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Mechanical, behavioural and Intentional understanding of picture stories in autistic children

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High-ability autistic children were compared with low-ability Down's syndrome children and clinically normal preschool children on a picture sequencing task. When the sequences could be understood in terms of causal–mechanical or simply descriptive–behavioural criteria, the autistic children were at least as good as the controls and often showed superior performance. However, on sequences that evoked understanding in terms of psychological–Intentional criteria, the autistic children performed much worse than the others. This pattern was also seen in the language used by the children in narrating the stories afterwards. In contrast to the controls, the autistic children used causal and behavioural language, but hardly ever mental state language. This experiment confirms and extends a previous study of ours which also tested the hypothesis of a specific cognitive deficit which apparently prevents the development of a 'theory of mind' in the autistic child.

Autistic children's understanding of the *physical* world (e.g. object concept and causality) appears to develop in line with their mental age (Serafica, 1971; Curcio, 1978; Hammes & Langdell, 1981; Sigman & Ungerer, 1981; Wetherby & Gaines, 1982). On the other hand, their *social* skills are by definition severely impaired (Kanner, 1943; Wing & Gould, 1979; Rutter, 1983; Lord, 1984), and this suggests a deficient understanding of the social world. We have been tackling this problem by attempting to identify a cognitive deficit which would give rise to severe social impairment, but which would allow understanding of the physical world to remain intact (Frith, 1984; Baron-Cohen *et al.*, 1985; Leslie, 1985).

In our previous study, we found that even high-ability autistic children (in contrast to low-ability controls) are unable to impute *Intentional** states to others. We tested 20 autistic, 14 Down's and 27 normal preschool children on a puppet play task devised by Wimmer & Perner (1983). In this simple yet stringent test of the ability to impute Intentional states conclusions about the consequences of someone's false belief have to be drawn. The child has to predict the behaviour of a doll protagonist (where will Sally look?) on the basis of a belief the doll should have ('the marble is in the basket'), given its opportunities to witness a series of events. One crucial event is not witnessed by the doll (the marble is taken out of the basket and put into a box), rendering the doll's belief false. Just as in Wimmer & Perner's study (1983), our normal 4-year-olds predicted the doll's behaviour (Sally will look in the basket) on the basis of the doll's belief and not on the basis of their own belief ('the marble is now in the box'). Down's syndrome children with a mean IQ of 64 performed remarkably close to the normal 4-year-olds (86 and 85 per cent correct respectively). But out of the 20 able autistic children with a mean IQ of 82, only four passed the task. The vast majority, 80 per cent, failed despite perfect performance on control questions which tested their general understanding of the task. The autistic children did not fail through random responding. They failed, we argued, because they did not

* We use the word 'Intentional' (with a capital I) following Dennett (1971) and Searle (1979) to denote the entire range of mental states with content and not just the particular mental state of 'having an intention to act' (with lower-case i). Intentional states with content (for example, believing something, hoping something, or wanting something) contrast with other mental states which are not *about* anything (for example, being in pain, simply being depressed, or simply being alert).

attribute a mental state, in this case a wrong belief, to the protagonist. They had therefore to rely, by default, on their own understanding of the situation. This led to perfectly consistent but wrong attempts to predict the doll's behaviour (Sally will look in the box).

The failure of the autistic children in our study was in striking contrast to the success of the more severely retarded Down's syndrome children. It is already known that the social competence of Down's syndrome children develops in line with MA (Wing & Gould, 1979; Coggins *et al.*, 1983). We suggested, therefore, that some important part of the social impairment of autistic children may be related to a *specific deficit* in their 'theory of mind'. Normal children, it appears, impute mental states to others or utilize a 'theory of mind', as Premack & Woodruff (1978) have called it, from at least 4 years of age (Macnamara, Baker & Olsen, 1976; Wellman & Johnson, 1979; Shultz *et al.*, 1980; Bretherton *et al.*, 1981; Shultz & Cloghesy, 1981; Wimmer & Perner, 1983), though its roots lie much further back in development (Leslie, 1985). The usefulness of this ability in understanding everyday social situations is obvious. For example: Why did the girl look in the basket? Because she *believed* her toy was in there and she *wanted* to play with it. A cognitive deficit in this area would have enormous impact on a child's ability to understand and predict the behaviour of others.

In the study that we shall now describe we wished to follow up the children from the previous experiment in order to obtain new evidence about our hypothesis of a specific cognitive deficit even in able autistic children. We also wanted to compare autistic children's understanding of physical and social events directly.

To pursue the first aim, we saw the same children but used a different sort of technique, namely picture sequencing. The picture sequencing paradigm has been used successfully with very young children in order to study the understanding of causal relations (Bullock, 1984). This technique also allowed us to gather subsequent narrative information from our subjects, giving us a further line of evidence and enabling us to check the child's interpretation of the picture sequences.

