British Journal of Developmental Psychology (1994), 12, 397–401 *Printed in Great Britain*

The 'seeing-leads-to-knowing' deficit in autism: The Pratt and Bryant probe

Simon Baron-Cohen* and **Frances Goodhart**

Departments of Psychology and Child Psychiatry, Institute of Psychiatry, University of London, Denmark Hill, London SE5 8AF, UK

This study retests the findings by Leslie & Frith (1988) and Perner, Frith, Leslie & Leekam (1989) that children with autism have a specific difficulty in understanding the principle that 'seeing leads to knowing'. It extends the earlier work by including a control group of subjects with mental handicap, and by using a simpler method, derived from Pratt & Bryant (1990). Despite these modifications, a very similar result was found: while 75 per cent of the subjects with mental handicap passed this test, only 33 per cent of the subjects with autism did so. This more stringent retest suggests this result is robust.

When do young normal children understand that people gain direct knowledge about an object by having informational access to that object? For example, when do they understand the principle that 'seeing-leads-to-knowing'? Wimmer, Hogrefe & Perner (1988) found that this was not until age 4 years. Pratt & Bryant (1990) suggested that in Wimmer *et al.*'s (1988) procedure, younger children may have been a little confused by the form of the questioning, and then went on to show that using a simpler format even 3-year-olds understand that seeing leads to knowing. Pillow (1989) found a similar result. This cornerstone principle of a theory of mind thus seems to be in place remarkably early in normal development.

What about children with autism, who show impairments in the development of a theory of mind (Baron-Cohen, Leslie & Frith, 1985)? Leslie & Frith (1988) found that only 44 per cent (and Perner, Frith, Leslie & Leekham, 1989, found that only 35 per cent) of their sample of children with autism understood the role of visual access in knowledge formation. On the face of it, therefore, their understanding of this principle seems almost as impaired as their understanding of the mental state of belief (see Baron-Cohen, 1993, for a review). However, neither Leslie & Frith (1988) nor Perner *et al.* (1989) included a non-autistic control group in their test of this principle, so it is hard to evaluate if this is an autism-specific deficit, or simply a result of the accompanying mental handicap found in the majority of children with autism. For this reason, the aim of this study was to retest their finding, but with the inclusion of a control group of children with mental handicap. This was felt to be important, as it has been proposed that such cognitive deficits underlie the observed social and communication abnormalities in autism (Baron-Cohen, 1988; Frith, 1989) yet, without such control data, the cognitive deficit itself remains difficult to

* Requests for reprints.

appraise. In addition it was decided to use a version of the Pratt & Bryant (1990) technique, since this is extremely simple for children to follow. Essentially, the child is shown two characters, one of whom *looks* into a box and one of whom does not, and is asked: 'Which one *knows* what is in the box?' A doll version of this technique was used, since previous work had shown that on other theory of mind tests in autism studies, inclusion of dolls or people makes very little difference to results (Baron-Cohen *et al.*, 1985; Leslie & Frith, 1988).

Method

Subjects

Two groups of 12 subjects were tested, those with autism, and those with mental handicap but without autism. All subjects were attending special education schools in the London area. The subjects with autism had all received a diagnosis using established criteria (DSM-III-R: American Psychiatric Association 1987; Rutter, 1978). A group of normal children were not tested, as we felt that previous studies were sufficient to provide normative data. The inclusion criterion used was based on an attempt to match our subjects with the samples used in previous experiments (Pratt & Bryant, 1990; Pillow, 1989; Perner *et al.*, 1989). Thus, only those subjects with a language comprehension level [measured by the Reynell Developmental Language Scale (Reynell, 1991), or the Test of Reception of Grammar [TROG; Bishop, (1983)] above 3½ years old were included. Their details are shown in Table 1.

Table 1. Background variables of subjects in the experiment

	N	Chronological age	Verbal mental age*
Autism	12	*M* 13:1	4:8
		SD 2:5	1:7
		Range 11:8–16:1	3:4–5:5
Mental handicap	12	*M* 14:3	4:6
		SD 2:1	1:5
		Range 10:7–18:7	3:6–5:9

* Reynell Developmental Language Scale (Comprehension) or TROG

Procedure

Subjects were tested individually in a quiet room in their school. The subject and the experimenter were seated at a small table and were facing each other. As mentioned earlier, the experimental procedure closely followed that used by Pratt & Bryant (1990), except that dolls were used rather than live assistants.

