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Prospects for a Cognitive Neuropsychology of Autism: Hobson's Choice

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Leslie (1987b) proposed a new, metarepresentational model for the cognition of pretense. This model identified a cognitive component necessary for the normal development of a "theory of mind." In this article, the relation of the child's early affective sensitivities to this component is considered. Early affective sensitivities seem to be cognitively distinct from the metarepresentational component. Childhood autism provides an interesting opportunity to study this problem. Three theoretical possibilities for the pathogenesis of this condition are presented: (a) a basic affective disorder as proposed by Hobson (this issue, p. 114), (b) a basic affective disorder and a basic cognitive disorder jointly, and (c) a basic cognitive disorder. There is little evidence for Option a, and a growing body of evidence supports Option c. Option b is sidelined for the time being on grounds of parsimony. Leslie's original theoretical proposals are revised, and some resulting implications are presented for the future investigation of the cognitive neuropsychology of autism.

Lamentable though it is, students of development are still far from reaching consensus on what a theory of development should be. To suggest that development can be understood in terms of the computational systems that result from brain functioning is still controversial. Within this general framework, Leslie (1987b) outlined some proposals for understanding the cognition of pretense in young children. These proposals were used to identify a cognitive component underlying the normal child's development of a "theory of mind." Malfunction of this component would lead to specific abnormalities of development that might show themselves in a characteristic pattern of social and communicative behavior. Childhood autism was hypothesized to involve just such a dysfunction. If true, this finding would take a neuropsychological theory of autism an important step further (Frith, 1988).

Although Hobson feels he can "endorse the validity" of some aspects of Leslie's (1987b) theory, he finds other aspects "seriously misleading" (Hobson, 1990, p. 114). Essentially, Hobson complains that Leslie's account of pretense and related matters did not address "affective" phenomena and instead tried to analyze cognitive mechanisms. We, for our part, find Hobson's comments to be a mixture of three things: ideology, confusion, and some interesting substantive issues. The substantive issues he raises concern the nature of childhood autism. Dealing with these issues forms the body of our reply.

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Under the heading of ideology, we place Hobson's unease at "Leslie's nondevelopmental, nonsocial, and restrictively cognitive account" (p. 114). All three of these epithets are inappropriate. (a) The account is developmental because it is concerned with characterizing part of the developmental basis of the child's theory of mind. Leslie proposed that this particular part was innate (cf. Fodor, 1987). This proposal does not make the theory nondevelopmental, however. All theories of development have been, and indeed have to be, crucially concerned with the innate basis of development.

(b) The theory can hardly be considered nonsocial. One distinctive feature of Leslie's account is that it explicitly shows how pretending is but a special case of understanding pretense in others. (c) We agree that the account is cognitive but cannot see what pejorative force the term *restrictive* has. (Of course, we are familiar with the feeling of some people that affective phenomena are inherently alien to a mechanistic account.) However, the account offered by Leslie (1987b) was cognitive because the phenomena addressed were cognitive; to call it restrictive is surely irrelevant because any useful theory must have specific limits. Nevertheless, the question of emotional reactions in pretense is interesting and has in fact been discussed in this theoretical context (Leslie, 1987a).

We do not wish to say more on ideological questions. However, there are one or two muddled ideas that we have to clarify. Hobson wants "to turn Leslie's theory on its head" (p. 116) and suggests that "a certain level of interpersonal understanding *is* Leslie's 'decoupling mechanism' " (p. 116). This statement simply misses the point, namely, that the decoupling mechanism explains what "a certain level" might mean here. For a start, this level must be distinguished from other levels of interpersonal understanding, such as the level of a "pre-reflective capacity to perceive the orientations of others" (p. 116).

Young infants may be endowed with preadapted sensitivities to the affective state of other people. How these sensitivities are related to the fully fledged appreciation that people have feelings about states of affairs is a separate question because these feelings, like beliefs and desires, have content. To elaborate: Primary affective sensitivities are direct responses to behavioral states of the other person. There is no reason to suppose that such sensitivities involve mechanisms that can represent mental states (or even that they represent at all). Our point is that reflexive emotional responding must be distinguished from a theory-of-mind understanding of emotions. Such a sophisticated understanding would entail an appreciation of the other person's attitude to a proposition about a state of affairs. This, in turn, requires a capacity for metarepresentation. A parallel distinction turned out to be fundamental to understanding the significance of pretense compared with earlier forms of play. This distinction is exactly what previous theories of pretense failed to recognize, as discussed at length in Leslie (1987b).

Although Hobson endorses this distinction for functional and pretend play, he denies its relevance in the case of interpersonal relationships. He would like the child to derive his or her sophisticated concepts of "people . . . as beings with . . . subjective experiences and [individual] orientations to a commonly perceived world" (p. 116) from the primitive and direct perception of "the orientations of others" (p. 116). However, without the addition of a metarepresentational component, he is unable to specify how this derivation might come about. Hobson's claim remains, then, simply an article of faith about which we confess skepticism.

