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Are Autistic Children "Behaviorists"? An Examination of Their Mental–Physical and Appearance–Reality Distinctions[1]

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This paper continues our earlier investigation of autistic children's deficit in attributing beliefs to others—in their "theory of mind." Three experiments are reported. The first tests the prediction that autistic children will fail to distinguish mental and physical entities. The second tests the prediction that they will also be unaware of the mental function of the brain. The third tests the prediction that they will be unable to take into account their own mental states. This latter prediction was tested using Appearance–Reality (A–R) tasks. All three predictions were supported. Deficits in these areas were not found among mentally handicapped or normal children of the same or lower mental and chronological age, suggesting that they may be autism-specific and independent of general developmental delay. It is argued that autistic children's failure to make A–R distinctions is consistent with Leslie's (1987) metarepresentation theory of autism.

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> Imagine a hypothetical being who knows nothing of internal mental states . . . Such a being might be able to remember, know, and learn, but it would possess no understanding of these activities. The social world, the world of self and others, would be an impoverished place for such a creature. All those aspects of behaviour that we attribute to the mind would be missing from its perspective. Persons would be seen and heard but there would be no notion of a backlog of ideas and beliefs organizing their actions and personalities. Indeed, for this hypothetical being, no one could be construed as possessing private persona; public present behaviour would have no deeper meaning. The concept of a lie would be inconceivable, as would . . . notions such as illusions, beliefs, hunches, mistakes, guesses, or deceptions. It is almost impossible to imagine what such a perspective would be like, how such a creature would view the world. (Wellman, 1985, pp. 169-170).

INTRODUCTION

In earlier studies we found that, given tests involving a simple social situation in which the subject has to attribute a false belief to another person, autistic children were specifically impaired, in contrast to nonautistic control groups with a lower mental age (Baron-Cohen, Leslie, & Frith, 1985, 1986). This result has been replicated (Baron-Cohen, 1989a; Dawson & Fernald, 1987; Harris & Muncer, 1988; Leekam & Pernes, 1990; Leslie & Frith, 1988; Perner, Leekam, Leslie, & Frith, 1989; Russell, Sharpe, & Mauthner, 1989; Sodian & Frith, 1990; Swetnam, forthcoming) and implies there may be subtle deficits in one aspect of autistic children's cognition, namely, in their ability to attribute mental states to others. This ability is also called a "theory of mind" (Astington, Harris, & Olson, 1988; Premack & Woodruff, 1978). If this deficit does exist, it is no wonder autistic children have such difficulties forming social relationships and developing communicative competence (Baron-Cohen, 1988; Kanner, 1943), as there are good grounds for arguing that a theory of mind is essential both for making sense of the social world (Dennett, 1978) and for all forms of communication (Grice, 1975).

Lacking a theory of mind is in one sense akin to viewing the world as a behaviorist. This comparison is trivial on most levels, since of course behaviorists do possess a theory of mind but go to considerable lengths to refrain from using it. We do not therefore intend to force an analogy between an impaired theory of mind and behaviorism, but instead to explore through a series of experiments what would be entailed if one genuinely lacked a theory of mind. To anticipate the experiments: if the "intentional stance," as Dennett (1978, 1987) referred to a theory of mind, is not available to autistic children, are they forced into viewing the world only in terms of behavioral and physical events?

The experiments reported here test three predictions from the earlier work. The first prediction is this. If autistic children's theory of mind is impaired, then we should expect their ability to distinguish *mental entities* (such

as thoughts [about food], dreams [about bicycles], etc.) from *physical entities* (such as food, bicycles, etc.) to be impaired also. It is worth noting that whereas Piaget (1929) claimed that "the [young] child cannot distinguish a real house, for example, from the concept or mental image or name of the house" (p. 55), Wellman and his colleagues (Estes, Wellman, & Wolley, 1989; Wellman & Estes, 1986) have shown that this distinction is in fact understood by normal 3- to 5-year-olds.

Second, if autistic children's theory of mind is impaired, we should expect their concept of the *brain* as having mental functions to be impaired as well. This concept is understood by 4- to 6-year-old normal children (Carey, 1985; Johnson & Wellman, 1982). Experiments 1 and 2 test these two predictions, respectively. Our methods are derived from the studies reported by Wellman and Estes (1986) and Johnson and Wellman (1982), but are modified for use with clinical groups.

Our final prediction is as follows: If autism involves dysfunction of the neural structures necessary for a theory of mind in general, then we should expect deficits in tests of attribution of mental states not only to others (as the earlier work found) but also to oneself. Testing a child's understanding of the *appearance–reality distinction* may be one way of examining the ability to attribute mental states to oneself (Gopnik & Astington, 1988), since in such tests the subject first perceives an object to be one thing (an *x*) but then comes to know it is really something else (a *y*). Normal 4- to 6-year-olds demonstrate that by this age they begin to understand this distinction too (Flavell, Flavell, & Green, 1983). We predicted autistic children would be unable to make this distinction. Experiment 3 tests this final prediction, using methods derived from some of the studies reported in Flavell et al. (1983). The relationship between a theory of mind and the three abilities tested here is summarized in Figure 1.

