

## Do Children with Autism Use the Speaker's Direction of Gaze Strategy to Crack the Code of Language?

Simon Baron-Cohen, Dare A. Baldwin, and Mary Crowson

Normal toddlers infer the referent of a novel word by consulting the speaker's direction of gaze. That is, they use the Speaker's Direction of Gaze (SDG) strategy. This is a far more powerful strategy than the alternative, the Listener's Direction of Gaze (LDG) strategy. In Study 1 we tested if children with autism, who have well-documented impairments in joint attention, used the SDG or the LDG strategy to learn a novel word for a novel object. Results showed that although 70.6% of children with mental handicap passed the test by making the correct mapping between a novel word and a novel object, via the SDG strategy, only 29.4% of children with autism did so. Instead, their reliance on the LDG strategy led to mapping errors. In Study 2 a group of normal children, whose chronological age (24 months old) was equated with the verbal mental age of the 2 clinical groups in Study 1, was tested using a similar procedure. Results showed that 79% of this normal group passed the test by making the correct mapping between a novel word and a novel object using the SDG strategy. Taken together, the results from both studies suggest that children with autism are relatively insensitive to a speaker's gaze direction as an index of the speaker's *intention to refer*. This result is consistent with previous findings showing that children with autism are relatively "blind" to the mentalistic significance of the eyes. Discussion centers on how the absence of an SDG strategy might disrupt specific aspects of language development in autism.

### INTRODUCTION

#### Consulting Speakers' Gaze to Crack the Language Code

How does the young toddler, aged 12-18 months, crack the code of language? Given the classic problem that a novel word the child has just heard could refer to any one of the objects present in the current environment (Quine, 1960), how does the toddler come to make the correct mapping of word to object and avoid the massive confusion that would ensue from mismapping errors? Recent studies by Baldwin, Tomasello, and their associates (Baldwin, 1991, 1993a, 1993b; Tomasello, 1995, 1988; Tomasello & Barton, in press) suggest that a key strategy that normal children use to narrow down the possible search space of likely objects that a speaker might be currently referring to is the *speaker's direction of gaze*. Thus, if a speaker says "Dog!" while looking at a dog, upon hearing this word for the first time the child infers that because the speaker's gaze is currently directed toward the hairy thing on the rug, *that* is what is being picked out (rather than the armchair next to it, or the mantelpiece above it, and so on). For shorthand, we shall refer to this as the Speaker's Direction of Gaze (SDG) strategy.

Note that if a child did not use the SDG strategy, they would be thrown back on the alternative, namely, assuming that a novel word uttered by a speaker refers to the object that they (the listener) are currently looking at. For shorthand, we refer to this

as the Listener's Direction of Gaze (LDG) strategy. The LDG strategy, if utilized indiscriminately, would often lead to children making mapping errors, in which a word is mistakenly linked to an incorrect object. This is because in everyday speech parents naturally produce labels for objects other than those at the center of children's attention (Collis, 1977). It would seem that by about the age of 18 months, the normal toddler uses the LDG strategy only when they have reason to believe that the speaker is indeed engaged with them in jointly focusing on the same object (Baldwin, 1995).

Clearly, using the SDG strategy is not the only strategy the young toddler uses to crack the code, because they also seem to expect language to be constrained in other ways. For example, they behave as if they assume by default that a word will ordinarily refer to a whole rather than part of an object (the "whole object constraint" [Markman, 1989, 1992]), and that each object will have just one label (the "mutual exclusivity constraint" [Markman, 1989, 1992]). But the SDG strategy seems to be one important strategy that toddlers use.

#### Is the SDG Strategy Innate?

The SDG strategy appears to develop spontaneously, without explicit training or instruction from

parents. Parents do not announce to their infant, "look where I look when I utter a novel word" (because they wouldn't understand this anyway), nor do they teach their child to do this, as far as we know. It is likely that the SDG strategy as a linguistic tool arises from a more basic strategy, gaze-monitoring, which may have been shaped by natural selection directly. That is, the SDG strategy is probably not innate, but its source, gaze-monitoring, probably is, because gaze-monitoring in the extralinguistic context has high survival value (Baron-Cohen, 1994, 1995a, 1995b). It can tell you if another animal has selected you as its target, and can thus act as an "early warning system" against an attack from a potential predator or rival. It can also act as a cue that another animal has prosocial designs upon you (they might want to groom you, or mate with you, or communicate with you), which would be worth knowing. Another animal's gaze direction can act as a source of information about the environment—maybe the other animal has spotted something important out there that you have not seen (e.g., a food source, or a potential predator or mate [Whiten, 1991]). Finally, to whom an animal is looking is an index of social status among primates (Chance, 1956), so monitoring another animal's gaze direction is a rapid way of identifying who to defer to, and therefore how to avoid the conflict that would ensue from inadvertently upsetting the social hierarchy. The evolution of gaze-monitoring is discussed in detail elsewhere (Baron-Cohen, 1994, 1995a, 1995b).