There are two additional points that we should comment on before turning to the interesting questions Hobson raises concerning autism. When infants begin to attend to their mother's reaction to a novel object or event ("social referencing"), they do so to determine what significance the object or event actually has (e.g., is this object dangerous or not? See, e.g., Feinman, 1982). There is no reason to suppose along with Hobson that in social referencing, the environment has one meaning for the infant and another meaning for the caretaker that the infant can simultaneously recognize as an alternative to his or her own. The infant only has to recognize someone's behavioral reaction to an object or event and need not attribute a mental content to the other. Thus, there is no compelling reason to assume that metarepresentation is involved.

Hobson's concern with other, more complex communicative abilities, such as pointing and head-shaking gestures, which predate pretense, is more soundly based. These abilities are indeed suggestive of metarepresentational involvement, as Leslie (1987b, p. 422) pointed out (cf. Sperber & Wilson, 1988). Indeed, shared pretense should be seen as a particular complex form of ostensive communication. Perhaps shared attention and sensitivity to others' attention-demanding (communicative) displays are part of what triggers the operation of the metarepresentational module (Leslie, in press). Following this line of argument, one must look for the emergence of metarepresentation earlier, possibly much earlier, than pretense. The problem is that there is not yet sufficient evidence to determine, before the emergence of pretense, whether early communicative acts reveal an underlying metarepresentational capacity or whether they are generated by mechanisms that are simply sensitive to social and behavioral factors (the "orientations" of others). On this question, Leslie (1987b) concluded that "the relation between metarepresentational capacity and communication in infancy remains an interesting but still open question" (p. 422). Hobson fails to produce any reason to change this assessment.

Autism

This article does not address the complex background of the severe developmental disorder of autism. For a detailed discussion, the reader is referred to Frith (1989). The most relevant facts are as follows. Autism has a biological basis; three quarters of afflicted children suffer severe or moderate mental retardation, and even those of normal intelligence show specific cognitive dysfunction. What all autistic children have in common is a distinctive triad of impairments (Wing & Gould, 1979), namely impairment of social, communicative, and imaginative activities. All of this is common ground between us and Hobson.

Where we differ is in the primacy Hobson affords the affective component of social relations in the psychopathogenesis of the disorder. Hobson echoes Kanner's (1943) original contention that autism is a disturbance of affective contact. Baron-Cohen (1988) has discussed the "affective theory" of autism, highlighting the greater usefulness of the cognitive theory in relation to the evidence on social and pragmatic deficits in autism. The evidence he considers is complementary to our own arguments.

Three major possibilities for the pathogenesis of autism are illustrated in Figure 1. First, there may be a basic affective disorder in autism that somehow produces other cognitive impairments. Some of these secondary consequences lead to impaired social–communicative capacities. Hobson urges a similar viewpoint, but, as we show, there is surprisingly little evidence to support it.

Second, there may be a basic affective disorder in autism, but it is independent of and additional to a basic cognitive deficit. These deficits combine to produce impaired social–communicative capacities. This possibility is less parsimonious than the other two and would therefore require more evidence.

Third, there may be a basic cognitive deficit in autism that produces as a secondary (but of course not less important) consequence the social–communicative impairments observed, including abnormalities of affect. We believe that the evidence to date favors this possibility.

There are several reasons for concluding that the evidence for the first case is weak. The starting point for the affective theory of autism is the following belief. Almost from birth there will be a social affective disorder severe enough to be obvious to anyone but the novice parent (i.e., producing behavior that is simply not within the normal range of temperamental variation). Curiously, retrospective evidence, even though it has the benefit of hindsight, has been equivocal. About half the parents responding in a large-scale questionnaire-based study by Ornitz, Guthrie, and Farley (1977) reported that they had suspected nothing abnormal in their autistic child's 1st year. In a British survey of 93 able autistic people (Newson, Dawson, & Everard, 1984), 60% were said to have been normally affectionate in infancy, and only 13% of parents were alerted to a