To pursue the second aim, we had to test the idea that the autistic child will understand some events relatively well, and other events relatively badly. So, we compared three types of picture story. The first, which we called 'mechanical', depicted physical–causal relations. We called the second type 'behavioural'; here people were depicted engaging in various activities and interactions. These could be perfectly understood simply by reference to overt behaviour, without considering mental states. The third type of story we called 'Intentional', since an intuitive and immediate understanding necessarily involved considering the mental state (i.e. a false belief) of the protagonist and not just the behaviour. Of course, there is no logical reason why any of the stories could not be understood in terms of any of these descriptive levels. For example, Intentional stories *could* be described in mechanical terms, and this is the common denominator that we have used in Table 2 (see below). Nevertheless, we expected that the first two story types would be most 'naturally' understood in mechanical and behavioural terms but the last type of story in Intentional terms. Therefore, we expected the first two types to be well understood by autistic children. On the other hand, we expected autistic children's performance to suffer on the last type of story since the most 'natural' level of understanding for this type should not be available to them. We expected this type of story to be easy for non-autistic control children since they should opt for understanding in Intentional terms. In particular, they should have no problem imputing a false belief.

It is important to rule out the possibility that difficulties in understanding the Intentional stories are simply due to problems with the social content of the scenario. Thus, Hobson (1983, in press) showed that the performance of able autistic children on various perceptual matching or sorting tasks was significantly worse for person stimuli than for object stimuli.

This prompted Hobson to hypothesize that the 'personal relation' was an area of specific difficulty for autistic children. For this reason, we distinguished between sequences that depicted mechanical events involving just objects and those involving persons as well. Furthermore, there might be a specific difficulty in the understanding of *person-to-person* interaction, possibly over and above any disorder in person perception. In order to test this notion, we compared behavioural sequences depicting events concerning one person only and those concerning at least two people. It is also worth noting that there were examples in all three conditions of stories depicting emotional expressions. These can be interpreted either as behavioural or as mental states, but do not critically differentiate the conditions. Hence any difference in performance will not be attributable to differences in this particular domain.

In summary, on the basis of our hypothesis of a specific deficit in the ability to impute mental states we predicted that autistic children would have specific difficulties with our Intentional stories all involving the attribution of false beliefs. The difficulties would be both relative to their own performance on the other two conditions (mechanical and behavioural) and relative to the other two groups. They should be present, not only in picture sequencing, but also in the use of language in narrating the stories. In addition, our hypothesis predicts that stories involving interpersonal interactions that can be understood appropriately without reference to mental states would not pose specific problems to the autistic child.

Method

Subjects

The 21 autistic children came from four special schools, all being diagnosed according to established criteria (Rutter, 1978; DSM-III, 1980). The 15 Down's syndrome children came from ESN schools and the 27 normal children attended various nurseries and primary schools in London. The children were the same as in our earlier experiment, with a few exceptions due to a few children being unavailable at follow-up. The sex ratio was approximately 1:1 in the latter two groups of children, but there were 14 boys and 7 girls in the autistic group. This reflects the bias towards males in the autistic population.

The background data for age (CA) and mental age (MA) are presented in Table 1. It can be seen that non-verbal MA (as assessed by the Leiter scale) was relatively high in the autistic group, much higher than for the Down's* group and by implication than for the clinically normal group also. This was also the case for verbal MA as assessed by the British Picture Vocabulary Scale (BPVS). Thus, in terms of these variables, the autistic group had a decided advantage over the other two groups. This enables a strict test of the specific deficit hypothesis as opposed to a general deficit explanation to be made.

Design and materials

We assessed the child's ability to arrange pictures into a predetermined sequence. This was taken to indicate the child's understanding of the story depicted in the sequence. In addition, we checked their understanding in an analysis of narrations based on these sequences.

We used five types of story, one for each of five conditions. These were:

Mechanical 1: Objects interacting causally with each other.
Mechanical 2: People and objects acting causally on each other.
Behavioural 1: A single person acting in everyday routines not requiring attribution of mental states.
Behavioural 2: People acting in social routines, involving more than one person, but not requiring attribution of mental states.
Intentional: People acting in everyday activities requiring attribution of mental states.

There were three different stories for each condition (see Table 2). Figure 1 provides illustrative examples of the stories used. The actual pictures used a variety of styles and were drawn on white cards, 5 × 5 inches. The images

* Although the mental age assessment of the Down's group on the Leiter test and BPVS are markedly discrepant, we cannot say whether our sample is atypical or not. This is because there is no normative information on the relationship between these two tests for Down's subjects. Perhaps fortuitously, it makes our two clinical groups comparable in terms of superiority of non-verbal over verbal MA.

Table 1. Subject data

	n		CA	Non-verbal (Leiter) MA	Verbal (BPVS) MA
Autistic	21	Mean	12·4	9·6	5·7
		SD	2·8	2·3	2·1
		Range	6·1–16·9	6·7–15·9	2·8–12·5
Down's	15	Mean	10·5	5·9	2·9
		SD	3·8	0·9	0·6
		Range	6·3–17·0	4·8–8·5	1·8–4·0
Normal	27	Mean	4·5	—	—
		SD	0·7	—	—
		Range	3·5–5·9	—	—

had simple black outlines and primary colours. We chose a standard length of four pictures, because pilot studies suggested that this was appropriate for the younger children in our groups.

