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Understanding Drawings and Beliefs: a Further Test of the Metarepresentation Theory of Autism: a Research Note

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Abstract—Leslie (1987, *Psychological Review,* **94,** 412–426) proposed that the "theory of mind" deficit in autism was the result of a *metarepresentation* impairment. Studies employing False Photograph or Belief tests have shown that in autism the deficit is restricted to representing mental representations, and does not extend to representing pictorial representations. In this study, we tested this claim further using a False Drawing test. Subjects with autism performed at the same level as mentally handicapped or normal 4-year-old subjects on the False Drawing test, but significantly worse on the False Belief test. This confirmed the specificity of the deficit in autism.

Keywords: Autism, metarepresentation, theory of mind, drawing

People with autism show severe abnormalities in their social and communicative development (DSM-IIIR, 1987; Kanner, 1943). Recent experimental studies suggest that underlying these social and communication difficulties might be a specific cognitive deficit in the development of a *theory of mind* (Baron-Cohen, Leslie & Frith, 1985, 1986; Leslie & Frith, 1988; Baron-Cohen, 1989a, b; Perner, Frith, Leslie & Leekam, 1989; Sodian & Frith, 1992; Reed & Petersen, 1990; Harris, 1991).

What might cause the theory of mind deficit? Leslie (1987) suggested that there might be damage to the specific cognitive mechanism that underlies the development of a theory of mind, called the *metarepresentation capacity.* He defined this as the ability to represent an agent's mental attitude or "informational relation" (belief, thought, knowledge, etc.) towards a proposition. He has extended this theory in a series of articles and chapters (Leslie, 1988; Leslie & Frith, 1990; Leslie & Happé, 1989; Leslie, 1991).

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What kind of evidence would one need in order to test the metarepresentation theory of autism? One kind of evidence would come from tests of children's understanding of representations which are clearly *not* mental. Leslie's theory would predict that children with autism should have no difficulty in understanding such representations, if the deficit really is restricted to the domain of understanding mental representations.

Zaitchik (1990) devised an ingenious test to parallel the representational complexity of the False Belief test, but without involving representation of *mental* representations. She called it the False Photograph test. It simply tested if 3–4-year-old normal children have as much difficulty in representing non-mental representations as they seem to in representing mental representations. In the standard False Belief test (Wimmer & Perner, 1983), an object is moved from one location to another whilst a character is absent; when the character returns, the subject is asked to predict where the character will look for the object. In the False Photograph task, the experimenter takes a photograph of an object in one location, the object is then moved to another location, and the subject is then asked to predict where in the photograph the object will appear.

Zaitchik found the fascinating result that the majority of 3-year-old normal children failed both the False Photograph test and the False Belief test. This result suggests their failure on the False Belief test is not specifically due to the involvement of *beliefs*: rather, it may be something to do with understanding *representation* itself. Leekam and Perner's (1991) sample of normal 3-year-olds also found the False Photograph test as difficult as the False Belief test (thus confirming Zaitchik's result), but went on to show that subjects with autism had no difficulty at all with the False Photograph test, even though the majority of them still failed the False Belief test. This suggests that when it comes to representing *non-mental* representations, people with autism are unimpaired. Leslie and Thaiss (in press) replicated this finding. This supports Leslie's original proposal that there is a metarepresentation deficit in autism, restricted to the domain of understanding mental representations.

We felt these studies were sufficiently important to merit extending them to a new test involving understanding other non-mental representations. We selected drawings, on the grounds that drawings are, in production terms, simpler to understand than photographs—there is no "mystery" about how they are created. Furthermore, many normal 3-year-olds may have had little experience with cameras, whereas drawings are more familiar to them. On the other hand, since drawings allow representation of non-existent states of affairs, whilst photographs are (almost) always a reflection of *some* real state of affairs, we wondered if understanding drawings as representations might turn out to be more difficult than understanding photographs as representations. We were also unsure whether subjects with autism would perform identically on a False Drawing task and a False Photograph task, as various authors have questioned if people with autism produce drawings using qualitatively different representational strategies to people without autism (Selfe, 1977; Charman & Baron-Cohen, in press). Our False Drawing test (inspired by Pollack's (1989) study of normal children) is reported below. Finally, our study aimed to improve on the False Photograph studies in autism by including a control group of subjects with mental handicap, not tested in the earlier experiments. Such a control is held to be critical in establishing autism-specific deficits (Hermelin & O'Connor, 1970; Frith, 1989).