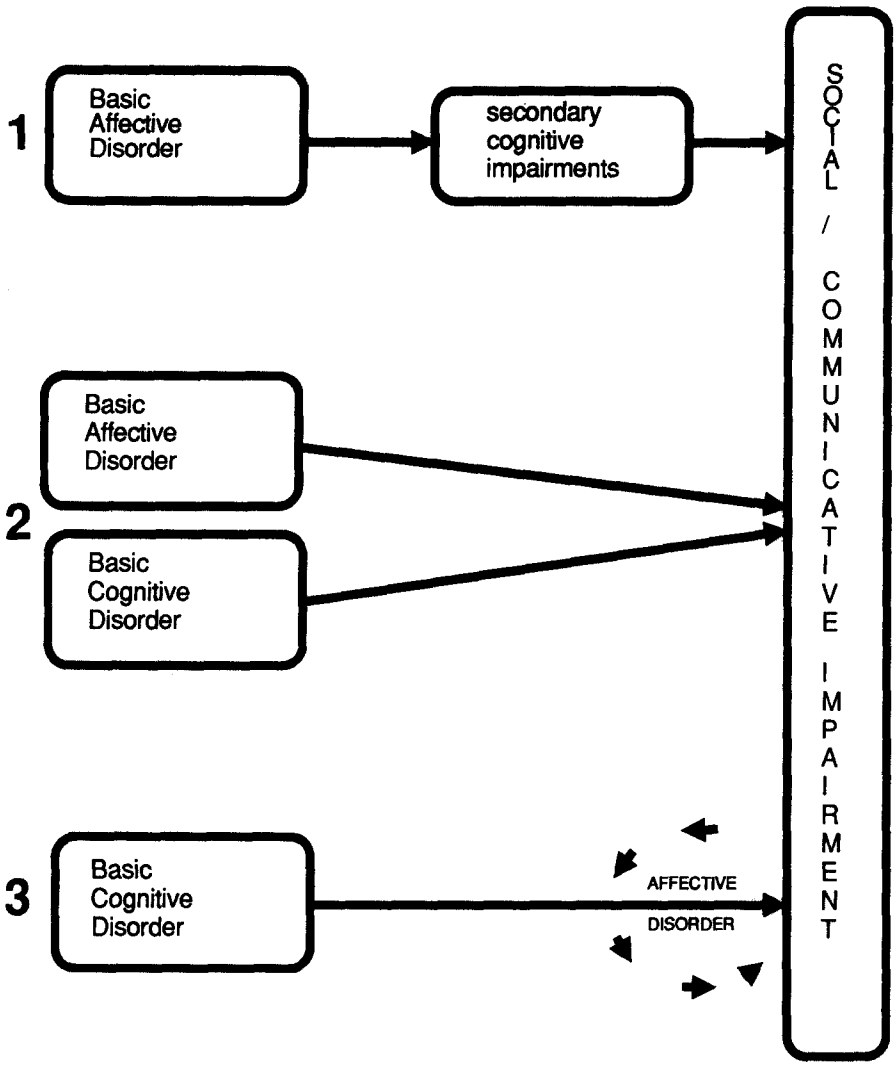

Figure 1. Three possible patterns of underlying impairment in autism.

definite concern or even vague disquiet in their child's 1st year. No study has made the relevant comparison with normal children to see if a proportion of their parents would, if asked, also admit to concern about affective social responsiveness during their child's 1st year. As for nonautistic but mentally retarded children, development of affective social responding is delayed along with other behaviors (Cicchetti & Sroufe, 1976), although this area is still little explored (Vietze, 1985).

The only prospective study of autism published is that by Knobloch and Pasamanick (1975), who studied a sample of 50 individuals referred sometime before the age of 3 to a large pediatric service. All of these children, when first seen, showed specific social impairment, described as "a failure to regard people as persons" (p. 184). This would thus seem to fit Hobson's requirements. Almost all of these children were also diagnosed as mentally retarded. In the follow-up 3–10 years later, the children who were originally seen during the first year of life had lost their specific social impairment, and none were found to be autistic. However, of the children first seen at age 2 and who at that time showed social impairment, 25% turned out later to be autistic—a proportion that increased to 80% for children who originally had been referred to the clinic at age 3 or older. This pattern suggests that there is a specific and late-emerging social impairment that can be distinguished from a general delay of social responsiveness. This delay is caused perhaps by mental retardation, appears early, and does not necessarily presage autism.

Perhaps the insensitivity of measuring instruments has prevented the detection of an autism-specific but subtle affective disability manifested from birth. Therefore, positive evidence of attachment behavior in autistic children would be particularly relevant. Just such evidence emerged in a study of the stranger reaction by Sigman and Ungerer (1984). On the other hand, Sigman and colleagues (Mundy, Sigman, Ungerer, & Sherman, 1986; Sigman, Mundy, Sherman, & Ungerer, 1986) found a specific deficit in communicative skills that normally

emerge at around 1 year (e.g., showing toys and pointing). This deficit was identifiable against the background of a high degree of general responsiveness to caregivers (e.g., looking, touching, vocalizing, and fretting). This specific communication impairment has been found also by Loveland and Landry (1986).

Given that 75% of autistic children are mentally retarded, and thereby developmentally delayed, it is not surprising that there may exist film records of autistic children that suggest impairments of affective social responsiveness almost from the start. Likewise, developmental delays may be found in cases of severe sensory incapacity, such as blindness (which Hobson makes much of) or deafness. Although there undoubtedly are blind (or deaf) individuals with social naivety, there are also blind preschoolers with a remarkable social competence (Landau & Gleitman, 1985; Urwin, 1983). We do not know how any of these groups with sensory handicap would fare on theory-of-mind tasks. Without such data, the relevance of blindness to autism is hard to determine.

In regard to mixing up personal pronouns, normal and even deaf signing children often show reversal as well (see, e.g., Karmiloff-Smith's [1987] discussion of such errors in light of the child's own analysis of the linguistic system). The interpretation of such errors in autistic children as a deep problem with a "self-concept" has long been discarded (Bartak & Rutter, 1974).

We could multiply examples like those presented thus far, but the following general point has more importance. To understand the neuropsychology of autism, there must be a focus on specific deficits over and above any general or additional deficits associated with intellectual or sensory deficiencies.