METHOD

Subjects in the Experiments

We begin by describing our subjects, since they are the same in all three experiments. Their details are summarized in Table I. The 17 autistic children had been diagnosed according to established criteria (DSM-III-R; American Psychiatric Association, 1987) and attended a special school for autistic children. In addition, there were 16 mentally handicapped and 19 clinically normal children, to control for mental age (MA) and chronological age (CA). The sex ratio in the normal and mentally handicapped groups was approximately 1:1, whilst in the autistic group it was 3:1 (M:F).

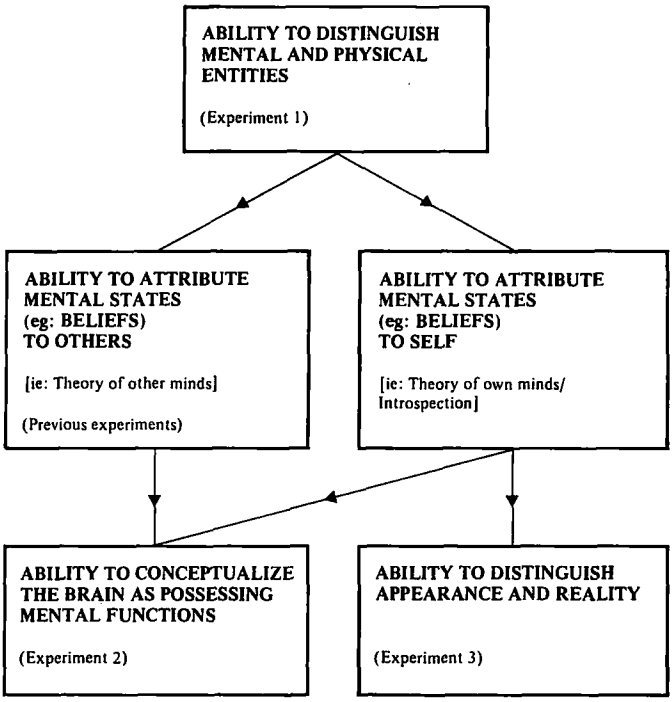

Fig. 1. Postulated relationship between different abilities under investigation. (Arrows signify possible precursors.)

The inclusion criterion for the clinical subjects was a verbal MA of at least 4 years old, this being the age at which normal children begin to pass the tests used by Wellman and Estes (1986), Johnson and Wellman (1982), and Flavell et al. (1983), variants of which were used here. Nonverbal MA was higher than verbal MA for both clinical groups, markedly so in the case of the autistic children. Using a minimum verbal MA as an inclusion criterion was therefore a conservative precaution against the risk that the clinical groups might be at a developmental disadvantage in comparison to the normal control group.

Verbal MA was assessed using the British Picture Vocabulary Scale (BPVS; Dunn, Dunn, Whetton & Pintilie, 1982). Nonverbal MA was assessed using the Raven's Coloured Progressive Matrices (Raven, 1956). We assumed that for the normal group, MA would roughly correspond to CA. The autistic group had a higher MA on both verbal and nonverbal measures than the mentally handicapped group, thus providing a strong test of the hypothesis that any impairment in the autistic group must be specific, that is, not due to general developmental delay.

Table I. Subject Variables: Means, *SD*s, and Ranges of Chronological Age (CA) and Mental Age (MA)

Diagnostic group	*n*	CA	Nonverbal MA[a]	Verbal MA[b]
Autistic	17			
Mean		13.78	8.48	6.91
SD		2.8	1.81	1.77
Range		9.7–19.8	5.6–11.2	4.0–9.9
Mentally handicapped	16			
Mean		15.44	6.03	6.47
SD		2.13	1.0	1.5
Range		9.3–18.3	5.0–8.5	4.0–10.0
Normal	19			
Mean		5.3		
SD		0.87	–	–
Range		4.1–6.8		

[a]Raven's matrices.
[b]British Picture Vocabulary scale.

EXPERIMENT 1: THE MENTAL–PHYSICAL DISTINCTION

We tested the children's understanding of four mental phenomena (thoughts, dreams, pretense, and memories) in comparison to their understanding of four physical phenomena (food, drink, bicycles, and swings). We predicted that if autistic children were unaware of the special nature of mental entities, they would attribute physical properties randomly to either mental or physical phenomena. On the other hand, we predicted that if subjects did understand the distinction between mental and physical phenomena, they would attribute physical properties to physical phenomena alone.

We used the first of Wellman and Estes' (1986) criteria for distinguishing mental and physical entities: physical entities afford "behavioral-sensory contact," that is, they can be acted upon (e.g., eaten, ridden, etc.), seen, and touched, etc. Mental entities, on the other hand, do not afford these qualities.[3]

Procedure

Subjects were tested individually, with only the experimenter present. In all cases, the child was seen in a quiet room in the school. The child was

[3]Wellman and Estes (1986) use two other criteria to distinguish physical from mental entities. Physical entities have (a) a public existence (i.e., Both you and I can experience them together); (b) a consistent existence (i.e., The physical object continues to exist from one day to another [fire, etc. allowing].) We have used the behavioral-sensory contact criterion alone, because the test of this requires fewer verbal demands on the child than the latter two criteria.

introduced to four dolls, Sam, Kate, David, and Anna, and then asked the Naming question "Which is Sam/Kate/David/Anna?," in order to control for the child's ability to distinguish the four characters. They were then told a story which contained a mental–physical contrast between two dolls, vis-à-vis a desired object. One such story went as follows:

> This is Sam. He likes biscuits. He is hungry, so his mother gives him a biscuit. This is Kate. She is hungry, but she is all alone. She is *thinking* about a biscuit.