#### Gaze Monitoring: One Facet of Joint Attention

In the human case, gaze-monitoring is part of the toddler's repertoire for establishing *joint attention* (Bruner, 1983). Joint attention behaviors are those behaviors that result in two individuals' focus of attention targeting the same object or event. Toddlers spontaneously produce joint attention behaviors from 9 to 14 months of age (Butterworth, 1991; Scaife & Bruner, 1975), and these include not only gaze-monitoring, but also the production of pointing and showing gestures—the "protodeclaratives" (Bates, Camaioni, & Volterra, 1975). This whole system, again, appears to have a strong innate component, in that the timing of development of joint attention seems to be universal. Cross-cultural differences, to the extent that they have been studied, have not been found (Bates, Benigni, Bretherton, Camaioni, & Volterra, 1979). This is suggestive evidence for a maturationist/genetic account, paralleling other universal developmental milestones such as walking (12–18 months), or first tooth loss (5–6 years).

A second clue that joint attention may be innate comes from studies of children with the neuropsychiatric condition of autism. Autism has a strong genetic basis in most cases (Bolton & Rutter, 1990). Such children show little if any joint attention (Baron-Cohen, 1989a; Leekam, Baron-Cohen, Brown, Perrett, & Milders, in press; Loveland & Landry, 1986; Phillips, Baron-Cohen, & Rutter, 1992; Sigman, Mundy, Ungerer, & Sherman, 1986), and a complete absence of joint attention at 18 months of age is predictive of a diagnosis of autism (Baron-Cohen, Allen, & Gillberg, 1992; Baron-Cohen et al., 1996). One possibility, then, is that there is a neurocognitive mechanism that normally allows the development of joint attention, and that is specifically impaired in autism. (See, e.g., the proposal of SAM, the Shared Attention Mechanism [Baron-Cohen, 1994, 1995a, 1995b].)<sup>1</sup>

#### Autism as a Window into Language Learning

To study how the normal child uses the SDG strategy to solve the puzzle of speakers' reference, we set out to assess children with autism as they hear a novel word. We reasoned that if the SDG strategy is the normal method for cracking the language code, then because children with autism show little if any gaze-monitoring, such children would be forced to use the less efficient LDG strategy, which should predict a high rate of mapping errors in their word learning.

The clinical literature certainly contains anecdotal reports of such mapping errors in the speech of autism. Typically they are called "metaphorical speech" (Kanner, 1973), although they are far from being genuine metaphors (Baron-Cohen, 1988; Tager-Flusberg, 1993). Thus, in Leo Kanner's (1973) original account of autism, he gives the following example:

"Peter eater" was another of Paul's "nonsensical," "irrelevant" expressions. It seemed to have no association with his experiences of the moment. His mother related that, when Paul was 2 years old, she once recited to him the

1. Baron-Cohen (1994) suggested that understanding gaze direction is one of the earliest markers of the child's recognition of intentionality, in that gaze is directed to something other than itself. In this respect, the deficit in autism in understanding the significance of gaze can be seen as part of the broader deficit in understanding intentionality—or, in employing a theory of mind (Baron-Cohen, 1989b, 1989c; Baron-Cohen, Leslie, & Frith, 1985; see Baron-Cohen, Tager-Flusberg, & Cohen, 1993). In the same vein, the joint attention deficit has been proposed as a precursor to the theory of mind deficit in that monitoring a person's attention is an example of monitoring a person's mental state (Baron-Cohen, 1989a, 1989d, 1991).

nursery rhyme about "Peter, Peter, pumpkin eater," while she was busy in the kitchen; just then she dropped the saucepan. Ever since that day, Paul chanted the words "Peter eater" whenever he saw anything resembling a saucepan. There was indeed, in the playroom, a stove on which sat a miniature pan. It was noted then that Paul, while saying these words, glanced in the direction of the stove and finally picked up the pan, running wildly around with it and chanting "Peter eater" over and over again. (Kanner, 1973, p. 46.)

A second class of language error commonly noted in autism is when the child uses his or her own private word to refer to an object, rather than the socially conventional usage. For example, we know of a child with autism who called a toy truck a "sausage." It is not clear whether such mapping errors are common or not in autism, but note that they are never produced by the normal 18-month-old child. In this case, the child's mother explained that the toddler had been playing with a toy truck when the mother said, "Tommy, come and eat your sausage." At the time, the child had been looking at his toy truck on the floor while the mother was facing away, looking at the plate of food on the table. The child had presumably failed to check the mother's direction of gaze, and so had learned the wrong association. He assumed that the object *he* (the listener) was looking at was the object being named. (This is the LDG strategy.) The situation that might give rise to such a mapping error is depicted in Figure 1, and reveals that in some instances, "metaphorical language" and "neologisms" in the speech of children with autism may have a common basis: use of the LDG rather than the SDG strategy to infer a speaker's intended referent.

### Experimental Studies

Such clinical anecdotes are clues that children with autism may not use the SDG strategy to infer a speaker's referent. Ultimately, however, carefully controlled experiments are needed to investigate this issue. The first of these was recently completed (Baron-Cohen, Campbell, Karmiloff-Smith, Grant, & Walker, 1995, Experiment 2). In that experiment, the child was shown two nonsense shapes and was asked, "Which one is the *beb*?" (a nonsense word). All children taking part in this experiment obligingly pointed to one of the shapes, in effect, guessing. They were then shown a cartoon face of Charlie, which was placed midway between the two nonsense shapes,