More relevant to the neuropsychology of autism is the evidence that Hobson has provided in an important series of experiments on autistic perception of emotion. In earlier studies, Hobson (1986a, 1986b) found that autistic children had greater difficulty than mental-age (MA)-matched control children in recognizing how different expressions (in voice, face, and gesture) of particular emotions are associated with each other. Although we agree with Rutter (1987) that the explanation for this effect is not yet clear, a specific failure in the processing of emotional stimuli might form part of the neuropsychology of autism. In Hobson's latest studies, however, in which he used standardized Ekman faces (Hobson, Ouston, & Lee, 1988a, 1988b), these earlier differences largely disappeared. In fact, in a sorting task, the autistic subjects scored nearly at ceiling for recognition of emotion in full-face expressions. Despite this fact, Hobson continues to describe his results as "indicat[ing] a specific abnormality in the way autistic individuals perceive emotion" (Hobson et al., 1988b, p. 441). In a recent study, Ozonoff, Pennington, and Rogers (in press) found no specific deficits in emotion perception when autistic subjects were matched with controls on verbal MA. In any case, even if there were a real deficit, it would not explain the results of the studies of autistic theory of mind to which we now turn.

The Autistic Child's Theory of Mind: Experimental Evidence

Baron-Cohen, Leslie, and Frith (1986) tested autistic children's ability to understand different types of event using a picture-sequencing task. An important feature of their study was the use of control groups of normal preschoolers and Down's syndrome children with substantially lower MA, both verbal and nonverbal, than those of the autistic children. The relative advantages enjoyed by the autistic group allow us to evaluate conservatively any relative disadvantages in their performance.

Three types of event were studied. In the first, the pictures depicted simple physical causal sequences. Some sequences showed only physical objects, whereas others showed a person and an object, as illustrated in the top panel of Figure 2. We used these two subtypes because we wanted to determine whether the involvement of a person made the event more difficult for the autistic children.

The second type of event we called social–behavioral because we thought the events would be understood as behavioral and social routines. Again, we had two subtypes: a person performing an action, such as getting dressed, and two people interacting, as illustrated in the middle panel of Figure 2. Again, we wanted to see whether human interaction was especially difficult for autistic children to understand.

Finally, we had a type of event we called "intentional" because such events seem to be best and most naturally understood only with reference to the protagonist's mental state—in the story illustrated in the bottom panel of Figure 2, the girl's expectation or belief that her teddy bear would be behind her.

Notice that any or all the stories could be understood in mental state terms. But we assumed that the most natural and spontaneous normal understanding would be appropriate to the three types of description: mechanical, social–behavioral, and mental state.

The results were striking. For all the groups, there were no differences between the subtype object alone versus person and object and none between one person acting and two people interacting. Figure 3 shows the scores for correct sequencing collapsed across story subtypes. The autistic children did best on the mechanical stories, where they displayed their MA advantage. They performed less well on the social–behavioral stories but still well above chance (represented by a score of around 2). Autistic performance on this condition matched that of the normal 4-year-olds but was dramatically worse on the intentional condition. Here autistic children's performance was at chance level and significantly worse than that of the children with Down's syndrome. Protocols taken from the children during sequencing were analyzed according to type of language used—causal, descriptive, or mental state language—producing results that paralleled the sequencing results. In particular, the protocols showed a marked poverty of mental state language in the autistic children relative to the control children.

These results suggest that the autistic child has difficulty in understanding certain social situations but not others. Because all the stories had emotional content and expression (except the object-only mechanical subtype), the results contradict the idea that autistic children have a general inability to deal with the social world on affective grounds. Instead, they seem to have a special difficulty with situations in which it is necessary to take into account what someone else knows or expects.

This conclusion is supported by the results of Baron-Cohen, Leslie, and Frith (1985). In that study, the participants were