A frame for holding a sequence of four cards, with each position marked with a number, was placed on a table before the child. In order to reduce ambiguity of possible stories that could be constructed from four given pictures we always presented the first of the four pictures as the start of the sequence. This meant that the child had to place only three pictures at each trial.

The order of the conditions was fixed (M1, M2, B2, I, B1). We started with the mechanical stories in the belief that these were the simplest. The critical condition (Intentional) was the penultimate one. This allowed it to receive any benefit of practice. One of the 'behavioural' conditions ended the session. This allowed us to assess any differential effects of practice/fatigue on the three groups of subjects.

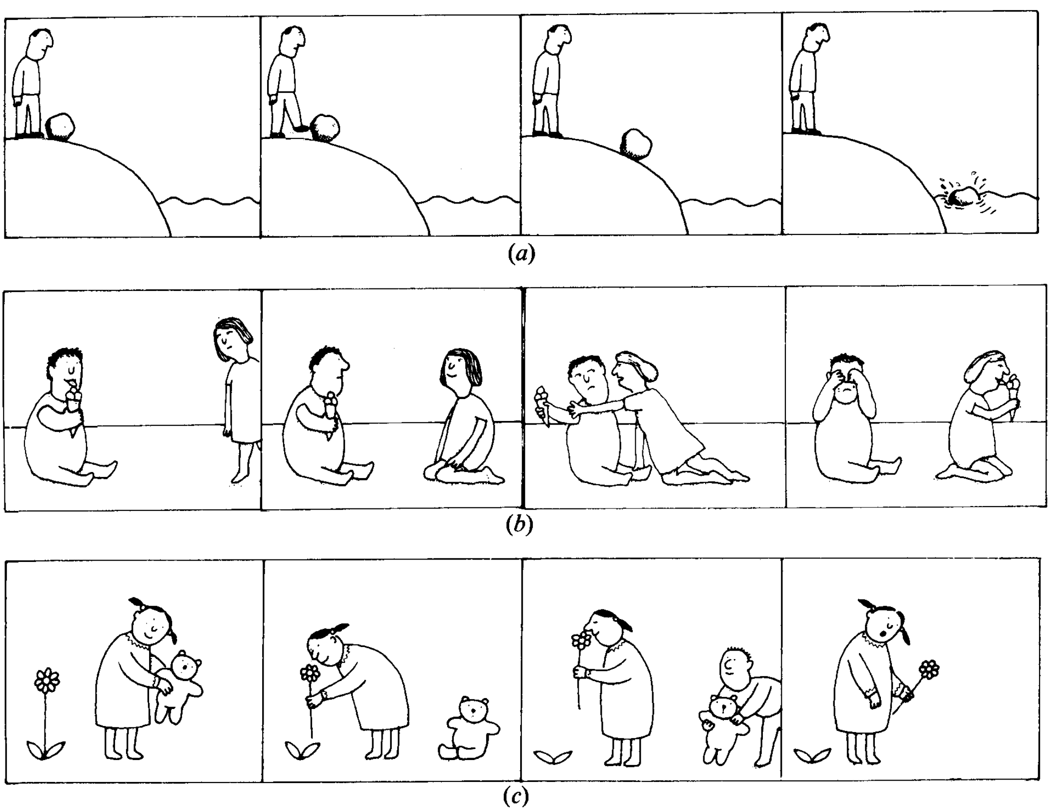

Figure 1. Examples of picture sequences: (*a*) 'mechanical' (person and object); (*b*) 'behavioural' (person-to-person); (*c*) 'Intentional'.

Table 2. Contents of picture stories

	Picture			
Condition	1	2	3	4
Mechanical 1	1. Rock on hilltop	Rock topples	Rolls down hill	Knocks tree over
	2. Egg on table	Egg rolls	Egg falls off table	Egg smashes
	3. Balloon	Balloon flies	Flies towards tree	Balloon bursts on tree
Mechanical 2	1. Man walking	Trips over	Falls down	Leg bleeds
	2. Rock on hilltop	Rock topples	Rolls down hill	Knocks man over
	3. Man with rock	Pushes rock	Rolls down hill	Falls in water
Behavioural 1	1. Boy turns on tap	Stands under	Soaps himself	Dries himself
	2. Boy puts on trousers	Then T-shirt	Then shoes	Is fully dressed
	3. Man with spade	Digs hole	Pours in seeds	Fills in hole
Behavioural 2	1. Girl walking	Opens shop door	Buys sweets	Leaves shop
	2. Man rolls dough	Sprinkles veg	Puts pie in oven	Serves out pie
	3. Boy eats ice-cream	Girl sits down	Girl takes away ice	Girl eats it
Intentional	1. Boy buys sweets	Leaves shop	Sweets drop out of bag	Boy sees sweets gone
	2. Girl puts teddy down	Turns to pick flower	Boy takes teddy	Girl sees teddy gone
	3. Boy puts choc in box	Goes out to play	Mum eats chocolate	Boy sees choc gone

Procedure

Sequencing. The order of presentation of trials within each condition was randomized. The experimenter placed the first picture of each story in its correct position in the frame, and the remaining three pictures in random order above it, so as to avoid any position cues which might lead to a systematic bias in sequencing. Each child was told for each story:

'This is the first picture. Look at the other pictures and see if you can make a story with them.'