The Experiment

Subjects

There were 17 subjects with autism, all of whom had been diagnosed according to established criteria (DSM-III-R, 1987; Rutter, 1978). In addition, there were 14 subjects with mental handicap of uncertain aetiology but without autism, in order to control for mental age (MA) and chronological age (CA), and 20 children attending a normal school, in order to collect normative data. The sex ratio in the normal group and in the group with mental handicap was approximately 1:1, whilst in the group with autism it was approximately 2:1 (m:f). Details of the subjects are summarized in Table 1.

Table 1. Subject variables: Means, S.D.'s, and ranges of chronological age (CA) and mental age (MA)

Diagnostic groups	*N*		CA	Non-verbal MA*	Verbal MA†
Autism	17	Mean	13.6	7.9	5.3
		S.D.	3.9	2.0	2.0
		Range	6.1–18.0	4.5–11.2	2.9–9.4
Mental	14	Mean	14.5	4.9	4.2
handicap		S.D.	3.0	0.5	1.1
		Range	10.0–18.1	4.0–5.5	2.9–5.9
3-year-olds	10	Mean	3.5	—	—
		S.D.	0.87		
		Range	3.2–3.9		
4-year-olds	10	Mean	4.5		
		S.D.	0.87		
		Range	4.0–5.1		

*Ravens Matrices.
†BPVS.

The inclusion criterion for the clinical subjects was a verbal MA of at least 3-years-old, representing the lowest age at which normal children can meaningfully be tested on both a False Belief test (Wimmer and Perner, 1983) and a False Photograph test (Zaitchik, 1990). (In fact, two subjects had verbal MAs of 2.9 years, but were still included as this was close enough to the inclusion criterion. The rest all had verbal MA's higher than this.) Verbal MA was assessed using the British Picture Vocabulary Scale (BPVS: Dunn, Dunn, Whetton & Pintillie, 1982). Non-verbal MA was higher than verbal MA for the subjects with autism. This also meant that, if anything, the group with autism was functioning at a higher level than the group with mental handicap. Their higher MA ensured that any deficits in the group with autism could not be attributed to general developmental delay. Non-verbal MA was assessed using Raven's Coloured Progressive Matrices (Raven, 1956). Two subjects with autism and two from the mentally handicapped group refused to be tested on the Raven's.

For the normal group we assumed that MA would roughly correspond to CA. We divided our normal group into two age groups, 3-year-olds and 4-year-olds, in order to allow a further investigation of Zaitchik's (1990) Two Stage Model for normal children's understanding of non-mental representations: both Zaitchik (1990) and Leekam and Perner (1991) found that the majority of 3-year-olds perform at chance on the False Photograph test, whilst the majority of 4-year-olds clearly pass it. Would the same be true of normal children on a False Drawing test?

Procedure

Each subject was tested in a quiet room in his or her school. All subjects were given the False Drawing test during one test session, and then a False Belief test during a second test session. In additon, a

Control Test was administered either before or after the False Belief test, in order to test for memory or linguistic factors affecting performance on the False Belief test.

The False Drawing test

We first presented the subject with an object, and then asked the Naming Question (NQ) "What's this?". After the subjects had correctly named the object (which all of our subjects were able to do), the experimenter then said "OK, now let's draw the *x*". In one trial the experimenter did the drawing, and in a second trial the subject drew the object. The order of these trials were counterbalanced. In the conditions in which the experimenter did the drawing, the experimenter then said "Look. I've drawn a picture of the *x*", and showed the subject the picture. The drawing was then put to one side, face down. Next, the original object was removed, and replaced with a second object. At this point, the experimenter asked the Reality Question (RQ) "Now, what's this?", pointing to the new object. All subjects answered this correctly. The next question was a Memory Question (MQ) "What was here before?". Finally, before retrieving the drawing, the subject was asked the Drawing Question (DQ) "What is in the picture?". The two objects were either a toy brick and an orange (Trial 1), or a spoon and a pen (Trial 2).