Each child was tested on four such stories (shown in Appendix 1), one each for think, remember, pretend, and dream. In all stories, all four dolls were present, and no other objects were introduced. The subject was asked to make two judgments by pointing to one of the four characters. These judgments related to the criterion of behavioral-sensory contact: (a) The Behavioral Judgment for the story above was: "Which child can eat the biscuit?"; (b) the Sensory Judgment for the story above was: "Which child can touch the biscuit?" In other stories, the appropriate verb and object were substituted.

After these questions, a Memory question was asked, to control for possible memory deficits: "Which child was given a bisuit/bicycle, etc?" At the end of the test session a Comprehension test of the lexical terms used in the stories and Judgment questions was given. The Comprehension test is shown in Appendix 2.

The Judgment questions and story orders were counterbalanced, as were the dolls associated with the physical and mental activity in each story. This meant that each doll appeared in two of the four stories, and was associated once with a mental and once with a physical activity, and the same pair of dolls were never the main characters in more than one story. In addition, the order in which the doll who was actually in possession of the real object appeared in the story was also counterbalanced.

Scoring

The correct response to both the Sensory and Behavioral judgments comprised pointing to or naming the doll who had been given the object. The correct doll was therefore the same for both judgments but different in each of the four stories. Each subject could score a maximum of 8 points (2 on each of the 4 stories). A Realist error (i.e., treating mental phenomena as if they were physical) comprised pointing to or naming the doll who was thinking (etc.) about the object. Other errors comprised pointing to or naming either of the other two dolls present.

Although there were four possible dolls the subject could point at, only two were actively used in each story. Therefore, the probability of a correct response by chance alone was assumed to be .5 for each judgment. If a sub-

ject scored 7 or more points out of 8 points, this was taken as an overall Pass. Lower scores would not have been significantly different from chance ($p < .035$, binomial).

RESULTS

All subjects passed all the Control questions (i.e., the Naming and Memory questions, and the Comprehension test). None of the subjects differed in the responses to the four mental verbs. Table II shows the number of children passing the Judgment questions in each group.

Whilst 78.9% of the normal and 68.8% of the mentally handicapped subjects passed the Judgment questions, only 23.5% of autistic subjects passed, and this was significantly lower than the other two groups, $\chi^2(1) = 5.1, p < .024$, Autistic × Mentally Handicapped. In terms of absolute scores, the mentally handicpped and normal groups' mean scores did not differ, whilst the autistic group scored significantly lower than the mentally handicapped group, $t(31) = -2.11, p < .043$, and indeed scored approximately at chance levels. This pattern of scores is shown in Table III. No child pointed to more than one doll, and no child pointed to the other two dolls present. A response tendency of always only pointing to the relevant two out of four dolls could not have been obtained by chance alone ($p < .05$, binomial).

DISCUSSION

This experiment replicates earlier findings (Estes et al., 1989; Wellman & Estes, 1986) that normal children of 4–6 years old can make judgments to distinguish physical and mental phenomena. In this sense they can be called ontological dualists. It also shows the same ability is present in mentally handicapped subjects of an equivalent mental age. In contrast, autistic children

Table II. Number of Children Passing Judgment Questions in the Mental–Physical Distinction (Experiment 1)

Diagnostic groups	*n*	Pass[a]	Fail
Autistic	17	4[b]	13[b]
Mentally handicapped	16	11	5
Normal	19	15	4

[a]Pass = Score of 7 or more (maximum = 8).
[b]Significant at the .024 level.

Table III. Mean Number of Correct Answers to Both Judgment Questions in the Mental–Physical Distinction (Experiment 1)

Diagnostic group	*n*	No. correct	
		M	*SD*
Autistic	17	4.71[a]	2.2
Mentally handicapped	16	6.2	1.8
Normal	19	6.74	1.6

[a]Significant at the .04 level.

with a higher MA than the other groups show no evidence of being able to make this distinction.

This failure was not due to an inability to distinguish the characters or to recall the narrative of the story, as all children passed the Naming and Memory questions. Nor was it due to an inability to understand the nonmental lexical terms in the stories and Judgment questions, as all subjects passed tests of these. Rather, the autistic group tended to point at random to either of the two relevant dolls. The fact that they did not point to the other two dolls suggests that they understood who were the relevant characters in each story.

If autistic children do not understand linguistic terms referring to thinking, pretending, etc., one wonders how they then process them when they hear them within a sentence in which all other terms are understood. One suggestion is that they may have used a "default representation" when trying to make sense of mental verbs: they may have recognized from their *-ing* suffixes that these were action-based words (verbs), and concluded that they must refer to indeterminate physical actions (Paul Harris, personal communication).

