little, Brown, 1987

30 Volkmar F, Cohen D. Disintegrative disorder or 'late onset' autism? *J Child Psychol Psychiatry* 1989;**30**:717–24