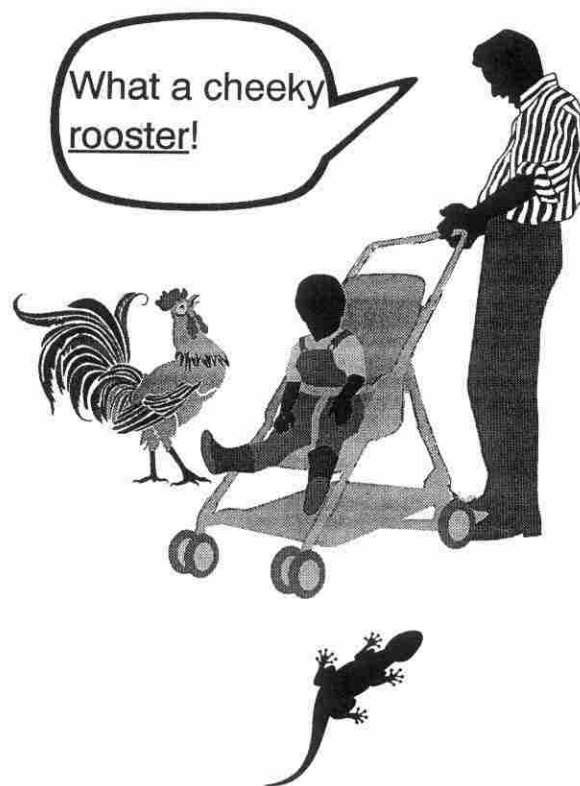


Figure 1 Child and adult (speaker) are both looking at different objects at the time the speaker uses a novel word to name a novel object. From Baldwin (1995).

slightly above them. The experimenter was careful to ensure that Charlie's eyes were pointing toward the shape the child had *not* named as the *beb*. The child was then asked, "Which one does Charlie say is the *beb*?" The results showed that 70% of normal children and 73% of children with mental handicap switched their response to indicate the shape that Charlie's eyes were looking at. In contrast, only 5% of children with autism did so. Instead, they asserted that Charlie would say the *beb* was the shape that they themselves had first pointed out. This egocentric error suggests that they may be relatively "blind" to the significance of a speaker's gaze direction as a cue to their intended reference.

In Study 1, we aimed to extend this finding in two ways. First, we wished to examine whether the autism-specific deficit in using the SDG strategy during novel word learning could be detected during a live interaction (using real humans rather than a cartoon depiction). Second, and related to this first aim, we wished to apply Baldwin's methodology to the study

of autism. This had been used solely with normal toddlers. Her method is described next.

#### Baldwin's Test of the SDG Strategy during Novel Word Acquisition

A very clear test of the normal toddler's active use of the SDG strategy in identifying a speaker's referent was reported by Baldwin (1993a, 1993b). In that test, children in three age groups were examined. The age groups were (1) 14- to 15-month-olds, (2) 16- to 17-month-olds, and (3) 18- to 19-month-olds. All children were shown two novel objects and heard the experimenter apply a novel label in one of two situations: (1) follow-in labeling, and (2) discrepant labeling. In both situations, the infant saw the two novel objects and was then given one of these to play with (henceforth "the child's toy"), while the other was placed in the palm of the experimenter's open hand (henceforth "the experimenter's toy").

In the *follow-in labeling* condition, the experimenter waited until the child was focused on the child's toy, and then the experimenter looked at the child's toy and uttered the label "toma." In the *discrepant labeling* condition, the experimenter also waited until the child was focused on his or her own toy, but then the experimenter looked at the experimenter's toy, uttering the label "peri." Thus in both conditions the child heard a novel label at a time when they were focused on a novel object. The only difference in the conditions was where the experimenter was looking at the time the label was produced.

Subsequently, the child was shown the two novel objects and asked comprehension questions, for example, "Where's the *toma*?" and "Where's the *peri*?" If the child selected his or her own toy after the discrepant labeling condition (i.e., if he or she used the LDG strategy), this would lead to a mapping error, and the child would be scored as failing the test. This could only happen if the child failed to use the SDG strategy: The two are mutually exclusive. If, however, the child selected the experimenter's toy after the discrepant labeling condition (i.e., they used the SDG strategy), this would ensure they avoided making the mapping error. Such a child would be scored as passing the test.

Baldwin's results showed that only the oldest group (18- to 19-month-olds) selected the correct object after both the follow-in and the discrepant labeling, indicating that by this age they instantly use the SDG strategy upon hearing the speaker utter a novel word. In Study 1, we adapted Baldwin's paradigm for use with two groups of participants: children with

autism, and children with mental handicap but without autism. The children with mental handicap were matched on verbal mental age to control for any effects of language delay, independent of autism-specific factors, that might affect results. We predicted that children with autism would use the LDG rather than the SDG strategy, and as a result would show a high rate of word-mapping errors.

## STUDY 1

### Method

#### Participants

Two groups of participants were tested. The first group was made up of 17 children with autism (12 males, 5 females), all attending one of two special schools for autism in the London area. They had all been diagnosed using established criteria (American Psychiatric Association, 1994). Their mean chronological age (CA) was 9 years, 2 months ( $range = 7;5-12;3$ ,  $SD = 2;3$ ). They were assessed on the Reynell Language Scale (Reynell & Huntley, 1987), and had a mean Language Expression age of 2;1 ( $SD = 1;3$ ), and a mean Language Comprehension age of 2;3 ( $SD = 1;1$ ). The second group of participants was made up of 17 children with mental handicap (but without autism), all attending a special education school in the London area. They were matched on sex (12 males, 5 females), CA ( $M = 9;1$ ,  $range = 7;7-12;0$ ,  $SD = 2;0$ ), Reynell Comprehension age ( $M = 2;2$ ,  $SD = 1;0$ ), and Reynell Expression age ( $M = 2;0$ ,  $SD = 1;4$ ). On none of these did they differ from the group with autism ( $t$  tests,  $p > .05$ ). The aetiology of their mental handicap was mixed or unknown. The two groups were deliberately selected for having low verbal MAs, because it is only at this level of language development that Baldwin's methodology had previously been used in normal samples.