The contrast between autistic and mentally handicapped subjects' comprehension of physical and mental phenomena replicates our earlier findings (Baron-Cohen et al., 1986). It also extends this work in two ways: It suggests that the deficit is not specific to understanding beliefs, but may apply to other mental states (pretense, dreams, memories, and thoughts).

It should be noted that correct responses to the Judgment and Memory questions involved pointing three times to the same doll, within one trial. In Wellman and Estes' (1986) experiment this design was avoided by including a Negative question "Which doll cannot touch the biscuit?," etc. We decided to exclude this question because our pilot studies suggested that negative questions led to bewilderment from many of our clinical subjects. However, this leaves open the possibility that the normal and mentally handicapped

subjects might have passed on this task not through genuine understanding but instead as a result of a perseverative tendency.

We consider this unlikely for three reasons: (a) It is apparent that they were not guessing, as their consistent identification of the correct doll on the first Judgment question was highly unlikely from chance alone; (b) many of the nonautistic subjects spontaneously expressed sympathy for the other doll who wanted the object but had not been given one, suggesting that they clearly understood the distinction between mental and physical phenomena. This response was never seen among the autistic children; (c) if any subject was likely to perseverate, we would have expected this among the autistic group, as they have been found to show such behavior (Frith, 1972). Instead, however, it was they who seemed to shift their response at random. We interpret this as showing that the nonautistic children understood the mental–physical distinction, whereas the autistic children did not.

Informal probing about dreams suggested the autistic children did not understand this concept at all. For example, when asked "What are dreams?," most autistic children replied that they "came in the night". When asked "Are dreams real?," most answered affirmatively. The wording of this particular question may have been difficult for autistic children as it contained the word "real," which our later study (Experiment 3) revealed was poorly understood by itself. However, even when asked "When you have a dream, where is the dream? In the room or inside your head?," most said "In the room." We did not probe for further understanding of the other mental concepts (memory, pretense, and thought). These require more attention as it may be that some of these concepts are understood by autistic children.

The results of this study suggest that autistic children treat mental phenomena as no different than physical ones. It may be that the physical level of understanding is the only one available to them, leading them to force all phenomena into it. To test this idea further, we next investigated autistic children's concept of brain, which we predicted should be behaviorist, not mentalist.

EXPERIMENT 2: THE CONCEPT OF BRAIN

Johnson and Wellman (1982) established that by age 4–6 years old, normal children regard the brain as an internal entity associated with a class of distinctly mental acts. In particular, they know that the main function of the brain is for cognition (i.e., they say it is responsible for thinking, dreaming, remembering, etc.). Only much later do children come to also believe the brain is necessary for all behavior (walking, involuntary actions, moving, etc.). Indeed, the behavioral function is not fully understood even by normal 11- or 12-year-olds (Johnson & Wellman, 1982).

We predicted that autistic children would show an abnormal pattern of development in their concept of brain, since they appear oblivious to the existence of mental phenomena. Specifically, we predicted that if they thought the brain had any function at all, it would be in the control of behavior, and that they would otherwise be unaware of its mental function.

Procedure

The subjects were the same three groups as took part in Experiment 1. They were given this test after the previous one, but on the same occasion. Each child was asked four questions, two about the brain and two about the heart. The heart questions were included to control for "nonmental" knowledge of biology. The Location questions were "Where is your brain?" and "Where is your heart?" Function questions were "What does your heart do?" and "What does your brain do?"

These questions were asked in random order. The child's spontaneous answers were noted, and only these were scored. Following the Function questions, the experimenter probed for any further beliefs/knowledge the child might have, using one standard probe ("Does it do anything else?"). A Pass was obtained for a Location question if the child referred to the organ as being "inside" the "head" and "chest" accordingly, or pointed to these locations, or used equivalent expressions.

A Pass was obtained for the Function questions if the child referred to mental phenomena (thinking, etc.) as a brain function, or made an association with "blood" for a heart function. If an answer was produced as a result of a probe, this also scored as a Pass, although it was coded separately so as to analyze the importance of probes. Other functions the child proposed (e.g., behavioral functions of the brain) were also noted, but in terms of the present hypothesis they were scored as a Fail.

Results

Location Questions

To reiterate, Location questions were never followed by probes: 94.7% of the normal children, 75% of the mentally handicapped subjects, and 88.2% of the autistic subjects passed both of the Location questions. Some children from all three groups used the word "tummy" to refer to the location of the heart, but pointed to their chest when asked to show the part of the body. This was counted as a Pass, as these children did not appear to know the word "chest" even though they could correctly indicate its location non-

verbally. Of the two autistic subjects who failed, one said both organs were in the chest, and the other said nothing. Of the four mentally handicapped subjects who failed one or both location questions, one indicated both organs were in his mouth, one denied having them, one located the brain in his schoolbag, and one produced no response. These differences on the Location questions were not significant, $\chi^2(1) = 0.28, p > .59$.