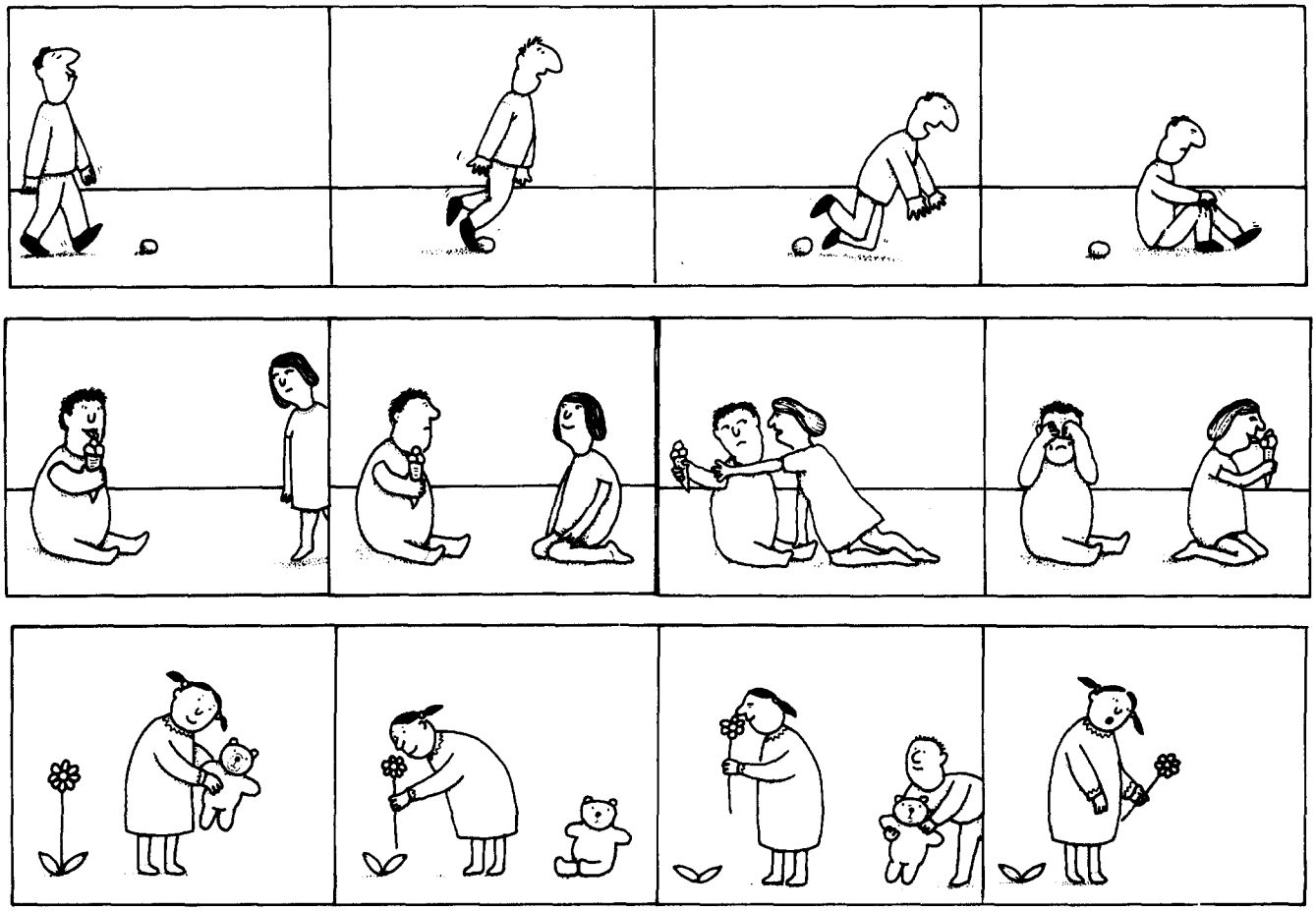

Figure 2. Illustrations of the three story types used by Baron-Cohen, Leslie, and Frith (1986): causal–mechanical (person–object subtype, top panel), social–behavioral (person–person subtype, middle panel), and mental state (bottom panel).

nearly all the same children as in the experiment just discussed. Dolls were used to present a social scenario to the children: "Sally" has a marble that she hides in a basket. She then goes away for a walk. While Sally is gone, "Anne" transfers the marble from the basket to a box. Sally then returns and wants her marble. The child is asked certain control questions to ensure he or she has understood the displacements of the object over time and that there are no memory problems; otherwise, the scenario is reenacted. Then the child is asked, "Where will Sally look for her marble?"

The results showed that 85% of the normal 4-year-old children correctly predicted where Sally would look on the basis of where Sally should (wrongly) *believe* her marble to be, as did 86% of the Down's syndrome children. By contrast, only 20% of the autistic children did this; the rest predicted Sally's behavior on the basis of where the marble really was. These results provided more support for the idea that high-ability autistic children were specifically impaired in their ability to understand certain mental states, such as belief, and to predict the behavior of others on this basis.

In another study (Leslie & Frith, 1988), we wanted to replicate the prediction from the false-belief study with additional controls and to extend the experiment to study autistic understanding of true belief. True belief (where another person knows the "truth" but not the whole truth) appears to be somewhat easier for normal children to understand and on which to base behavioral predictions. The autistic children had verbal MAs in excess of 4 years, 5 months (M = 7 years, 2 months), the scenarios were acted out by people instead of with dolls, and we ensured in several ways that the autistic children could understand when the actors could and could not see something. Finally, we used a group of specific-language-impaired (SLI) children matched for verbal MA to help control for possible effects in these tasks of autistic language delay.

When we presented this new sample with the same prediction from the false-belief task, 100% of the SLI control children passed, compared with 28% of the high-ability autistic children. This result confirmed, with additional controls, our earlier results.

We also had the autistic children perform a new task in which an actor watched while the experimenter hid a counter. We ensured that the autistic child noted that the actor had seen this.