#### Procedure

Each child was tested individually in a quiet room in their schools. Twenty-five percent of children were videotaped during testing, for later tests of reliability.

*Control pretest.* The child was first shown two familiar objects and was asked, "Which one is the [X]?" The familiar objects were drawn from a set of four: a book, a pencil, a brush, and a glove. If a child passed these two comprehension questions, then they proceeded to the main experiment. All participants passed this pretest.

*Test.* The child was then presented with two novel



objects, drawn from a set of four. All were unusual looking objects purchased from a hardware store. The experimenter then gave one of the two objects to the child (the child's toy), and kept the other (the experimenter's toy) in her hand, palm upward. In the *Discrepant* condition, the experimenter (a female) waited until the child was looking at the child's toy, and then she looked intently at the experimenter's toy and uttered the novel word (e.g., "*peri*"). This was repeated a second time. After this, *Comprehension* was tested as follows: The child was invited to put both objects into a small cloth bag. Then the experimenter asked the child to help her find something in the bag. The child and experimenter both looked into the bag, which contained the two novel objects just used, the two unused novel objects, and the two familiar objects that had been used in the pretest. The experimenter then looked at the child and said, "Can you help me find the *peri*?"

In the *Follow-in* condition, the experimenter again presented the child with two novel objects (the two that had not been used in the other condition). The experimenter again gave the child one of the objects (the child's toy), while keeping the other (the experimenter's toy) in her hand, palm upward. Again, she waited until the child was looking at the child's toy, but this time she too looked at the child's toy and uttered a different novel word to that used in the other condition ("*toma*"). This was repeated a second time. Again, after this, the child was invited to put both objects away in the cloth bag. Then, again, *Comprehension* was tested: The child was invited to help her find something in the bag, which contained the same six objects as before. In this condition, the experimenter said, "Can you help me find the *toma*?" The whole procedure took less than 10 min to run.

#### Counterbalancing and Randomization

Order of conditions was counterbalanced across the participants. (Because of the odd number of participants in each group, counterbalancing was in terms of eight children receiving one condition first, and nine receiving the other condition first.) In addition, the two familiar objects in the pretest were selected randomly from a pool of familiar objects. For the two novel objects labeled, for half the children one object was the *peri*, and for the other half the *toma* label was used for this same object. This assignment of labels was similarly counterbalanced with respect to experimental condition. Finally, children were assigned to the two orders of condition randomly.

**Table 1** Proportion of Each Group in Study 1 Passing Each Condition

	Discrepant Labeling	Follow-in Labeling
Autism	5 / 17 (29.4%)*	14 / 17 (82.35%)
Mental handicap	12 / 17 (70.58%)	15 / 17 (88.23%)

\*  $p < .04$ .

#### Control Question

After both conditions had been administered, participants were asked a Preference Control Question to ensure that their responses to the "Can you help me find . . ." questions were not just reflecting their preferences. This was worded as, "Which one do you like best?" There was no consistent relation between children's responses on the comprehension questions and their preferences.

#### Results

A pass was scored if the child correctly picked the experimenter's toy out of the bag after the discrepant condition and correctly named it in the posttest. All other combinations were scored as a fail. Results showed that 12 out of 17 children with mental handicap (70.6%) passed the test, whereas only 5 of 17 children with autism did so (29.4%). This group difference was highly significant,  $\chi^2(1) = 4.24$ ,  $p < .05$ . From chance alone, because the probability of picking the correct object by chance alone would be 0.166 (or 1 out of 6), we would expect 16.6% of each group to pass (or three participants out of 17). Therefore, the proportion of each group actually passing was compared to the proportion of each group expected to pass by chance. Analysis showed that although the proportion of children with autism passing did not differ significantly from chance levels,  $\chi^2(1) = 0.16$ , *ns*, the proportion of children with mental handicap passing was significantly above chance levels,  $\chi^2(1) = 7.64$ ,  $p < .01$ . The results by condition are summarized in Table 1.

An error analysis showed that the 12 children with autism who failed this test all chose the child's (novel) toy. The passers ( $n = 5$ ) did not differ from the failers ( $n = 12$ ) in either MA or CA (both *t* tests,  $p > .05$ ). Finally, we analyzed the number of children correctly identifying the child's novel toy after the follow-in condition. Fourteen out of 17 (82.35%) of children with mental handicap and 15 out of 17 (88.23%) of the children with autism passed this. These proportions were not significantly different (Fisher's Exact Probability Test, *ns*), but

both were significantly above chance (Fisher's,  $p < .05$ ).

### Reliability Coding

Approximately 25% of children (four from each group), randomly selected, were filmed during the experiment, and these tapes were coded by an independent rater who was blind to the hypotheses of the study. The raters were not blind to the diagnoses of the participants, because this was impossible to hide. In all cases it was very clear whether the word had been uttered when the child and experimenter were looking in the relevant directions, and which object a child picked out of the bag; thus interrater reliability was 100%.