Function Questions

The Brain. On the Function questions, 84.2% of the normal children and 68.8% of the mentally handicapped subjects spontaneously referred to a mental phenomenon as one function of the brain ("thinking" was the most common; other mental functions mentioned included dreaming, remembering, keeping things secret, tricking people, learning things, and loving). After prompting ("Does it do anything else?"), 31.3% of the mentally handicapped and 31.6% of the normals also referred to a motor function (e.g., "It tells you to walk"; "you couldn't do nothing if you didn't have a brain"). In contrast, only 23.5% of the autistic children spontaneously referred to a mental phenomenon, whilst 70.6% of them spontaneously referred to its role in behavior (e.g., "It makes you move," "It makes you wake up and go to sleep," "Running and walking," etc.). The difference between the proportion of each group referring to a mental function of the brain was highly significant, $\chi^2(1) = 5.1, p < .024$, Autistic × Mentally Handicapped, and the difference between the proportion of each group referring to a behavioral function also approached significance, $\chi^2(1) = 3.65, p < .056$, Autistic × Mentally Handicapped.

The Heart. The Function question on the heart was passed by 82.4% of the autistic group, 87.5% of the mentally handicpped, and 94.7% of the normal children, although 11 (57.9%) of the normal children, 10 (58.8%) of the autistic, and 10 (62.5%) of the mentally handicapped children needed to be prompted (e.g., Child: "It bangs in your chest." Experimenter: "Does it do anything else?" Child: "It pushes the blood into my legs"). The remainder of each group produced correct answers to the Function question of the heart spontaneously. These differences were not significant, $\chi^2(1) = 0.01, p < .933$, Autistic × Mentally Handicapped. The results from both the Location and Function questions are shown in Tables IV and V.

Discussion

Whereas the normal and mentally handicapped subjects showed a clear belief that the brain was involved with mental functions, the majority of autistic children tended to only associate it with a *behavioral* function. This

Table IV. Number of Children Passing Location and Function Questions in the Concept of Brain Test (Experiment 2)

Diagnostic groups	*n*	Location		Function	
		Brain	Heart	Brain	Heart
Autistic	17	15	15	4[a]	14
Mentally handicapped	16	12	13	11	14
Normal	19	19	18	16	18

[a]Significant at the .024 level.

difference is all the more striking in that behavioral functions are not well understood in normal children of this age. This means that the autistic children produced more complex answers than their controls.

Two possible explanations strike us for this result. It may be that lacking a mental conception of the brain, their concept of physical objects is precociously developed, perhaps to compensate for this deficiency. A more parsimonious explanation might be that their more complex answers were due to their higher MA. The autistic group had an MA advantage of almost 3 years over both control groups on the nonverbal scale.

The three groups did not differ in their beliefs about the function of the heart, and this replicates Gellert's (1962) findings for normal children. Nor did they differ in their beliefs about the location of these two organs. Their correct performance on the Function question of the heart shows that autistic children do possess a theory of unobservable events. It appears however that specifically mental unobservable events are beyond their comprehension. Future work is needed to explore how elaborate a theory autistic children can build of nonmental unobservable events.

Experiment 2 replicates Johnson and Wellman's (1982) findings for normal 4- to 5-year-olds, and supports the results from Experiment 1, in that the autistic subjects alone appear to be largely unaware of the mental world. However, the fact that almost 24% of the autistic group were able to pass leaves open the possibility that other autistic children might also be able to

Table V. Number of Children Referring to Mental and Behavioral Functions in the Concept of Brain Test (Experiment 2)

Diagnostic group	*n*	Mental	Behavioral
Autistic	17	4[a]	12[b]
Mentally handicapped	16	11	5
Normal	19	16	6

[a]Significant at the .024 level.
[b]Significant at the .056 level.

do so, given suitable probes. Nevertheless, the present study provides further evidence that their difficulty in understanding mental phenomena is independent of general developmental delay.

Our final experiment was designed to test this hypothesis yet further. Since Experiment 1 had found a general failure to appreciate the mental–physical distinction, and since our earlier studies (Baron-Cohen et al., 1985, 1986) had found a deficit in attributing beliefs to others, we expected autistic children would also be impaired in their attribution of mental states to themselves, that is, in introspection. The Appearance–Reality (A-R) paradigm was used to test this.

EXPERIMENT 3: THE APPEARANCE–REALITY DISTINCTION

Children begin to appreciate the difference between appearance and reality somewhere around 4–6 years old (Flavell et al., 1983). For example, a child in this age range who is given a deceptive object, such as a sponge painted to look like a rock, is likely to say that the object looks like a rock but is really a sponge. In contrast, a 3-year-old is likely to say either that it looks like a sponge and really is a sponge (the Realist error), or that it looks like a rock and really is a rock (the Phenomenist error). Children at this younger age thus appear unable to represent both an object's real and apparent identities simultaneously.

Gopnik and Astington (1988) argued that this is also an indication of the 3-year-old's inability to represent the distinction between their perception of the object (its appearance) and their knowledge about it (its real identity). In this sense, the A-R distinction is a test of the ability to attribute mental states to oneself. This was one of our reasons for using it with our autistic subjects. Our prediction was that they would fail the test of the A-R distinction.