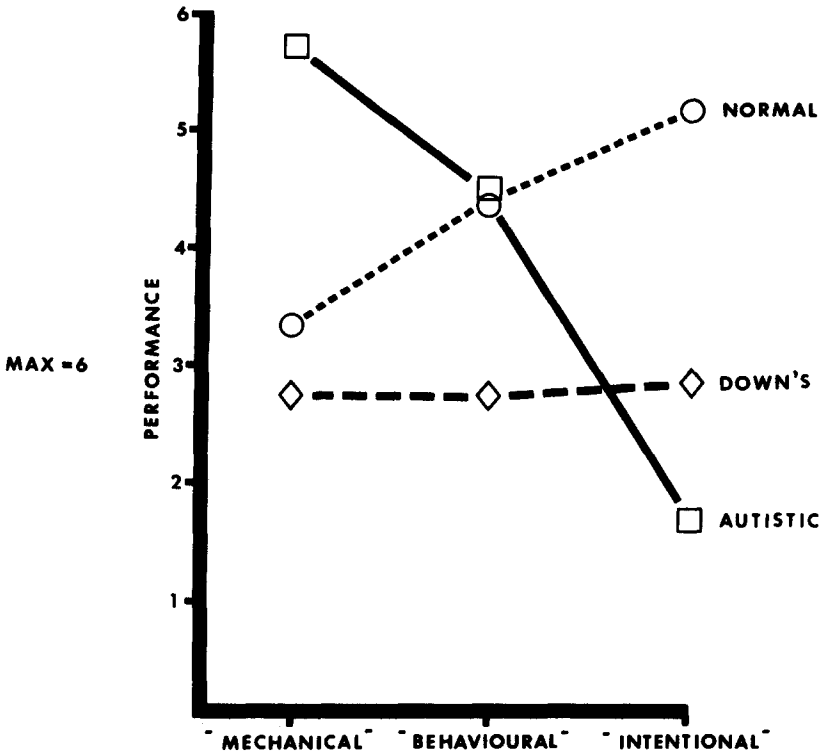

Figure 3. Results of picture-story-sequencing task from Baron-Cohen, Leslie, and Frith (1986).

The actor then left the room. The experimenter then produced an identical counter and asked the child to hide it somewhere different (prominent hiding places were provided). The child was then asked a series of questions, including a question about where the still-absent actor would look for a counter on her return. This scenario thus closely paralleled the false-belief situation, except that instead of there being one object that changed place unbeknownst to the actor, there were two identical objects, one of which the actor did not know about. The results showed that slightly (but not significantly) more autistic children passed this task than passed the test of false belief. However, despite an MA in excess of 7 years, 56% of the group failed. For instance, the autistic children pointed to where they themselves had hidden an object while the experimenter was absent and said that she knew it was there. The autistic child's difficulties, then, apply to understanding both false and true belief.

In a subsequent study (Perner, Frith, Leslie, & Leekam, 1989), we extended the results on false belief by using Perner, Leekam, and Wimmer's (1987) "Smarties" task. The child is shown a box or tube of a well-known European confectionery (U.S. equivalent is M&M's) and is asked what he or she thinks is inside. In both studies, children invariably said "Smarties." The box or tube was then opened and the child was shown that its contents consisted simply of a pencil. The pencil was replaced in the box, and the child was asked what he or she had said was in the box when first shown and what it really contained. In effect, the child had just undergone a false-belief situation. The child was then told that X (a friend) was going to come in and that X would be shown the box all sealed up "just as I showed you" and would be asked what was in the box. The child was then asked to predict what X would reply. From Perner et al. (1987), we know that most 4-year-olds correctly predict their friend's false belief. In the later Perner et al. (1989) study, 92% of the SLI children (mean verbal MA = 6 years, 9 months) also correctly predicted their friend's false belief, whereas only 17% of the autistic children (mean verbal MA = 8 years, 3 months) could make a correct prediction of belief.

Perner et al. (1989) also studied autistic understanding of true belief using a different paradigm from that used by Leslie and Frith (1988), but achieved very similar results (67% of the subjects could not infer someone else's belief even when that belief would be true). Incidentally, in the former study, it was also found that autistic children were no better at understanding the conditions under which they themselves did or did not know something than they were at understanding the conditions for another person.

To review the results from the four studies: First, autistic children as a group are severely impaired on tasks that tap their theory of mind even relative to their own level of general intellectual functioning, or MA. This finding is remarkable in that the autistic children's performance is poor even though they have an MA several years greater than that at which the normal child performs near ceiling. However, not one of these studies has shown a reliable association between passing and failing on any of the tasks and MA, verbal or nonverbal. Indeed, other clinical groups with as great or greater mental retardation (e.g., the Down's syndrome group we studied) perform comparatively well at these tasks.

Second, some tasks appear to be slightly easier for some autistic children (true vs. false belief), and some autistic children reliably pass even the false-belief tasks. For example, Baron-Cohen et al. (1985) found 4 autistic children who passed the "Sally and Anne" prediction task; of these, 2 children also passed on the Baron-Cohen et al. (1986) picture-sequencing task and produced mental state language in their protocols as well. Retesting has shown passing and failing results to be reliable (for instance, see Leslie & Frith, 1988).

What of these approximately 17–28% of high-ability autistic children who pass theory-of-mind tasks? In a recent study by Baron-Cohen (1989), a special group of 10 autistic individuals was assembled by screening for those who could pass the Sally and Anne task. A group of 10 MA-matched Down's syndrome adolescents acted as control subjects. These subjects were given a higher order false-belief task, modeled on Perner and Wimmer's (1985) study. In this task, two protagonists simultaneously acquire the same false belief, but then each has his or her belief corrected independently so that neither knows about the other's correction. The child is then asked to predict one of the protagonists' behavior on the basis of the one's false belief about the other's false belief. Naturally, this kind of task is more difficult for the normal child but is passed by most children between 7 and 9 years old. Baron-Cohen (1989) found that 6 of the 10 subjects with Down's syndrome passed the higher order false-belief task as expected from their MA. In contrast, none of the matched autistic subjects could do so.