Pre-test and control condition. A pre-test task was administered to familiarize the subjects with the general procedure of choosing one of the dolls and to eliminate subjects who were unable to follow the simple procedure. First, the experimenter took out two dolls and said to each subject, 'This is John and this is Fiona'. The subject was then asked the naming question: 'Which is John? Which is Fiona?' Next, the subject was shown a red and a blue counter and was asked to name each of their colours. All subject passed these questions. The experimenter then said, 'Let's give Fiona a red counter and John a blue counter'. Having watched the experimenter give each doll a counter, the subject was then asked, 'Who has the blue counter, John or Fiona?' This last question constituted a control condition to the main experiment, reported below, in comprising a very

similar 'story' but entailing no knowledge formation. Six trials were given to each subject, in which the colour of the counter and order of mention of the dolls was randomized across trials. Again, all of these subjects successfully passed this question on at least five out of the six trials, and were therefore permitted to participate in the experimental task.

Experimental task. The experimenter introduced the experimental task to the subject by saying, 'Look! I've got some boxes here. There is something inside each box. I am going to show the boxes to John and Fiona'. Five trials were administered, and on each trial the experimenter made one doll simply pick up the closed box, and the other doll open the lid of the box and 'look' inside. Each action was accompanied with a statement such as 'John lifts the box up. Fiona opens the box and has a look'. The subject was then asked 'Who knows what is in the box? John or Fiona?' On each of the five trials the doll who looked, the order of looking versus lifting, and the order in which the two dolls were mentioned in the question, were randomized. In these trials, we ensured that the subject could not see into the box when one of the dolls opened it. This meant that the subject remained ignorant of the contents of the box, and therefore had to answer the knowledge question purely on the basis of what could be ascribed to another character.

Results

Subjects were considered to have passed the experimental task if they correctly identified the doll who knew what was in the box on all five trials. This was to rule out success by chance alone, since chance success on each trial was .5, and on five trials was .03. Using these criteria, as is clear from Table 2, only a third of the subjects with autism passed the experimental task, whereas three-quarters of the subjects with mental handicap did so. This difference was highly significant (Fisher's exact probability test, $p < .01$). The number of subjects passing each trial is shown in Table 3. The four subjects with autism who passed the test overall, using the above criteria, were unremarkable in terms of both chronological age and mental age, when compared to those who failed. Since there were only four such subjects, this comparison was not tested statistically.

Table 2. Number of subjects in each group passing the experimental task

Group	Pass[a]	Fail
Autism	4*	8
Mental handicap	9	3

[a] Criterion for passing = correct on five out of five trials.
* Fisher's exact probability test, $p < .01$.

Table 3. Number of subjects in each group passing different numbers of trials

	Number of trials passed					
Group	0	1	2	3	4	5
Autism	1	2	3	2	0	4
Mental handicap	1	0	2	1	0	8

Fisher's exact probability test, $p < .01$.

Discussion

The results of the study are consistent with those by Leslie & Frith (1988) and Perner *et al.* (1989) in finding that only about a third of subjects with autism understand the simple principle that to know something one has to have had informational access to it. This study provides stronger support for this impairment by contrasting it with the good understanding shown by subjects who have a mental handicap but who do not have autism. This suggests that the results of the earlier studies were unlikely to have stemmed from their subjects being generally developmentally delayed, but rather indicate an autism-specific deficit. Furthermore, the present results provide evidence for the utility of Pratt & Bryant's (1990) technique as a probe to uncover this deficit. Given its simplicity, this probe may have potential as part of a diagnostic battery of tests.

The result of this study is also consistent with the performance by children with autism on the Penny Hiding Game (Baron-Cohen, 1992; Ollendick and Oswald, 1989) in which they have been shown to make specific errors: when asked to hide a penny in one of their hands, the majority of subjects with autism either (1) omitted to close the hand that the penny was not in, or (2) opened the hand the penny was in before the other person had had a chance to guess, or (3) hid the penny in full view of the guesser. All of these errors reveal a fundamental inability to understand the point of hiding—to occlude *information* and not just objects. More relevant to the present study, they also reveal a failure to understand that a guesser will *know* the location of an object if she or he is allowed to *see* where it is put.

Some additional conclusions can be drawn from the present study. First, the deficit in the children with autism could not have been due to the subject simply responding to the 'salience of the object' (Russell *et al.*, 1991), an explanation that has been proposed for some of the earlier results in this field. This conclusion is possible because the subject did not see inside the box. Nor could the deficit have been due to reasons to do with motivation or distraction, etc., as all subjects passed our pre-test/colour control condition. Indeed, this was one of the inclusion criteria for the experimental study, and all subjects were therefore at ceiling on this. Finally, language level seems an unlikely explanation of the pattern of results, since as Table 1 shows, both groups were closely matched to each other on verbal mental age.