### Discussion

This study tested whether children with autism use the normal strategy of inferring a speaker's intended referent by consulting the speaker's direction of gaze when the speaker used a novel word in the presence of two novel objects. That is, do they use the Speaker's Direction of Gaze (SDG) strategy? We found that although 70.6% of children with mental handicap correctly learned the mapping between a novel word and a novel object, under conditions when the novel word was uttered while the experimenter and the child were looking at *different* objects (so-called discrepant labeling), only 29.4% of children with autism did so. Instead, the majority of them used the alternative Listener's Direction of Gaze (LDG) strategy: They assumed that the novel label referred to the object they (the listener) had been looking at at the time the label was uttered, rather than referring to the novel object the speaker was looking at at the time it was uttered. Use of the LDG strategy thus led them to commit an egocentric mapping error. This was not due to a general failure to pick up word-object associations, as the children with autism performed at a high level in the "follow-in labeling" condition. This confirms our prediction about autism and the role that the joint attention deficit may play in disrupting language learning in this group.

However, a possible confound in interpreting these findings is that the SDG strategy has only been demonstrated in normal 18- to 19-month-olds, and the participants with autism had verbal MAs with a mean of around 24 months. Although unlikely, it is possible that in normally developing children with a verbal MA of 24 months the SDG strategy diminishes. If this is the case, the group with autism might

simply be showing an MA-appropriate pattern. We suspect this is unlikely simply because the mental handicap group had an equivalent MA, and yet did show the SDG strategy. Nevertheless, to check this possibility, we carried out a second experiment.

## STUDY 2

### Method

#### Participants

The participants were 24 normally developing toddlers, selected on the basis that their CA matched the mean verbal MA of the clinical groups in Study 1 ( $M = 24.4$  months,  $SD = 3.3$  months,  $range = 20-30$  months). They were all term at birth, showed normal development, were of monolingual background, and had no history of serious ear infection. These factors were checked because they can affect rate of language development.

#### Procedure

Children were first given the opportunity to play freely in the testing room at the University of Oregon (Psychology Department) to become acquainted with the experimenter and the surroundings. After about 10 min, the child was then seated at a table opposite the experimenter, with the parent seated some distance away. As in Study 1, each child received one trial of follow-in labeling, and one trial of discrepant labeling, the label being uttered twice in each trial. Order of condition was counterbalanced across children, as was assignment of toy pairs to conditions, assignment of target toys to condition, and assignment of novel labels to target toys across conditions. The method for both conditions exactly matched that of Study 1 and so is not repeated here.

In the Comprehension Test, the procedure differed marginally from that in Study 1 in that the two novel toys were placed inside a pouch, together with just the two familiar toys. This means that, whereas in Study 1 the child had to select the object from an array of six, in Study 2 the selection was from an array of four. This was because piloting with young normal children suggested that an array of six objects contained too much distraction. The experimenter showed the child the pouch, saying, "I'm gonna hide the [X]." Then, as the child peered into the pouch, the experimenter said, "See the [X]? Go get the [X]." The Naming Question was not asked with the normal group because many of them were unable to comprehend the force of the question. After the child had selected one of the toys from the pouch, the experi-

menter said, "Did you find it?" in a pleasant but neutral tone, and then dumped the remaining toys out of the pouch. After the child played with the toys for a short time, the four toys were again hidden in the pouch. The experimenter then asked the child to find one of the familiar objects in the pouch. Because there was no Naming Question, this whole procedure was repeated using a new hiding place (a cosmetics container) to be confident that the child had not picked out the object correctly by chance alone. Assignment of novel and familiar toys to the right versus left side in the pouch or cosmetics container was counterbalanced.

## Results and Discussion

A pass was defined as the child correctly choosing the experimenter's novel toy out of a choice of two novel toys, on at least one trial, after the Discrepant Labeling condition. Using this criterion, 19 out of 24 (79%) of the participants passed. If we assume chance performance was 50% (because the child had to choose between two objects on each Comprehension Test), this is a significantly higher proportion of children passing than one would expect from chance alone,  $\chi^2(1) = 18.88, p < .00005$ . In addition, 17 out of 24 (74%) passed the Follow-in Labeling condition, which again was significantly better than chance,  $\chi^2(1) = 12.19, p < .0005$ . Because this is in line with previous studies using younger children, we can conclude that the SDG strategy persists at least until the age of 24 months of age in the normal case, or until a verbal MA equivalent of this. We now turn to a general discussion of these two studies.

## GENERAL DISCUSSION

In Study 1, we tested whether children with autism used the SDG strategy on hearing a novel word uttered in the presence of two novel objects. The SDG strategy is when the child looks up at the speaker's face when hearing the novel word, and uses the speaker's gaze direction to correctly infer the speaker's intended referent for the novel word. We found that, whereas 70.6% of children with mental handicap (and without autism) showed this effect, only 29.4% of a group of children with autism did so. Instead, they used the LDG (Listener's Direction of Gaze) strategy: They assumed the novel word referred to the object they themselves had been looking at at the time of hearing it. This led them to commit an egocentric mapping error. This replicates a finding

from Baron-Cohen et al. (1995) using a cartoon method, and extends this by showing how, in a real social situation and with a live face, children with autism fail to use a person's gaze direction to infer their intended referent. This is further support for the idea that children with autism are relatively "blind" to the mentalistic significance of the eyes (*ibid.*).