Procedure

The subjects were the same as those in Experiments 1 and 2. They were tested with the A-R distinction after Experiment 2, but on the same occasion. They were first given a warm-up procedure so as to demonstrate the meaning of key terms in the later questions. In the warm-up procedure the experimenter said, "Look. We can close the curtains and turn off the light. Now the room is dark and it looks like it's the night. But really it's day time." The child was then asked, "Does it look like day or night?" (Answer: night). "What is it really?" (Answer: day). Corrective feedback was given if needed

so that each subject received training in the use of the lexical terms "looks like" and "really."

They were then given a Memory pretest in which changes in an object's apparent color were produced by putting an orange filter on top of a white sheet of paper. The children were then asked, "When I take this (filter) away, will the paper look white or orange?" Passing the pretest was the inclusion criterion for this experiment, because it indicated that the subject (a) knew that the filter did not permanently alter the real color of the object, and (b) remembered the object's original color. Both of these have been argued to be prerequisites for passing A-R tasks which involve transformations (Flavell, Green, & Flavell, 1986), a component of two of our present tasks. All subjects passed this Memory pretest.

Following this, four A-R tasks were presented, in random order, in which an object's color, size, material, and identity were manipulated separately. There were two trials (i.e., using two different objects) in each task. In each trial, an Appearance question and a Reality question were asked, in a fixed order (Appearance, then Reality). The order of these questions was not randomized because the pragmatics of the Reality question are such that it assumes the object's appearance has already been considered. Once the child had answered both questions (later referred to as a pair of Appearance-Reality questions), their response was coded into correct, phenomenist, realist, or other. The four tasks are described.

Color. A bottle of milk was placed on the table and the child was asked "What is this?" All subjects replied correctly, thus demonstrating object recognition. The child was then asked "What color is the milk?" All subjects replied that it was white, thus establishing that they could discriminate color. The bottle was then placed behind an orange filter and the child was asked the Appearance question, "Now what color does the milk look?" The child was then asked the Reality question, "What color is it really?" A correct response comprised saying the milk looked orange but was really white. A phenomenist error occurred if the child said it looked orange and really was orange, and a Realist error occurred if the child said it looked white and was really white. This task was then repeated, using a piece of white chalk instead.

Size. Two British coins (a penny and a 10p) were placed on the table, and the child was asked, "Is the penny smaller or bigger than the 10p?" (Answer: smaller). All subjects passed this, thus demonstrating size discrimination ability. A magnifying glass was then held over the penny, making it appear bigger than the 10p, and the Appearance Question asked, "Now how does the penny look? Smaller or bigger than the 10p?" All the children replied correctly (bigger). The experimenter then asked the Reality question, "What size is the penny really? Bigger or smaller?" A correct response com-

prised saying the penny looked bigger but was really smaller. A Phenomenist error occurred if the child said it looked bigger and really was bigger. Realist errors (saying it looked smaller and really was smaller) did not occur in this condition and therefore were not analysed. This task was then repeated, using two other coins of different sizes (a £1 coin and a 50p coin).

Material. A plastic, realistic-looking chocolate was taken out of a chocolate box and was placed in front of the child, and the experimenter asked, "What is this?" Having replied that it was a chocolate (which all subjects did, testifying to its verisimilitude), the child was then invited to examine it until she or he had discovered its plastic quality. Their discovery was evident in their correct answer to a probe question, "What is it made of?" The child was then asked the Appearance Question, "What does it look like?," and finally the Reality Question, "What is it really?" A correct response comprised saying it looked like chocolate but was really plastic. A Phenomenist error occurred if the child said it looked like chocolate and really was chocolate. A Realist error occurred if the child said it looked plastic and was really plastic.[4] This task was then repeated, using a plastic, realistic-looking hamburger.

Identity. A stone, realistic-looking egg was shown to the child (without the child being able to touch it) and asked, "What is this?" Having replied that it was an egg (which again all subjects did), the child was then invited to handle and examine it until s/he had discovered it was a stone. At this point, again, a probe question was asked, "What is it made of?," which all subjects answered correctly. The child was then asked the Appearance question, "What does it look like?," and finally the Reality question, "What is it really?" A correct response comprised saying it looked like an egg but really was a stone. A Phenomenist error occurred if the child said it looked like an egg and really was an egg, and a Realist error occurred if the child said it looked like a stone and was really a stone. This task was then repeated, using a sponge that had been made to look like a slice of bread.

Scoring

A correct answer to a pair of Appearance–Reality questions was awarded 1 point. Each child could therefore score a maximum of 8 points (2 on each of the 4 tasks). If the child scored on both trials of a task, this was

Realist errors in the Material and Identity tasks of the A-R experiment are in one sense not errors at all since, for example, the object was plastic and (in principle at least) might have looked like plastic. In practice, the objects were such good fakes that all of the subjects were initially fooled. However, the only errors in these two conditions were made by the autistic group, and their errors were all phenomenist rather than realist.

counted as a Pass on that task. The probability of passing one task was therefore .25. If the child passed 3 out of 4 A-R tasks, this was counted as a Pass on the A-R distinction overall. The probability of passing 3 out of 4 A-R tasks was .01.