These results therefore point to another important piece of theory of mind knowledge being poorly developed in autism (Baron-Cohen, 1993). Whether subjects with autism also fail to understand other implications of this principle, such as hearing-leads-to-knowing (under appropriate circumstances) or touching-leads-to-knowing (under other appropriate circumstances), remains to be established. In this respect, it would be of interest to test children with autism using O'Neill & Gopnik's (1991) methodology, developed with normal children. But it is clear that, as far as the principle that seeing-leads-to-knowing is concerned, these subjects are severely impaired. The identification of such principle-based knowledge deficits is important before specific teaching programmes can be developed (Baron-Cohen & Howlin, 1993).

Acknowledgements

The experiment reported here formed part of a thesis submitted in part fulfilment of the MSc Degree in Clinical Psychology, by the second author, to the University of London, 1991. The first author was

supported by grants from the Mental Health Foundation and the Medical Research Council during the period of this work. We would like to thank the staff and pupils at Heathlands School, Cherry Garden School and Griffin Manor School for their cooperation with this research.

References

American Psychiatric Association (1987). *Diagnostic and Statistical Manual of Mental Disorders*, 3rd ed. rev., Washington DC: American Psychiatric Association.

Baron-Cohen, S. (1988). Social and pragmatic deficits in autism: Cognitive or affective? *Journal of Autism and Developmental Disorders*, **18**, 379–402.

Baron-Cohen, S. (1992). Out of sight or out of mind: Another look at deception in autism. *Journal of Child Psychology and Psychiatry*, **33**, 1141–1155.

Baron-Cohen, S. (1993). From attention-goal psychology to belief-desire psychology: The development of a theory of mind and its dysfunction. In S. Baron-Cohen, H. Tager-Flusberg & D. J. Cohen (Eds), *Understanding Other Minds: Perspectives from Autism*. Oxford. Oxford University Press.

Baron-Cohen, S. & Howlin, P. (1993). The theory of mind deficit in autism: some questions for teaching and diagnosis. In S. Baron-Cohen, H. Tager-Flusberg & D. J. Cohen (Eds), *Understanding Other Minds: Perspectives from Autism*. Oxford: Oxford University Press.

Baron-Cohen, S., Leslie, A. M. & Frith, U. (1985). Does the autistic child have a 'theory of mind'? *Cognition*, **21**, 37–46.

Bishop, D. V. M. (1983). *Test for the Reception of Grammar*. MRC APU, 15 Chaucer Road, Cambridge, UK.

Frith, U. (1989). *Autism: Explaining the Enigma*. Oxford: Basil Blackwell.

Leslie, A. M. & Frith, U. (1988). Autistic children's understanding of seeing, knowing, and believing. *British Journal of Developmental Psychology*, **6**, 315–324.

O'Neill, D. & Gopnik, A. (1991). Young children's ability to identify the sources of their beliefs. *Developmental Psychology*, **27**, 390–397.

Oswald, D. & Ollendick, T. (1989). Roletaking and social competence in autism and mental retardation. *Journal of Autism and Developmental Disorders*, **19**, 119–128.

Perner, J., Frith, U., Leslie, A. M. & Leekam, S. R. (1989). Exploration of the autistic child's theory of mind: Knowledge, belief and communication. *Child Development*, **60**, 689–700.

Pillow, B. H. (1989). Early understanding of perception as a source of knowledge. *Journal of Experimental Child Psychology*, **47**, 116–129.

Pratt, C. & Bryant, P. (1990). Young children understand that looking leads to knowing (so long as they are looking into a single barrel). *Child Development*, **61**, 973–982.

Reynell, I. (1967). *Reynell Developmental Language Scales*. Windsor: NFER.

Russell, J., Mauthner, N., Sharpe, S. & Tidswell, T. (1991). The Windows Task as a measure of strategic deception in preschoolers and autistic children. *British Journal of Developmental Psychology*, **9**, 331–349.

Rutter, M. (1978). Diagnosis and definition. In M. Rutter & E. Schopler (Eds), *Autism: A Reappraisal of Concepts and Treatment*. New York: Plenum.

Wimmer, H., Hogrefe, J. & Perner, J. (1988). Children's understanding of informational access as a source of knowledge. *Child Development*, **59**, 386–396.

Received 18 August 1992; revised version received 29 June 1993