It is important, however, to consider some possible counterarguments to this conclusion. First, might it be that the lack of the SDG strategy in autism<sup>2</sup> was due to the group's verbal MA level? This possibility can be ruled out both by the inclusion of the group with mental handicap in Study 1, and by the group of normally developing 24-month-olds in Study 2. In both cases, these groups had a similar verbal MA to the group with autism, and yet the SDG strategy was strongly in evidence. Second, might the lack of an SDG strategy in autism be due to a failure to learn word-object associations? This is also clearly ruled out in that, under the Follow-in Labeling condition, where an LDG (egocentric) mapping strategy would actually lead to a "pass," the children with autism all learned the association between the novel word and the novel object. Rather, the results are most parsimoniously explained in terms of the child not spontaneously "decentering" away from his or her current percept to check the speaker's current percept.

Note that this egocentric error would be predicted not only by the theory of mind/joint attention hypothesis, but also by the executive function hypothesis (Ozonoff, 1995; Russell, 1996), in that executive function is held to involve disengaging from the salience of reality. We suggest that this explanation is unlikely to hold in a general form, however, because there are several experiments in which disengaging from reality is required, yet on which children with autism show no impairment. These include the false photograph task (Leekam & Perner, 1991; Leslie & Thaiss, 1992; Swettenham, Gomez, Baron-Cohen, & Walsh, 1996), the false drawing task (Charman & Baron-Cohen, 1992), the false model task (Charman & Baron-Cohen, 1995), the false map task (Leslie & Thaiss, 1992), and visual perspective-taking tasks (Baron-Cohen, 1989a; Hobson, 1984; Tan & Harris, 1991). There may well be an executive dysfunction in autism (see Baron-Cohen & Swettenham, *in press*; Bishop, 1992), but an inability to disengage from reality does not seem to be evident in a strong

2. We use the phrase "lack of the SDG strategy in autism" while acknowledging that this description of our results goes a little beyond the evidence presented. Strictly speaking, what we have found is the domination of the LDG over the SDG strategy.

form. In the final section of this article, we turn to consider the implications of the present findings for language development in autism.

### How Might a Lack of the SDG Strategy Disrupt Language Development in Autism?

From the outset, we should recognize that if a child lacked the SDG strategy, this would not necessarily disturb all aspects of language. For example, syntactic development may be relatively independent of such social factors (Pinker, 1994). Nevertheless, the SDG strategy might be expected to play a key role in certain aspects of language, such that if a child lacked this, subtle language deficits might be expected. Which kind of deficits?

The first and most likely aspect would be the development of a shared vocabulary. Without an SDG strategy, the child-as-language-learner would be forced to use the alternative LDG strategy (to repeat: assuming that the object the listener is attending to when hearing a new word is the referent). Although this might in fact coincide with the speaker's intended referent in the majority of cases (and thus lead the child to acquire a reasonable, shared vocabulary), the LDG strategy would also lead to errors, specifically, in those instances where the speaker's focus of attention is different from that of the child. We suggest, then, that the first feature of autistic language that this might explain would be the production of some words being used in *unconventional* ways. In the introduction we gave some examples of these, and several clinical accounts include these.

Second, and more speculatively, one might expect that lacking the SDG strategy would slow down the rate of vocabulary development. If it is the case that the normal child "cracks the language code" via the SDG strategy, such that a single utterance of a novel word is correctly mapped onto its referent, vocabulary development will proceed as virtual one-trial learning. In contrast, the young child with autism using the LDG strategy would be led to many false starts, conflicting information, and confusion.

Consider this example. If a child first hears the word "computer" when Daddy is sitting at his desk at home typing away, and the child is looking at his or her toy bricks on the floor, the LDG strategy would lead to the mapping ["computer" = bricks]. If the same child next hears the word "computer" when Mummy is in her office, and the child is looking at the goldfish tank, the child would search his or her lexical memory, retrieve the item "computer," which would produce the interpretation "bricks"; but then,

not finding any bricks in his or her current perceptual field, the child would delete the mapping ["computer" = bricks], and substitute this with ["computer" = goldfish]. After several more mismappings of this kind, one might expect the child to lose some motivation for vocabulary acquisition, and turn to more predictable aspects of the environment.<sup>3</sup> Because language delay is a defining feature of autism (American Psychiatric Association, 1994), the lack of the SDG strategy may be an important contributory factor in causing this.<sup>4</sup> We recognize, however, that *lexical* development is not specifically impaired in autism, relative to *syntactic* development (Tager-Flusberg et al., 1991), so it is likely that other factors are also involved in the cause of their language delay.

In closing, we reiterate our view that the lack of the SDG strategy in young children with autism is ultimately part of a joint-attention deficit. In the language domain, it suggests an inability by children with autism to understand that language exists primarily as a means to establish a *joint topic*, with a view to sharing *comments* on the topic. The topic-comment distinction in language is a traditional and fundamental one that is drawn by most theorists. Here we emphasize that identifying a topic can be done socially or privately. To do this socially presumes a capacity for joint attention. Note that topics can also be identified and commented on socially without language. For example, the topic can be identified for the other person by *pointing* with the index finger (or with the eyes) at an object, or by *showing* an object to someone, and commenting can be achieved by *facial expression* (surprise, disgust, fear, and so on). Children with autism not only fail to check the speaker's verbal topic via the SDG strategy, but, as mentioned in the introduction, they also do not spontaneously produce the declarative forms of the pointing and showing gestures (Baron-Cohen, 1989a; Baron-Cohen et al., 1992, 1996; Sigman et al.,

3. For the LDG strategy user, there is a further strategy available, namely, the Common-Feature (CF) strategy. The child in the above example, on discovering ["computer" = bricks] and ["computer" = goldfish] could, using the CF strategy, search for common features of both situations, and eventually correctly deduce that ["computer" = computer], because this was the only common feature of the bricks and goldfish situations. However, although the CF strategy would be effective in eventually ironing out mapping errors, it is clearly not as efficient as the SDG strategy, and so should still lead to some delay in vocabulary development.