If the child did not respond immediately, the experimenter named all the objects in the first picture to ensure there was no ambiguity in the drawings, and then said: 'Which is the next picture?'

The order chosen by the child was noted down, after any self-corrections. Each child was allowed to proceed at his or her own pace, but had only one attempt at each of the 15 stories.

Narration. Protocols were collected by asking 'can you tell the story' after each sequence had been ordered by the child. Some children never responded verbally to this request. Using a clinical interview method prompting questions were asked only when it was felt that more information could be obtained. It was impossible to use a standardized procedure due to the overriding requirement that the experimenter maintain rapport with the children from widely differing clinical groups. The narrations, spontaneous and elicited, were tape-recorded and later transcribed.

Results

Sequencing

A completely correct sequence (i.e. according to the predetermined order) was awarded 2 points. If the child chose only the correct end point for the story, placing the last card correctly, 1 point was awarded. The other four possible orders scored zero. This strict scoring procedure was designed to minimize spuriously correct responses. For each condition the maximum score was 6 (three trials). Table 3 and Fig. 2 illustrate the results.

Performance in all groups on the mechanical and behavioural subconditions comparing object versus person or single person versus person-to-person was highly similar. Accordingly, these subconditions are collapsed in Fig. 2.

On the mechanical condition the autistic group was far superior to the normal group, while on the Intentional condition the opposite occurred. This was reflected in a highly significant groups × conditions interaction ($F = 20{\cdot}22$, d.f. = 8,240, $P < 0{\cdot}001$) in a 3(groups) × 5(conditions) analysis of variance. Since the results on the subconditions of the mechanical and behavioural stories were so similar, they were collapsed for further analysis. Three main conditions therefore were compared: mechanical, behavioural and Intentional. On the mechanical condition the autistic group was significantly better (Scheffé test, $P < 0{\cdot}001$) than the other two groups, who did not differ, presumably reflecting the autistic children's higher MA. On the behavioural condition, autistic and normal groups performed identically, while the Down's syndrome children were significantly worse (Scheffé test, $P < 0{\cdot}01$).

Most importantly for our hypothesis, autistic performance slumped on the Intentional condition and was significantly worse even than the Down's group's (Scheffé, $P < 0{\cdot}05$).

Table 3. Average performance on sequences based on three trials per condition (max. score = 6)

Condition		Mec. 1	Mec. 2	Beh. 1	Beh. 2	Intent.
Autistic	Mean	5·71	5·76	4·52	4·38	1·76
	SD	0·72	0·62	1·33	1·66	2·53
Down's	Mean	2·80	2·66	2·60	2·80	2·86
	SD	1·86	1·23	1·24	2·11	1·06
Normal	Mean	3·30	3·37	4·41	4·33	5·19
	SD	1·64	2·04	1·42	1·86	1·47

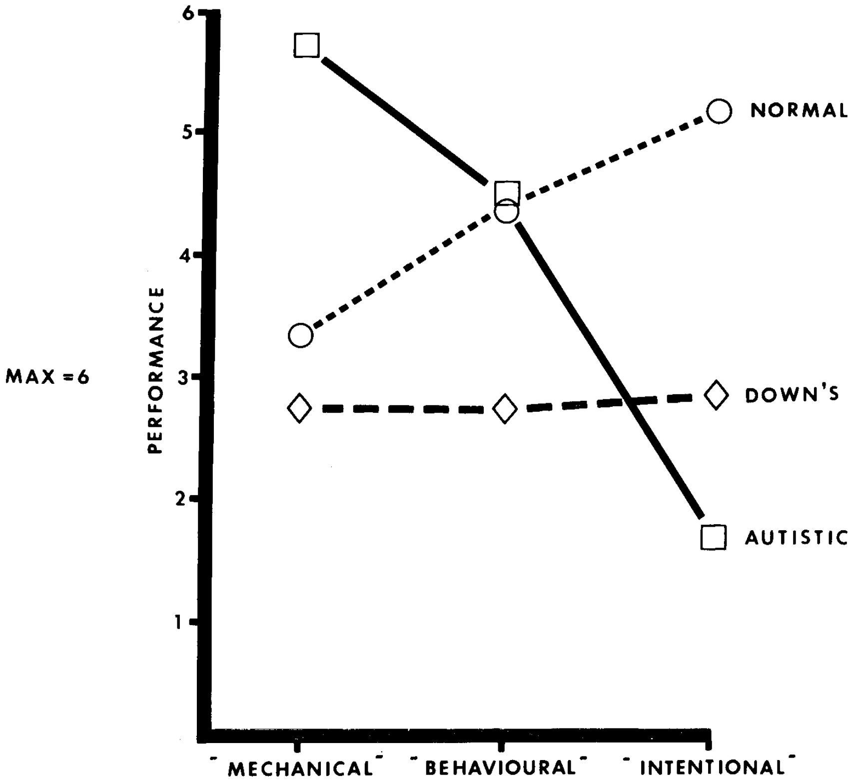

Figure 2. Mean performance on picture sequencing by groups.