Scoring and rationale for control questions

If we refer to the two objects as *x* and *y*, then correct answers to these four questions (NQ, RQ, MQ, and DQ) was *x, y, x, x*. In order to avoid the risk that subjects might fail the DQ simply because of alternating their response with each question, assuming a different answer to the previous question was wanted, we inserted a Filler Question between the MQ and the DQ. This was "What colour is the *y*? (Or what colour is your y? etc.)". The rationale for including the other control questions was to check that the stimuli were part of the subject's vocabulary, and that failure on the DQ was not simply due to the subject forgetting the first object. Our criterion for passing the DQ was passing on both trials.

The False Belief test

Subjects received a False Belief test similar to the one developed by Perner, Leekam and Wimmer (1987). The subject was shown a familiar milk carton and was asked "What do you think is inside this?". All the subjects said milk. The box was then opened and the subject was shown it really contained a green squash ball. The box was then closed again, and they were then asked "Now what do you think is inside this carton?". All of them said a ball. This confirmed that their belief had now changed. The subject was then asked the Belief Question "When I first asked you, before we opened the carton, what did you think was inside?". This was repeated on a subsequent trial, using a smarties tube with a pencil inside.

All subjects also received a Control task to ensure that they understood the questions in the False Belief task, and could remember past events. In the Control task, subjects were presented with a change in an object and were asked to recall the previous state of the object. Thus, subjects were shown a black box and the lid was then removed, revealing a small green wooden brick inside. The experimenter then asked what was inside the box and the subjects replied "A green brick". The experimenter then said "Let's take the green brick out and put this yellow one in". The box was then closed again, and the subjects were then asked "Now what's in the box?". All of them replied "A yellow brick". They were then asked the test question "When I first showed you the box, before we opened it, what was inside then?". The Control task functioned not only as a control for memory factors, but also linguistic factors surrounding the Test question of the False Belief task. It mirrors the Test question of the False Belief task in every way except for the inclusion of a mental state term.

Results

We will deal with the False Drawing test first. All subjects passed the RQ and NQ

on both trials. On the MQ, 5 subjects in the mentally handicapped group, 4 subjects in the autistic group, and 4 normal subjects scored less than two points*. The remainder of subjects passed all of the control questions. In Table 2 we report the results from those subjects who passed the test (i.e. who passed the DQ on both trials). As can be seen from Table 2, no significant differences emerged between the number of subjects in the groups with autism, mental handicap, and the normal 4-year-olds passing or failing the DQ (all comparisons, using the Fisher's Exact Probability Test, were $p > .05$). However, the normal 3-year-olds were significantly worse than the normal 4-year-olds (Fisher's Exact Test, $p < .03$). Passing or failing did not seem to be related to whether the subject or the experimenter did the drawing.

Table 2. Percentage of subjects in each group passing the False Drawing and False Belief tests

Diagnostic Groups	*N*	Drawing	Belief
Autism	17	70.6	29.4*
Mental Handicap	14	78.6	71.0
Normal 3-year-olds	10	40*	30*
Normal 4-year-olds	10	90	80

*$p < .04$.

Turning to the results of the False Belief test, we found that using the criterion of passing the Belief Question on both trials, the mentally handicapped and 4-year-old normal children did not differ from each other (Fisher's, $p > .05$). However, the mentally handicapped group and the 4-year-old normal children did differ from the group with autism and the 3-year-old normal children (all of these comparisons, using Fisher's, were $p < .04$). The group with autism did not differ from the 3-year-old normal children (Fisher's, $p > .05$). These results are also shown in Table 2.

Finally, all subjects passed the Control task, demonstrating that any failure on the False Belief task was unlikely to be due to either linguistic or memory factors *per se*. The pattern of results from the False Drawing and False Belief test its shown in Fig. 1.

The role of CA and MA

Analysis of the role of CA and MA in performance showed that, in the group with autism, the subjects who passed the False Drawing test did not differ significantly from those who failed it in terms of either CA ($t = 0.79$, 15d.f.) or verbal MA ($t = 0.16$, 15d.f.) or non-verbal MA (t = 0.48, 13d.f., all $p > .05$). However, those that passed the False Belief test differed from those who failed it in terms of verbal MA ($t = 2.25$,

*Whilst the errors on the Memory Questions were not predicted, they seemed to occur with equal frequency in all 3 groups of subjects. We thus felt they were unlikely to introduce any systematic bias into the results. However, as a precaution, we analysed performance on the Drawing Question only including those subjects who also passed both Memory Questions, but statistically the results stayed the same.