4. Frith and Happe (1994) make a related argument that theory of mind deficits may be sufficient to cause language delay in autism. Here we suggest there are specific language learning strategy deficiencies that might cause this.



1986). For these reasons, it is likely that the present results are part of a deeper deficit in sharing a focus of attention both verbally and nonverbally.<sup>5</sup>

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## ADDRESSES AND AFFILIATIONS

Corresponding author: Simon Baron-Cohen, Departments of Experimental Psychology and Psychiatry, University of Cambridge, Downing Street, Cambridge CB2 3EB, United Kingdom; e-mail: sb205@cus.cam.ac.uk. Dare A. Baldwin is at the University of Oregon, and Mary Crowson is at the University of Miami, Coral Gables.

## REFERENCES

- American Psychiatric Association. (1994). *Diagnostic and Statistical Manual of Mental Disorders*, 4th ed. (DSM-IV). Washington, DC: American Psychiatric Association.
- Baldwin, D. (1991). Infants' contribution to the achievement of joint reference. *Child Development*, 62, 875-890.
- Baldwin, D. (1993a). Infants' ability to consult the speaker for clues to word reference. *Journal of Child Language*, 20, 395-418.
- Baldwin, D. (1993b). Early referential understanding: Infants' ability to recognize referential acts for what they are. *Developmental Psychology*, 29, 832-843.
- Baldwin, D. (1995). Understanding the link between joint attention and language acquisition. In C. Moore & P. Dunham (Eds.), *Joint attention: Its origins and role in development*. Hillsdale, NJ: Erlbaum.
5. Given the importance of joint attentional deficits in autism, we would encourage future studies to include video-recording to enable more fine-grain analysis than was possible in the present study.
- Baron-Cohen, S. (1988). Social and pragmatic deficits in autism: Cognitive or affective? *Journal of Autism and Developmental Disorders*, 18, 379-402.
- Baron-Cohen, S. (1989a). Perceptual role-taking and proto-declarative pointing in autism. *British Journal of Developmental Psychology*, 7, 113-127.
- Baron-Cohen, S. (1989b). 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. (1989c). Are autistic children behaviorists? An examination of their mental-physical and appearance-reality distinctions. *Journal of Autism and Developmental Disorders*, 19, 579-600.
- Baron-Cohen, S. (1989d). Joint attention deficits in autism: Towards a cognitive analysis. *Development and Psychopathology*, 1, 185-189.
- Baron-Cohen, S. (1991). Precursors to a theory of mind: Understanding attention in others. In A. Whiten (Ed.), *Natural theories of mind*. Oxford: Basil Blackwell.
- Baron-Cohen, S. (1994). How to build a baby that can read minds: Cognitive mechanisms in mindreading. *Cahiers de Psychologie Cognitive [Current Psychology of Cognition]*, 13(5), 513-552.
- Baron-Cohen, S. (1995a). The Eye-Direction Detector (EDD) and the Shared Attention Mechanism (SAM): Two cases for evolutionary psychology. In C. Moore & P. Dunham (Eds.), *The role of joint attention in development*. Hillsdale, NJ: Erlbaum.
- Baron-Cohen, S. (1995b). *Mindblindness*. Cambridge, MA: MIT Press/Bradford Books.
- Baron-Cohen, S., Allen, J., & Gillberg, C. (1992). Can autism be detected at 18 months? The needle, the haystack, and the CHAT. *British Journal of Psychiatry*, 161, 839-843.
- Baron-Cohen, S., Campbell, R., Karmiloff-Smith, A., Grant, J., & Walker, J. (1995). Are children with autism blind to the mentalistic significance of the eyes? *British Journal of Developmental Psychology*, 13, 379-398.
- Baron-Cohen, S., Cox, A., Baird, G., Swettenham, J., Drew, A., Nightingale, N., Morgan, K., & Charman, T. (1996). Psychological markers of autism at 18 months of age in a large population. *British Journal of Psychiatry*, 168, 158-163.
- 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., & Swettenham, J. (in press). The theory of mind hypothesis of autism: Relationship to executive function and central coherence. In D. Cohen & F. Volkmar (Eds.), *Handbook of autism and developmental disorders*, 2d ed. New York: Wiley.
- Baron-Cohen, S., Tager-Flusberg, H., & Cohen, D. J. (Eds.). (1993). *Understanding other minds: Perspectives from autism*. Oxford: Oxford University Press.
- Bates, E., Benigni, L., Bretherton, I., Camaioni, L., & Volterra, V. (1979). Cognition and communication from 9-13 months: Correlational findings. In E. Bates (Ed.), *The emergence of symbols: Cognition and communication in infancy*. New York: Academic Press.