The performance of the Down's group was consistently poor. They were worse in comparison with the autistic group on all conditions except on the Intentional one, where the Down's subjects were superior to the autistic group. This same pattern of results was obtained even after performance on the last administered (behavioural) condition was used as a covariate in an analysis of covariance in order to control for the effect of fatigue on performance. Thus, there was still a significant groups × conditions interaction when only autistic and Down's subjects were compared ($F=25{\cdot}1$, d.f. $=6{,}165$, $P<0{\cdot}001$). The results, therefore, are not due to differential effects of fatigue on the two clinical groups.

Narration

Ten autistic and seven Down's syndrome children were sufficiently cooperative to provide verbal descriptions for either all or almost all 15 picture sequences. The minimum requirement was that the child should have given narrations in at least eight out of 15 trials. In addition, protocols were gathered from a randomly selected one-third of the normal children.

The narrations were scored in one of the following categories: Causal, Mental state or Descriptive. For this procedure merely the surface form of the verbal utterances was looked at. Thus, no account was taken of whether they were 'correct' or whether they related well a particular event in the story. Our examples are therefore considered in their own right as a source for Causal, Mental state or Descriptive language terms. For each picture story a narration, regardless of length, was categorized into one of the three classes. Each story was scored for the presence or absence of Causal and Mental state expressions, and failing this was scored Descriptive. An independent rater's scoring agreed with ours on 96 per cent of utterances.

The Causal category was applied only when the utterance contained at least one of the following:

(*a*) *because* clauses, e.g. *The egg broke because it fell off the table* (story M1.2, see Table 2);
(*b*) explicit mention of agent–causal verb–object, or passive construction with *by*-phrase, e.g. *The boulder broke the tree* (M1.1), *The man was hit by the rock* (M2.2);
(*c*) causal verb phrase, e.g. *made* ... happen: *The rock made the man fall down* (M2.2).

Some examples were considered to be too equivocal to qualify for the Causal category, e.g. *He tripped over and his foot bleeded* (M2.1); *It popped on tree* (M1.3); *The ball hits the man and he falls down* (M2.2). All these utterances were placed by default into the Descriptive category together with utterances such as: *It broke on the floor* (M1.2); *It smashed* (M1.2); *He tripped over the brick* (M2.1).

The Mental state category was applied only when the utterance contained:

(*a*) a mental state expression (*want*, *believe*, *know*, *pretend*, *wish*, etc.), e.g. *He wanted to buy sweets* (I,1); *The boy didn't know she pinched his chocolate* (I,3);
(*b*) an implicit attribution of a mental state, e.g. *The boy was surprised cuz he couldn't find his chocolate* (I,3);
(*c*) an attribution of an utterance to the protagonist appropriate to his or her mental state often marked by special intonation, e.g. *He's shouting, 'Where's my sweet gone?!'* (I,1).

Examples that were *not* considered to fall into the Mental state category (because they are equivocal in terms of Intentional language and are probably merely Descriptive) were: *He stole the teddy* (I,2); *His mother claps her hands, he is frightened and goes outside* (I,3). This last example shows that merely mentioning an emotion without attributing a content to the emotion (i.e. frightened about something) did not qualify for the Mental state category. Again these equivocal utterances were placed by default into the Descriptive category

Table 4. Proportion of narratives by conditions using the most appropriate language for each condition[a]

Condition:		Mechanical	Behavioural	Intentional
Appropriate narrative type:		Causal	Descriptive	Mental state
Groups				
Autistic	Mean	0·78	0·95	0·22
$n=10$	SD	0·20	0·11	0·33
Down's	Mean	0·17	0·98	0·78
$n=7$	SD	0·14	0·08	0·27
Normal	Mean	0·39	0·76	0·81
$n=9$	SD	0·16	0·19	0·24

[a] The complement of these proportions was always Descriptive for the Mechanical and Intentional conditions. For the Behavioural condition the complement was Mental state, with one exception of an autistic subject's utterance which was scored as Causal.

together with utterances such as *The girl puts her teddy down and the boy takes it, and the girls picks the flower* (I,2); *The boy buys some sweets and he drops them on the road. Then there are no more* (I,1).

The Descriptive category was applied straightforwardly in examples such as: *She goes to the sweet shop. She opens the door. She buys the sweets. She goes out* (B2.1). The entire narrative here contained no Causal or Mental state surface forms.