Taken together, then, the results of these studies suggest that high-ability autistic children are specifically delayed in their theory-of-mind understanding, even relative to their own general intellectual functioning. Work on the development of a theory of mind in normal children (see, e.g., chapters in Astington, Harris, & Olson, 1988) indicates that there is a "watershed" around the 4th birthday. Only after this age can the normal child reliably solve false-belief and other related tasks. Are grossly delayed autistic children, then, like normal 3-year-olds in this domain? Do they simply get stuck at the 3-year-old level, or is there something more to their impairment?

There are four reasons for thinking that autistic children are not simply like normal 3-year-olds in this domain. First, as noted in Leslie (1987b; cf. Leslie & Frith, 1987), autistic children have been widely reported as impaired or delayed in pretend play (e.g., Baron-Cohen, 1987; Lewis & Boucher, 1988; Ungerer & Sigman, 1981). This would set them apart from the normal 3-year-old, who can bring sophisticated cognitive powers to bear on pretending.

Second, interesting comparisons can be made by matching autistic performance on a standard false-belief task to that of normal 3-year-olds and then comparing the two groups' performances on other theory-of-mind tasks. For example, Figure 4 shows a comparison of autistic performance on Leslie and Frith's (1988) tasks with performance of normal 3-year-olds on analogous true-belief tasks reported by Wellman and Bartsch (1988). The two groups performed similarly on false-belief tasks but appear to differ substantially on true-belief tasks. The procedural differences between the two studies has prompted us to undertake an experiment that draws the two procedures within a single design. Until these results are at hand, we must,

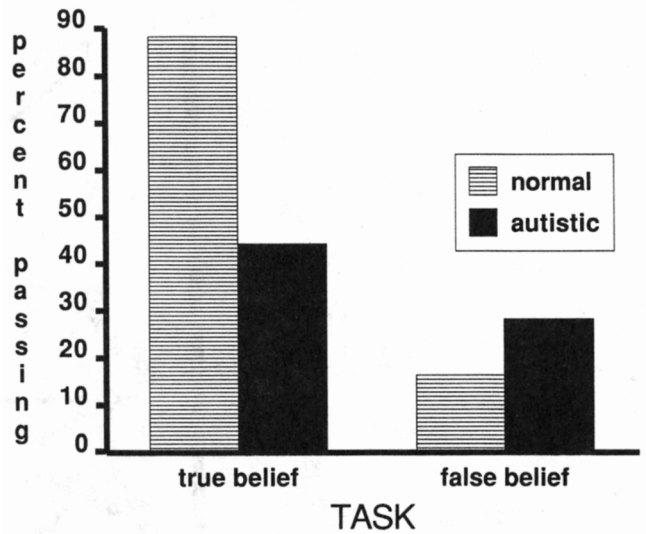

Figure 4. Comparison of high-ability autistic (Leslie & Frith, 1988) and normal 3-year-olds (Wellman & Bartsch, 1988) on analogous theory-of-mind tasks. (Verbal mental age = 7:2 for autistic children, 3:7 for normal children.)

of course, draw only limited conclusions from the comparison presented in Figure 4.

A third piece of evidence comes from a recent study by Harris and Muncer (1988), in which high-ability autistic children were impaired in their understanding not only of false belief but also in their understanding of desires, particularly unfulfilled desires, where what someone desires does not match up to reality. Again, studies of normal children suggest this concept is within the grasp of the 3-year-old (e.g., Wellman & Bartsch, 1988).

Finally, Baron-Cohen (in press) has found that autistic children (with mean verbal MA of 6.5 years and mean chronological age [CA] of 12) fail on tests of the mental–physical distinction (e.g., a banana can be eaten, but the thought of a banana cannot), whereas most Down's syndrome children pass (mean verbal MA of 4.5 years and CA of 13). Wellman and Estes (1986) found that this distinction was well within the grasp of normal 3-year-olds.

The pattern we see emerging from the seven existing studies is one of gross delay, plus, in a large proportion of autistic children, some further impairment in theory of mind. This pattern provides a compelling argument for a cognitive deficit. Hobson would have to derive these cognitive impairments from an underlying affective disorder, such as that shown in the first option of Figure 1. However, it is difficult to determine what kind of affective disorder could produce the cognitive dysfunction implied by the particular pattern of delays and impairments we have documented. This is not all; this potent affective disorder must be impotent to impair the understanding required by those of our stories that depicted affective social interactions that could be understood without reference to mental states (see, e.g., Figure 2, middle panel). Certainly, Hobson makes no suggestions that begin to match up to the dissociation we found (Baron-Cohen et al., 1986).

What sort of cognitive deficit could produce Option 3 of Figure 1 and explain the results from the theory-of-mind tasks? How can we begin to understand the underlying processes in normal development that might be impaired in autism? We see no alternative but to develop a cognitive neuropsychological account. In this spirit, we have been advancing the "metarepresentational conjecture."

