CPC, 1994, 13 (5), 695-705

COMMENTARY ON "COGNITIVE MECHANISMS IN MINDREADING" (S. BARON-COHEN)

The eyes as a window: What young chimpanzees see on the other side

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Les yeux! These "distinctive orbs" bear down upon us with such great intensity that can they cause us to break away from others in fear or shame, or conversely, lunge forward in hopeless, headstrong love. What another person thinks, wants, feels, are all read off of the eyes with virtually no effort at all. The eyes are almost literally a window into the private minds of others. Indeed, the eyes are so thoroughly associated with mental activity that as adults we can hardly escape the inference that the one who sees knows, or that the one who is looking is attending. Seeing is equated with both knowing and attending.

But has this always been so? That is, has the attraction and use of the eyes of others always been isomorphic with reading their minds, or can we think of developmental and/or evolutionary dissociations between reading eyes and reading minds? Baron-Cohen addresses both ends of this question in his intriguing recipe (hypothesis) for creating infants that can "read minds." He assumes the existence of two brain modules (the Intentionality Detector and the Eye Direction Detector), and argues for the development of two additional ones in the course of the child's early years (the Shared Attention Mechanism, and the more widely dis-

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cussed Theory of Mind Module). His argument is that an evolutionary and developmentally primitive Eye Direction Director can be coupled with a Shared Attention Mechanism to "trigger" (an existing?) Theory of Mind Module.

The focus of our commentary centers around whether there is really evidence of a Shared Attention Mechanism in humans infants by 9-14 months of age. In doing so, we do not question the existence *per se* of brain modules that evolved for the purpose of extracting useful information from the eyes of others. Nor do we question the fact that by 14 months of age infants are acting *as if* they appreciated the existence of a shared attentional focus with adults. Rather, we question whether the evidence for joint visual attention (i.e., turning to look where someone else is looking, or gaze-following) is unique evidence of a system which understands the presence of the mental state of attention behind the eyes which do the looking. We admit up front that we shall do this is in a rather peculiar manner; we show that young chimpanzees display gaze-following, but yet display no comprehension of the intentional significance of that gaze. Baron-Cohen takes evidence of gaze-following in human infants (e.g., Scaife & Bruner, 1975) as among the clearest evidence for joint-attention, and hence the presence of the hypothesized Shared Attention Mechanism. But we hypothesize that these two systems can be dissociated; that is, gaze-following may occur quite independent of understanding the attention that lies behind the eyes. Of course, demonstrating that the two can be dissociated in chimpanzees does not prove that they are in 9-14 month-old human infants. On the other hand, it does eliminate the Scaife/Bruner effect as being used as *unique* evidence for the infants comprehension of shared attention. We suspect that other eye-directed behaviors in human infants (and chimpanzees) can be accounted for in similar terms.

What young chimpanzees (don't) know about seeing

We recently completed a series of more than a dozen studies with seven 5- to 6-year-old chimpanzees, in which we explored if they understand seeing as a subjective mental event that connects organisms to the external world (Povinelli & Eddy, unpublished manuscript). Such an understanding that seeing is 'about' something would seem to qualify as a logical prerequisite for understanding how the subjective experience of attention can be shared via visual gaze. Flavell (1988) has argued that by 2 to 3 years of age children understand that they and others can be

"cognitively connected" to objects and events in the world. In an extended series of studies Flavell and his colleagues discovered that by 2½ years young children appear to understand that others are subjectively connected to the world through visual perception (Flavell, 1974; Lempers, Flavell, & Flavell, 1977; Flavell, Flavell, Green, & Wilcox, 1980; Flavell, Shipstead, & Croft, 1978; Flavell, Everett, Croft, & Flavell, 1981).