For each child the ratings were turned into proportions relative to the total number of trials where verbal responses were made as shown in Table 4. In the 'mechanical' condition there was not a single case of Mental state expressions. Therefore the complement of the proportions is entirely Descriptive. For the 'behavioural' condition the complement is almost entirely Mental state, apart from one case in the autistic group (which was Causal) and a small set of cases in the normal group where the children expressed the goal of the protagonist's behaviour. Since these cases were too few to merit a separate coding category, we also scored them as Mental state utterances. For the 'Intentional' condition the complement was exclusively Descriptive.

On the whole, we feel that the preferred mode of narration supports our earlier intuition about the 'natural' level of description for each type of story.* These data were sufficiently normally distributed to allow ANOVA (groups × conditions × appropriate narrations) with *post hoc* Scheffé tests. In the mechanical condition, autistic children used significantly more Causal terms in their verbal descriptions than the other two groups who did not differ from each other ($F = 10{\cdot}33$, d.f. = 2,21, $P < 0{\cdot}001$). This is consistent with performance on sequencing and suggests that success on this condition implies an understanding of physical causality.

In the behavioural condition all subjects used more Descriptive utterances than any other kind but this was less evident in the normal group, who used a significantly greater proportion of Mental state expressions ($F = 5{\cdot}48$, d.f. = 2,21, $P < 0{\cdot}01$).

In the Intentional condition a significant difference was obtained between the autistic group and the rest, since they used Mental state expressions much more rarely than Down's syndrome and normal subjects ($F = 10{\cdot}33$, d.f. = 2,21, $P < 0{\cdot}001$). This is entirely consistent with our earlier prediction and with the results of sequencing.

Discussion

These results confirm and extend the findings of Baron-Cohen *et al.* (1985) that autistic children show a *specific deficit* in employing a 'theory of mind'. We argued that good performance on the Intentional stories would require understanding of the characters' mental states. The picture sequencing evidence showed that the autistic children performed at a chance level on these and well below their own performance on the mechanical and behavioural stories, and worse even than the severely retarded Down's syndrome children. The protocol evidence, though clinically gathered and therefore inconclusive, was consistent with this pattern. The autistic children produced very little mental state language—again even in comparison to the Down's children. Taken together, these results are strong confirmation of the predictions that we made based on the specific deficit hypothesis.

* The differentiation of the behavioural and Intentional stories is especially critical here as, in principle, both could have been narrated in either Descriptive or Mental state language. But, in practice, there was a clear preference: e.g. Fig. 1*b* (ice-cream story) was scored Descriptive in seven out of nine normal and four out of five Down's syndrome children. Only three children of these two groups used Mental state expressions such as 'the girl *wants* to eat the ice-cream'. In example 1*c* (teddy story), however, seven out of nine normal and five out of six Down's syndrome children used Mental state expressions, such as, the utterance 'Where is my teddy gone?' (with surprise intonation), implying that the girl in the story *believed* the teddy still to be where she left it.

We extended the previous findings by including a test of the understanding of other kinds of event sequence: causal, involving both physical objects and people; and behavioural, involving social routines and activities. Here the autistic child's performance, both in terms of picture sequencing and language, was strikingly better. On the 'mechanical' stories the autistic children demonstrated their MA advantage over the other groups. It is likely, but remains to be seen, whether an MA-matched normal group would do equally well. Our results therefore suggest that the autistic child's understanding of causality develops normally, even beyond the early stages studied previously (e.g. Sigman & Ungerer, 1981).

Meanwhile, the Down's children showed consistently poor performance on all three story types. Obviously, the sequencing task was fairly taxing for these severely retarded children, but nevertheless, their performance on all conditions was above chance. The normal children clearly gave their best performance on the Intentional stories. It is interesting that the autistic children did not seem to have any problem with the involvement of people in the stories (e.g. mechanical 2) or with interactions between two people (behavioural 2).

We therefore find no support for a *general* 'social' deficit explanation of autism. On the other hand, we have found a *specific* deficit in social understanding. The search for other specific impairments (Hobson, 1983; in press) should be continued. The nature of the social impairment of autistic children will, no doubt, turn out to involve deficits in a number of distinct processes, all of which will have to be explored.

The narrations for the autistic children showed that, with the exception of two subjects, they gave purely descriptive renderings of stories for which the other children readily gave mental state explanations, either implicit or explicit. For example, a normal child said for Intentional story 3:

> *The boy is putting the sweet in the box so nobody won't find it. Then he goes out. She eat it. And he's shouting, 'Where's my sweet gone?!'*

One Down's syndrome child's simple narration consisted of:

> *He says, 'Where's my chocolate?!'*

In both cases, the child attributes an utterance appropriate to the boy's discovery of his false expectation about where the chocolate or sweet is. A typical response to this story by an autistic child was:

> *The sweet is in the box, and the boy goes out, and the sweet's missing, and Mummy eats the sweet.*

A particularly transparent narration of an autistic child who actually got the order of the pictures correct, was:

> *The boy puts the chocolate in the box, then his mother eats it, then he comes back, and the box . . .*

At this point—the crucial point for understanding the story—the child's narrative peters out. Having waited for the child to continue, the experimenter eventually prompts by asking,

> *What does the boy say?*
> The child replies, *Nothing.*
> The experimenter asks, *Why does this picture go last?*
> The child replies, *Because here the chocolate is here, then the mother eats it, then the chocolate is gone.*

We think that against the background of our experimental results this particular protocol may be rather revealing. It suggests that this autistic child has understood the story full well in terms of the sequential displacements of characters and the focal object, the chocolate. It is the final step of realizing that the boy believed the chocolate still to be in the box that seems to be missing. We think that it is not coincidental that this child's confident description of the main events of the story petered out when it did—when the normal (or Down's syndrome) child would have taken the protagonist's false expectations into account.