Results and Discussion

The percentage of each group passing the A-R test overall is shown in Table VI: 78.9% of the mentally handicapped group and 81.3% of the normal group passed, producing answers such as, "It looks like a biscuit, but really it's plastic!" or "It's not a real egg; it's only pretend!" In contrast, only 35.3% of the autistic group did so, and this is highly significant, $\chi^2(1) = 5.37, p < .0205$, Autistic × Mentally Handicapped.

A task-by-task analysis (summarized in Table VII) showed that for the mentally handicapped and normals, the tasks were not significantly different in difficulty, whilst for the autistic group the color task alone was easier than the other three tasks, which were uniformly difficult for them. Where errors occurred, the autistic children tended to make Phenomenist errors. These comprised 75% of their errors. A common example of this was the assertion that the egg and the biscuit were real. Of the mentally handicapped group, 54% of their errors were Phenomenist, whilst of the normal group, 29% of their errors were Phenomenist.

It is also of interest that in those tasks that included plastic food, the autistic children alone persisted in trying to eat the object long after discovering its plastic quality. Indeed, so clear was this perseverative behavior that the experimenter could only terminate it by taking the plastic object out of their mouths. In contrast, the normal and mentally handicapped subjects indicated they perceived the Experiment as some kind of joke or trick, showing laughter at the fake food and making comments like "It's pretend chocolate!" (This interpretation of the A-R stimuli is presumably that intended by their manufacturer, as they were purchased in a Joke Shop.)

The results from Experiment 3 replicate those of Flavell et al. (1983) and others (e.g., Gopnik & Astington, 1988) in finding this sort of task wi-

Table VI. Number of Children Passing Three or More Tasks in the Appearance–Reality Distinction (Experiment 3)

Diagnostic group	*n*	Pass	Fail
Autistic	17	6[a]	11
Mentally handicapped	16	13	3
Normal	19	15	4

[a]Significant at the .0205 level.

Table VII. Number of Children Passing Each Task in the Appearance–Reality Distinction (Experiment 3)

Diagnostic group	*n*	Color	Size	Material	Identity
Autistic	17	11	8	7	6
Mentally handicapped	16	11	11	11	12
Normal	19	15	12	15	15

thin the ability of most normal 4- to 6-year-old children, and establish it as within the repertoire of mentally handicapped subjects of a comparable MA. The prediction that this would be an area of difficulty for autistic subjects was supported, and this suggests that these children alone are unaware of the A-R distinction, and by implication unaware of their own mental states. These results suggest that when perceptual information contradicts one's own knowledge about the world, the autistic child is unable to separate these, and the perceptual information overrides other representations of an object.

There may of course be other explanations for the autistic children's tendency to produce phenomenist errors on the A-R tasks. It may, for example, be that the nonautistic children interpreted the pragmatics of the Reality questions as an indication that they should change their response, and that the autistic children were not sensitive to this pragmatic cue. We tried to control for this by the use of warm-up procedures which suggested all the children understood the meaning of the Reality question. Another related possibility is that autistic subjects might have benefited from more help in recognizing the point of the task. Future studies could usefully include an "amount of help" metric, along the lines suggested by Campione (1986).

A final point concerns the interpretation of the A-R tasks. We have interpreted them as tests of introspection, but it may be that A-R tests require more than just the ability to introspect. Introspection may be necessary but insufficient for success on the A-R task. Other necessary skills may be the ability to recognize the occurrence of "a trick," and then communicate this recognition. Certainly, the spontaneous reactions of the nonautistic children to our fake objects indicated that to them the notion of a trick was an important part of the task.

One thing is certain: We know that all of our subjects could discriminate the real and fake objects on the basis of their perceptual differences, in that when we asked them to sort these into two categories, all of them performed at ceiling. We interpret this as showing that autistic children are able to identify critical differentiating features of real and fake objects when these objects are presented separately (examples of critical features might include edible–inedible, plastic–nonplastic, normal–unusual, etc.), but when they are

asked to make judgments about one object with two possible representations (egg–stone), they fail. This raises the possibility that their failure is due to an impaired metarepresentation capacity. We return to this notion in the final section of this paper.

GENERAL DISCUSSION

The results from Experiments 1 and 2 suggest that autistic children fail to distinguish mental and physical phenomena, and seem unaware of the mental function of the brain. These abnormalities are not accounted for by insufficient MA or CA, as mentally handicapped and normal children of an equivalent or younger MA and CA did not show these deficits. In the shorthand used earlier, most of the autistic children seem to perform on these tests like behaviorists, ignoring the special significance of mental events.

The results from Experiment 3 suggest that autistic children have a specific bias towards Phenomenist errors on Appearance–Reality tasks, suggesting a lack of awareness of their own mental states and an inability to represent an object in two different ways simultaneously. Again, this deficit was not found in our control groups. Taken together, these three experiments extend our earlier work (Baron-Cohen et al., 1985, 1986) in finding deficits in other aspects of autistic children's theory of mind.