- Bates, E., Camaioni, L., & Volterra, V. (1975). The acquisition of performatives prior to speech. *Merrill-Palmer Quarterly*, 21, 205–226.
- Bishop, D. (1992). Autism and frontal-limbic functions. *Journal of Child Psychology and Psychiatry*, 34, 279–294.
- Bolton, P., & Rutter, M. (1990). Genetic influences in autism. *International Review of Psychiatry*, 2, 67–80.
- Bruner, J. (1983). *Child's talk: Learning to use language*. Oxford: Oxford University Press.
- Butterworth, G. (1991). The ontogeny and phylogeny of joint visual attention. In A. Whiten (Ed.), *Natural theories of mind*. Oxford: Basil Blackwell.
- Chance, M. (1956). Social structure of a colony of *Macaca mulatta*. *British Journal of Animal Behavior*, 4, 1–13.
- Charman, T., & Baron-Cohen, S. (1992). Understanding beliefs and drawings: A further test of the metarepresentation theory of autism. *Journal of Child Psychology and Psychiatry*, 33, 1105–1112.
- Charman, T., & Baron-Cohen, S. (1995). Understanding models, photos, and beliefs: A test of the modularity thesis of metarepresentation. *Cognitive Development*, 10, 287–298.
- Collis, G. (1977). Visual coorientation and maternal speech. In H. Schaffer (Ed.), *Studies in mother-infant interaction*. London: Academic Press.
- Frith, U., & Happe, F. (1994). Language and communication in autistic disorders. *Philosophical Transactions of the Royal Society of London*, 346, 97–104.
- Hobson, R. P. (1984). Early childhood autism and the question of egocentrism. *Journal of Autism and Developmental Disorders*, 14, 85–104.
- Kanner, L. (1973). *Childhood psychosis: Initial studies and new insights*. New York: Wiley.
- Leekam, S., Baron-Cohen, S., Brown, S., Perrett, D., & Milder, M. (in press). Eye-direction detection: A dissociation between geometric and joint-attention skills in autism. *British Journal of Developmental Psychology*.
- Leekam, S., & Perner, J. (1991). Does the autistic child have a metarepresentational deficit? *Cognition*, 40, 203–218.
- Leslie, A. M., & Thaiss, L. (1992). Domain specificity in conceptual development: Evidence from autism. *Cognition*, 43, 225–251.
- Loveland, K., & Landry, S. (1986). Joint attention and language in autism and developmental language delay. *Journal of Autism and Developmental Disorders*, 16, 335–349.
- Markman, E. (1989). *Categorization and naming in children: Problems of induction*. Cambridge, MA: MIT Press.
- Markman, E. (1992). Constraints on word learning: Speculations about their nature, origins, and domain specificity. In M. Gunnar & M. Maratsos (Eds.), *Minnesota Symposium on Child Psychology* (Vol. 25, pp. 59–101). Hillsdale, NJ: Erlbaum.
- Ozonoff, S. (1995). Executive functions in autism. In E. Schopler & G. Mesibov (Eds.), *Learning and cognition in autism*. New York: Plenum.
- Phillips, W., Baron-Cohen, S., & Rutter, M. (1992). The role of eye-contact in the detection of goals: Evidence from normal toddlers, and children with autism or mental handicap. *Development and Psychopathology*, 4, 375–383.
- Pinker, S. (1994). *The language instinct*. New York: Penguin.
- Quine, W. (1960). *Word and object*. Cambridge, MA: MIT Press.
- Reynell, J., & Huntley, M. (1987). *Reynell Developmental Language Scales*. Windsor: NFER.
- Russell, J. (1996). "At two with Nature": Agency and the development of self-world dualism. In J. Bermudez, A. Marcel, & N. Eilan (Eds.), *The body and the self*. Cambridge, MA: MIT Press/Bradford Books.
- Scaife, M., & Bruner, J. (1975). The capacity for joint visual attention in the infant. *Nature*, 253, 265–266.
- Sigman, M., Mundy, P., Ungerer, J., & Sherman, T. (1986). Social interactions of autistic, mentally retarded, and normal children and their caregivers. *Journal of Child Psychology and Psychiatry*, 27, 647–656.
- Swettenham, J., Baron-Cohen, S., Gomez, J.-C., & Walsh, S. (1996). What's inside a person's head? Conceiving of the mind as a camera helps children with autism develop an alternative theory of mind. *Cognitive Neuropsychiatry*, 1, 73–88.
- Tager-Flusberg, H. (1993). What language reveals about the understanding of minds in children with autism. In S. Baron-Cohen, H. Tager-Flusberg, & D. J. Cohen (Eds.), *Understanding other minds: Perspectives from autism*. Oxford: Oxford University Press.
- Tan, J., & Harris, P. (1991). Autistic children understand seeing and wanting. *Development and Psychopathology*, 3, 163–174.
- Tomasello, M. (1988). The role of joint-attentional processes in early language acquisition. *Language Sciences*, 10, 69–88.
- Tomasello, M. (1995). Joint attention as social cognition. In C. Moore & P. Dunham (Eds.), *Joint attention: Its origins and role in development*. Hillsdale, NJ: Erlbaum.
- Tomasello, M., & Barton, M. (in press). Learning words in non-ostensive contexts. *Developmental Psychology*.
- Whiten, A. (Ed.). (1991). *Natural theories of mind*. Oxford: Basil Blackwell.