The protocols also make the point that the autistic children did not do badly on the Intentional stories because they could not make inferences or inventions 'behind the scenes', as it were, to turn a group of pictures into a story. On the contrary, two autistic children even made sense of the above story by inventing a second piece of chocolate!

> *The boy puts his chocolate in the box. He eats his chocolate. He goes out to play. His grandmother eats a chocolate.*

> *The boy has a chocolate. He puts it in the box. Then his mother eats it and then he eats one too. He goes out of the door.*

None of the other children showed this particular kind of inventiveness.

We would suggest that it is possible to look at all the sequences we used as depicting mechanical and displacement events of varying complexity. So, for example, in the 'mechanical' condition, one (or perhaps two) mechanical events are shown stretched out over the four pictures. In the 'behavioural' condition two (or three) such events are shown, while in the 'Intentional' condition there are three (or four). This increasing complexity of sequences would neatly predict the autistic group's decreasing sequencing performance. But clearly, it completely fails to predict either young normal or Down's performance. These two groups may 'change gear', as it were, overriding the increasing complexity by applying different systems of understanding in the different conditions.

If we look at the narrative data in terms of preferred descriptions, it is clear that this 'change of gear' also applies to the Down's group (even though their sequencing performance did not *increase* markedly). Indeed, the proportion of purely descriptive utterances for behavioural and Intentional conditions changed dramatically in both the Down's (98 to 22 per cent) and the normal subjects (76 to 19 per cent). By contrast, the autistic subjects used 95 per cent descriptive utterances in the behavioural condition, but still used 78 per cent in the Intentional condition.

What can we say of the autistic children's performance in the present study in relation to the 'attribution of false belief' task set by Baron-Cohen *et al.* (1985)? Nineteen of the autistic children in the present study also took part in the previous task. Of these, 12 failed in both experiments, i.e. failed to predict correctly where the doll would look for her marble on the basis of her false belief, and scored less than 4 on the picture sequencing task on the Intentional condition. Three children who failed on the prediction task passed the picture sequencing task (scoring 4 or more), while another two who passed on prediction failed picture sequencing. (These five children were retested on both tasks some weeks later with exactly the same pattern of passing and failing.) This leaves two children who passed both tasks. Interestingly, it was these two, alone among these autistic children, who also scored on using 'mental state expressions' in the protocols from the Intentional condition.

It seems very likely then that at least two of our high-ability autistic children were able to employ a 'theory of mind'. (There was one other autistic child who passed sequencing *and* scored on mental state expressions but who was unavailable for testing on the prediction task.) A question mark hangs over the three children who failed on prediction and use of 'mental state expressions' but passed on Intentional sequencing, since we think it is possible (but fairly difficult) to get the sequence of pictures right *without* understanding the mental state of the protagonist (see the remarks above on complexity). Nevertheless, taken together, all three tests—prediction from a false belief, picture sequencing of an 'Intentional' story, and use of mental state expressions—will provide, we think, a fairly powerful and reliable diagnostic for the presence of a usable 'theory of mind' in autistic children.

Of course, it would be interesting to investigate other aspects of 'theory of mind', for example, understanding of emotions, of ignorance, of lying and so on. The exact nature and extent of the deficit remain to be determined (but see Frith, 1984; Leslie, 1985). A question also remains concerning those autistic children who show clear evidence of employing a 'theory of mind': does it develop in a normal way in line with mental age or is it still subject to *specific deficit* but at a higher level of complexity? For example, our results show that a small minority of autistic children can form second-order mental states—beliefs about beliefs. But can these children handle third-order states—beliefs about beliefs about beliefs? Recent work by Perner & Wimmer (1985) indicates that this ability emerges in normal children between about 6 and 7 years. Baron-Cohen (1985) followed up the four autistic children who had passed the second-order prediction task and tested them on Perner & Wimmer's third-order prediction task. Despite having MAs well in excess of 7 years, all four failed, giving answers corresponding to second-order predictions. Out of four Down's children with MAs of approximately 7 years, three passed the third-order task. This preliminary evidence, then, suggests that even the minority of high-ability autistic children who can employ a 'theory of mind', nevertheless still suffer a specific deficit in this area but at a higher level.

In conclusion, we suggest that the critical feature of social impairment in autism may not be a general turning away from the realm of interpersonal interaction but may involve a specific dysfunction in conceiving of mental states. Clearly, this would matter in many, but by no means all, social interactions. Therefore, we believe that the nature of the social impairment will only be completely understood by investigating further the idea of damage to certain underlying cognitive processes whose consequences are subtle, selective and far reaching.