Leslie (1987) has formulated a metarepresentation account of their inability to attribute beliefs to others. His theory also attempted to account for autistic children's deficits in pretend play (Baron-Cohen, 1987; Ungerer & Sigman, 1981; Wing & Gould, 1979) by assuming that both attribution of beliefs and pretend play require metarepresentation, that is, the capacity to *represent representations.* This seems to be a reasonable analysis in the case of belief attribution, in that knowing what another person thinks logically requires being able to have beliefs about beliefs. Leslie's argument that engaging in pretend play also requires metarepresentation is more controversial. (See Perner, 1988, for a counterargument.)

Metarepresentation is thought to develop at the end of the first year of life, following the development of the capacity to represent objects, or what Leslie calls the capacity for "primary representation." Primary representation is most clearly demonstrated in the possession of the object concept, a skill unambiguously present in autism (Sigman & Ungerer, 1981). Metarepresentation also goes by another name, "metacognition." It is of crucial relevance here that A-R tasks are also seen as requiring metacognition (Flavell et al., 1986; Gopnik & Astington, 1988). We agree with these authors that the ability to distinguish mental and physical phenomena, and appearance from reality, reflects the capacity for metacognition. Autistic children's

failure on these tasks is therefore consistent with the metarepresentation theory of autism.

Discussing the A-R distinction, Flavell et al. (1986) wrote:

> It is probably a *universal* developmental outcome in our species. This knowledge seems so necessary to everyday intellectual and social life that one can hardly imagine a society in which normal people would not acquire it . . . Knowledge about the distinction seems to presuppose the explicit knowledge that human beings are *sentient, cognizing subjects* [italics added] . . . whose mental representations of objects and events can differ—differ both within the same person and between persons . . . It is part of the larger development of our conscious knowledge about our own and other minds. (pp. 1-2)

The case of autism suggests the A-R distinction is however not universally developed. Its link to the mental–physical distinction is supported by the present studies. Indeed, where an autistic child passed Experiment 1, the subject was also likely to pass Experiments 2 and 3, thus providing tempting evidence that the same cognitive structures are involved in each task (3 autistic subjects passed all 3 Experiments, 2 passed Experiment 3 only, 1 passed Experiments 1 and 3 only, and 1 passed Experiment 2 only).

Many questions remain unanswered from these studies. Why, for example, do the different abilities tests here emerge at different times in normal development, if (as Leslie has argued) the same cognitive structures are involved in all of them? Why, for example, is pretend play present, as much as 2 years earlier than the appearance–reality distinction, in normal development? Speculative answers to these questions are beginning to be proposed (see, for example, Flavell, 1988; Forguson & Gopnik, 1988; Leslie, 1988; Perner, 1988; Wimmer, Hogrefe, & Sodian, 1988), but the simultaneous impairment of all of these abilities in autism suggests they must be closely interdependent. The autistic children who passed all three experiments raise the interesting possibility that the deficits most autistic children show in this area are not damaged once and for all, but rather are severely delayed. This is explored elsewhere (Baron-Cohen, 1989a).

In closing, consider the question posed in the title of this paper: "Are Autistic Children 'Behaviorists'?" The data reported here suggest that much of autistic children's view of other people is limited to perception of behavior rather than mental states, but it is by no means the case that all internal states are beyond thier understanding. For example, they may have intact understanding of desire and the link from desires to the simpler emotions of happy and sad (Baron-Cohen, 1989b). Other internal states that they are predicted to understand include psychological states such as hunger, since such states, like desires, can be understood without a capacity for metarepresentation (Wellman, in press).

Such predictions remain to be tested, but they raise the notion that autistic children are not so much behaviorists as "desire-psychologists" (Wellman & Bartsch, 1988), that is, they may be able to predict people's actions in terms of desires and physical causes, but fail to develop a "belief-desire psychology" characteristic of even normal 3-year-olds. If such a formulation of their theory of mind is true, the range of types of social situations that they are able to understand must be very restricted, and the vast majority of social situations must be completely bewildering to them.

APPENDIX 1: STORIES IN EXPERIMENT 1

This is Sam. He likes biscuits. He is hungry, so his mother gives him a biscuit. This is Kate. She likes biscuits. She is hungry, but she is all alone. She is *thinking* about a biscuit.

This is Anna. She likes bicycles. She wants to ride on one, but it is time to go to sleep. She is *dreaming* about a bicycle. This is David. He likes bicycles. He wants to ride on one, so his mother buys him a bicycle.

This is David. He likes Coca-Cola. He is thirsty, but he is all alone. He is *pretending* to drink some Coke. This is Kate. She likes Coca-Cola. She is thirsty, so her mother gives her a drink of Coke.

This is Anna. She likes to go on the swing, so her mother takes her to the park where the swings are. This is Sam. He likes to go on the swing, but he has to go to school. He is *remembering* when he went on the swing.

APPENDIX 2: COMPREHENSION TEST IN EXPERIMENT 1

The Comprehension test included (a) the verbs *eat,* "What do you like to eat?"; *touch,* "Can you touch the table?"; *ride,* "What things can people ride on?"; and *drink,* "What do you like to drink?"; (b) the nouns *biscuit, "Coke", bicycle,* and *swing,* "What is a . . . ?"; (c) the adjectives *hungry* and *thirsty,* "What do you do if you're hungry/thirsty?"

The verbs referring to the four mental states (dream, think, pretend, and remember) were not included in the Comprehension test.

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