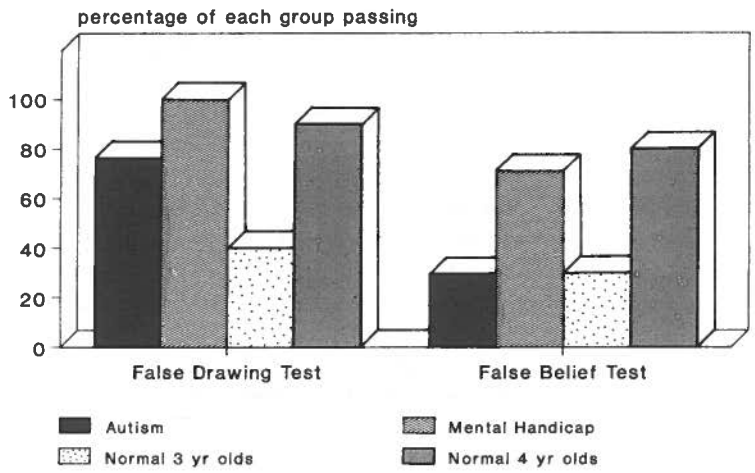

Fig. 1. False drawing vs false belief.

15d.f., $p < .04$) but not non-verbal MA ($t = 0.92$, 13d.f., $p > .05$) or CA ($t = 1.26$, 15d.f., $p > .05$). Nevertheless, there were subjects with autism with equally high verbal MA who failed the False Belief test, suggesting that by itself this is not a sufficient factor in accounting for success on this task.

In the group with mental handicap, those who passed the False Belief test all had an MA above 4-years-old, whilst those that failed did not. Finally, in the normal 3-year-old group, those that passed the False Drawing test were older than 3 years 8 months (with the exception of one subject of 3 years 4 months), whilst those who failed were younger than this.

Discussion

The present experiment tested if subjects with autism understand drawings as representations. In comparison with both nomal 4-year-old children and subjects with mental handicap of an equivalent verbal mental age, subjects with autism show no specific difficulties on our False Drawing test. This replicates Leekam and Perner's (1991) and Leslie and Thaiss' (in press) results from the False Photograph test for subjects with autism, and extends their result in showing intact understanding of a different non-mental representation, drawings. Taken together, these three studies firmly rule out that people with autism have a general impairment in the capacity for representing *all* representations, and supports Leslie's metarepresentation theory of autism, insofar as it claims the deficit is restricted to representing mental representations.

Normal 3-year-old children's poor performance on the False Drawing test matches their poor performance on the False Photograph test as reported by Zaitchik (1990). Indeed, she predicted that "although (normal 3-year-old) children might perform

better on a 'false' representation test using drawings, it still makes sense that they should have *some* difficulty'' (*ibid*, p.65), and our data support this prediction. Despite their apparent simplicity, drawings appear to pose similar comprehension demands to photos for young children. Our results also replicate Pollack's (1989) study who reported that 3-year-old normal children perform poorly on a false drawing task, compared to 4-year-olds.

Our data also replicate the finding that 3-year-old normal children and subjects with autism (but not 4-year-old normal children or subjects with mental handicap) manifest severe difficulties on False Belief tests (Baron-Cohen *et al.*, 1985; Wimmer & Perner, 1983). However, the subjects with autism alone showed a clear dissociation between performance on the two tests, passing the False Drawing test whilst failing the False Belief test. This mirrors Leekam and Perner's (1991) and Leslie and Thaiss' (in press) findings on a new task, and introduces the important contrast to subjects with mental handicap (not included in either of the earlier samples). Furthermore, whilst the False Drawing and False Belief tasks make different demands on language and memory, data from the Control Test suggests that the dissociation is unlikely to have been due to these factors. Quite why children with autism should find mental representations so much more difficult to understand than non-mental representations requires further research.

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References

Baron-Cohen, S. (1989a). The autistic child's theory of mind: a case of specific developmental delay. *Journal of Child Psychology and Psychiatry,* **30,** 285–298.