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References

Baron-Cohen, S. (1985). Social cognition and pretend play in autism. Unpublished PhD Thesis, University of London.

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

Bretherton, I., McNew, S. & Beeghley-Smith, M. (1981). Early person knowledge as expressed in gestural and verbal communication: When do infants acquire a 'theory of mind'? In M. E. Lamb & L. R. Sherrod (eds), *Infant Social Cognition*. Hillsdale, NJ: Erlbaum.

Bullock, M. (1984). Preschool children's understanding of causal connections. *British Journal of Developmental Psychology*, **2**, 139–148.

Coggins, T. E., Carpenter, R. L. & Owings, N. O. (1983). Examining early intentional communication in Down's Syndrome and nonretarded children. *British Journal of Disorders in Communication*, **18**, 98–106.

Curcio, F. (1978). Sensorimotor functioning and communication in mute autistic children. *Journal of Autism and Childhood Schizophrenia*, **8**, 281–292.

Dennett, D. C. (1971). Intentional systems. *Journal of Philosophy*, **LXVIII** (4), 87–106.
DSM-III (1980). *Diagnostic and Statistical Manual of Mental Disorders*, 3rd ed. Washington DC: American Psychiatric Association.
Frith, U. (1984). A new perspective in research on autism. In ARAPI (eds), *Contributions à la Recherche Scientifique sur l'Autisme: Aspects Cognitifs*. Paris: Association pour la Recherche sur l'Autisme et les Psychoses Infantiles.
Hammes, J. G. W. & Langdell, T. (1981). Precursors of symbol formation and childhood autism. *Journal of Autism and Developmental Disorders*, **11**, 331–345.
Hobson, R. P. (in press). The autistic child's appraisal of expressions of emotion: An experimental investigation. *Journal of Child Psychology and Psychiatry*.
Hobson, R. P. (1983). The autistic child's recognition of age-related features of people, animals, and things. *British Journal of Developmental Psychology*, **1**, 343–352.
Kanner, L. (1943). Autistic disturbances of affective contact. *Nervous Child*, **2**, 217–250.
Leslie, A. M. (1985). Pretense and representation in infancy: The origins of 'theory of mind'. Unpublished manuscript, MRC Cognitive Development Unit, London.
Lord, C. (1984). The development of peer relations in children with autism. In F. J. Morrison, C. Lord & D. P. Keating (eds), *Advances in Applied Developmental Psychology*, pp. 165–229. New York: Academic Press.
MacNamara, J., Baker, E. & Olsen, C. (1976). Four-year-olds' understanding of pretend, forget, and know: Evidence for propositional operations. *Child Development*, **47**, 62–70.
Perner, J. & Wimmer, H. (1985). 'John thinks that Mary thinks that . . . ' Attribution of second-order beliefs by 5–10 year old children. *Journal of Experimental Child Psychology*, **39**, 437–471.
Premack, D. & Woodruff, G. (1978). Does the chimpanzee have a theory of mind? *Behavioral and Brain Sciences*, **4**, 515–526.
Rutter, M. (1978). Diagnosis and definition. In M. Rutter & E. Schopler (eds), *Autism: A Reappraisal of Concepts and Treatment*. New York: Plenum.
Rutter, M. (1983). Cognitive deficits in the pathogenesis of autism. *Journal of Child Psychology and Psychiatry*, **24**, 513–531.
Searle, J. R. (1979). What is an Intentional state? *Mind*, **LXXXVIII** (349), 74–92.
Serafica, F. C. (1971). Object concepts in deviant children. *American Journal of Orthopsychiatry*, **41**, 473–482.
Shultz, T. R. & Cloghesy, K. (1981). Development of recursive awareness of intention. *Developmental Psychology*, **17**, 456–471.
Shultz, T. R., Wells, D. & Sarda, M. (1980). The development of the ability to distinguish intended actions from mistakes, reflexes, and passive movements. *British Journal of Social and Clinical Psychology*, **19**, 301–310.
Sigman, M. & Ungerer, J. (1981). Sensorimotor skill and language comprehension in autistic children. *Journal of Abnormal Child Psychology*, **9**, 149–165.
Wellman, H. M. & Johnson, C. N. (1979). Understanding of mental processes: A developmental study of 'remember' and 'forget'. *Child Development*, **50**, 79–88.
Wetherby, A. M. & Gaines, B. H. (1982). Cognition and language development in autism. *Journal of Speech and Hearing Disorders*, **47**, 63–70.
Wimmer, H. & Perner, J. (1983). Beliefs about beliefs: Representation and constraining function of wrong beliefs in young children's understanding of deception. *Cognition*, **13**, 103–128.
Wing, L. & Gould, J. (1979). Severe impairments of social interaction and associated abnormalities in children: Epidemiology and classification. *Journal of Autism and Developmental Disorders*, **9**, 11–29.

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