Autism and the Metarepresentational Conjecture

To understand the kind of mental states we have been considering, that is, beliefs and desires, the ability to entertain a particular kind of internal representation is required. We call this *metarepresentation.* From this point of view, early pretense can be linked developmentally to the capacity to acquire a theory of mind (Leslie, 1987b, 1988b, in press). In this section, we outline a small but significant revision to the theory of metarepresentation presented in Leslie (1987b). This revision simplifies the theory in certain respects and clarifies the relationship between decoupling and inferential processes (see Leslie, 1988a).

Leslie (1987b) argued that pretense should be understood as computing a three-term relation, PRETEND **(agent, e, "e"),** between an agent (possibly self), a primary representation **e,** which picks out those aspects of the real (current) situation to which the pretense relates, and a decoupled representation **"e,"** which represents the (imaginary) content of the pretense. In discussing examples, such as **I PRETEND "the banana is a telephone"** (p. 417), the notation did not make clear that **the banana** was really a primary representation of, for example, a currently present object. Accordingly, we revise this formulation to show that **the banana** in this example is really a primary representation (of a currently present object); thus, **I PRETEND the banana$_i$ "it$_i$ is a telephone."** This change simplifies the account of the relation between the pretend representation and the real situation. More importantly, perhaps, is that it modifies a strict "quotation approach" and directs attention toward the effects of decoupling on inferential processes.

Consider the following statements as internal representations:

The cup is full.	(1)
The empty cup is full.?	(2)
I pretend the empty cup is full.	(3)
I pretend the cup is both empty and full.?	(4)

There is something queer about thinking Representation 2, and this queerness is due to a mechanism that can perform (something like) elementary deductive inferences on such representations (see Leslie, 1988b, for further discussion). In this particular case, the mechanism quickly detects the contradiction between a cup being both full and empty, but why does this mechanism not also detect such a contradiction in Representation 3? One might suppose that this had something to do with the element **pretend,** but in Representation 4, the contradiction appears again. We propose that there is extra structure in Representations 3 and 4 that is not depicted above—extra structure that influences the operation of the inferencing mechanism. Thus, Representation 3 is really **I pretend the empty cup "it is full."** The decoupling creates an extra level within the representation, whereas the inferences, in this case logical, respect the levels and apply to them one at a time. The "upstairs" level of Representation 3 then appears as **I pretend the empty cup X** (no contradiction detected), whereas the "downstairs" level appears as **it is full** (again no contradiction). With Representation 4, however—**I pretend the cup "it is both empty and full"**—there is within the downstairs level an easily detected contradiction.

Leslie (1987b) discussed at length a theoretical example of how causal inference within pretense might work (pp. 418–419). We refer the reader to this article, where it can be readily seen that causal as well as logical inferences appear to respect and preserve the levels within a metarepresentation marked by decoupling.

This reformulation has two main implications for the "metarepresentational conjecture" as far as autism is concerned. First, it focuses our attention on the processing of metarepresentations, particularly on inferential processing. Second, Leslie (1987b) proposed a specific hypothesis about autistic impairment, namely that a mechanism (called the *expression raiser*) that creates metarepresentations by copying other representations was compromised. The revision we propose lessens the need for such a mechanism. Therefore, we reformulate and broaden the metarepresentational conjecture as follows.

The conjecture: Autistic children are impaired in their capacity to form and process metarepresentations. This impairment, in turn, impairs their capacity to acquire a theory of mind.

Frith (1989) considered in some detail what the possible consequences for the emotional life of the autistic child might be if this conjecture were true. Consider, for example, not being able to understand deception. Likewise, Frith also showed how a person's subjective experience of interacting with autistic children—the "feel" of the experience as Hobson puts it—can be understood from this point of view. In 1986, Fein, Pennington, Markovitz, Braverman, and Waterhouse (1986) drew attention to the gulf between the then-established cognitive deficits and the actual social impairments in autism. We believe the metarepresentational conjecture could bridge this gulf.

Several questions spring from this reformulation. For example, are autistic children impaired in metarepresentational capacity only as it relates to theory of mind, or do they also show deficits in understanding representations that are not mental? Are they more or less impaired in forming a metarepresentation (e.g., by inference) than they are in using a metarepresentation as a basis for further inference (entering it as a premise)? Do autistic children show sets of metarepresentational deficits, for example, affecting decoupled or primary parts of embedded representations or both (a representational deficit), affecting informational relations (a conceptual deficit), or affecting their inferential capabilities with metarepresentations (a processing deficit)?

Finally, we also recognize the need for much more information on the general inferential abilities and conceptual-knowledge-building capacities of autistic children (or, indeed, of any mentally retarded children). Some of these wider issues are considered by Frith (1989).

Answers to all these questions are not available yet, but they do seem empirically tractable, and to echo Rutter (1987), their

answers may be on the horizon. We see it as a realistic and exciting, if long-term, goal to investigate the nature and possible modular structure of the specific mechanisms underlying the development of commonsense theory of mind. The neuropsychology of autism may be an important part of this program. It may help researchers understand how specialized information-processing mechanisms can function as "engines" of development and how an impaired engine leads to impaired development.

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The recent disclosures of fraud in the conduct of research, reporting of research, or both in a number of scientific disciplines have prompted a widespread program of self-examination of publication practices and ethics.

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