Baron-Cohen, S. (1989b). Are autistic children behaviourists? An examination of their mental–physical and appearance–reality distinctions. *Journal of Autism and Developmental Disorders,* **19,** 579–600.

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

Baron-Cohen, S., Leslie, A. M. & Frith, U. (1986). Mechanical, behavioural and intentional understanding of picture stories in autistic children. *British Journal of Developmental Psychology,* **4,** 113–125.

Charman, T. & Baron-Cohen, S. (in press). Drawing development in autism: the intellectual to visual realism shift. *British Journal of Developmental Psychology.*

De Myer, M. K. (1976). Motor, perceptual–motor and intellectual disabilities of autistic children. In L. Wing (Ed.) *Early childhood autism.* Oxford: Pergamon Press.

DSM-III-R (1987). *Diagnostic and statistical manual of mental disorders* (revised 3rd edn). Washington, DC: American Psychiatric Association.

Dunn, L., Dunn, L., Whetton, C. & Pintilie, D. (1982). *British Picture Vocabulary Scale.* Windsor, Berks: NFER: Nelson.

Frith, U. (1989). *Autism: explaining the enigma.* Oxford: Basil Blackwell.

Harris, P. (1991). The work of the imagination. In Whiten, A. (Ed.) *Natural theories of mind.* Oxford: Basil Blackwell.

Hermelin, B. & O'Connor, N. (1970). *Psychological experiments with autistic children.* London: Pergamon Press.

Kanner, L. (1943). Autistic disturbance of affective contact. *Nervous Child,* **2,** 217–250. Reprinted in Kanner, L. (1973). *Childhood psychosis: initial studies and new insights.* New York: John Wiley & Sons.

Leekam, S. & Perner, J. (1991). Does the autistic child have a theory of representation? *Cognition,* **40,** 203–218.

Leslie, A. M. (1987). Pretence and representation: the origins of "theory of mind". *Psychological Review,* **94,** 412–426.

Leslie, A. M. (1988). Some implications of pretence for mechanisms underlying the child's theory of mind. In J. Astington, P. Harris & D. Olson (Eds) *Developing theories of mind.* Cambridge: Cambridge University Press.

Leslie, A. M. (1991). The theory of mind deficit in autism: evidence for a modular mechanism of development. In Whiten, A. (Ed.) *Natural theories of mind.* Oxford: Basil Blackwell.

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

Leslie, A. M. & Frith, U. (1990). Prospects for a cognitive neuropsychology of autism: Hobson's choice. *Psychological Review,* **97,** 122–131.

Leslie, A. M. & Happé, F. (1989). Autism and ostensive communication: the relevance of metarepresentation. *Development and Psychopathology,* **1,** 205–212.

Leslie, A. M. & Thaiss, L. (in press). Domain specifity in conceptual development: evidence from autism. *Cognition.*

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

Perner, J., Leekam, S. & Wimmer, H. (1987). Three year olds' difficulty with false belief: the case for a conceptual deficit. *British Journal of Developmental Psychology,* **5,** 125–137.

Pollack, J. (1989). Children's understanding of "false" drawings. Unpublished manuscript, University of Oxford, Department of Experimental Psychology, South Parks Road, Oxford.

Raven, J. C. (1956). *Coloured Progressive Matrices.* London: H. K. Lewis & Co.

Reed, T. & Petersen, C. (1990). A comparative study of autistic subjects' performance at two levels of visual and cognitive perspective taking. *Journal of Autism and Developmental Disorders,* **20,** 555–568.

Rutter, M. (1978). Diagnosis and definition. In M. Rutter and E. Schopler (Eds) *Autism: a reappraisal of concepts and treatments.* New York: Plenum Press.

Selfe, L. (1977). *Nadia: a case of extraordinary drawing ability in an autistic child.* London: Academic Press.

Sodian, B. & Frith, U. (1992). Deception and sabotage in autistic, retarded and normal children. *Journal of Child Psychology and Psychiatry,* **33,** 591–606.

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.

Zaitchik, D. (1990). When representations conflict with reality: the preschooler's problem with false beliefs and 'false' photographs. *Cognition,* **35,** 41–68.