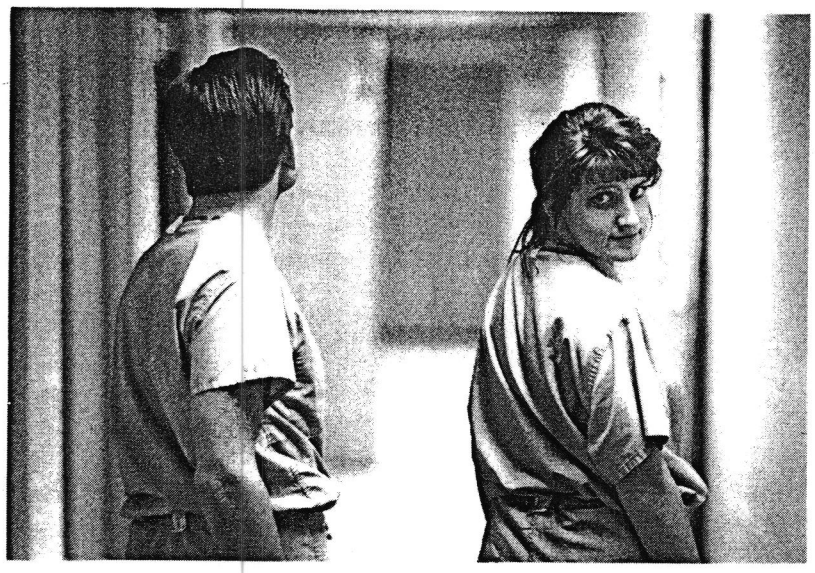
Our strategy to test the chimpanzees for this kind of subjective understanding of visual perception was straightforward. First, we assumed that the most salient kind of eye contact for most organisms occurs when another organism is looking in their direction. Thus, we devised a simple situation to ask the chimpanzees if they possessed a disposition to request food from someone who was looking, versus someone who was not. We first trained our chimpanzees to use their natural begging gesture (extended arm with palm up) to request food from one trainer who was situated in one of two locations, equidistant from the chimpanzees. Soon, the subjects were perfect at entering the test room, orienting to the correct side, and gesturing toward the trainer. Second, we established that before any learning could occur, when the chimpanzees were confronted with two trainers occupying both positions, one holding out a cookie and the other holding out a block of wood, the chimpanzees would gesture to the one holding food on all trials. Thus, in a situation which did not require them to reason about mental states, the chimpanzees could easily choose between two trainers. This particular finding was not all that surprising, but it did allow us to progress further and ask: who would the chimpanzees gesture to if they entered the test room and occasionally were confronted with two trainers, one who could not see them (for example, because they had a blindfold over their eyes), and one who could see them (because their blindfold was covering their mouth)?

Across 14 separate studies of the type described above, we obtained little evidence that our young chimpanzees preferred to gesture in front of a trainer who could see them (Povinelli & Eddy, unpublished manuscript). We tried a number of situations in which visual deprivation was achieved by use of familiar objects: (blindfolds over the eyes, cardboard screens obscuring one of the trainer's faces, a bucket covering one of the trainer's heads). We also tried a number of situations involving natural treatments (one trainer facing forward, the other facing backwards; both trainers facing backwards, but one looking over their shoulder toward the subject; one trainer covering the eyes with their hands, the other covering their ears; one trainer with their eyes open,

the other with their eyes closed). In all but one of the eight treatments we administered, the chimpanzees initially performed as if they had no idea that one of the trainers was 'connected' to them (because he or she could see them) and the other was not. A particularly dramatic case in point of their absence of comprehension occurred in the initial looking-over-the-shoulder trials (see Figure 1a) in which the subjects performed completely randomly, despite the fact that they performed perfectly on surrounding control trials involving only one trainer, or two trainers with one offering food the other offering a block of wood (Figure 1b). The sole exception was in the back-versus-front condition (Figure 2), but other results strongly suggest that the chimpanzees were using an unrelated rule to solve this problem – a rule they had learned during the initial training phase. We tentatively concluded that young chimpanzees do not appreciate the role of the eyes in mentally grounding organisms to the external world. Of course, our findings leave open the possibility that older chimpanzees may develop this understanding of visual perception. In addition, our results do not exclude the possibility that despite their difficulty with understanding the exact role of visual perception in attentional processes, young chimpanzees may possess an 'amodal' theory of attention in which the subjective focus of others is determined not by eye contact or gaze alone, but by other behavioral parameters of interest such as body and head orientation.

Tracking gaze without tracking attention

Given our results, we realized we were in a position to attempt to determine if the Scaife/Bruner effect (interpreted by Baron-Cohen as evidence of joint-attention) is really evidence of an understanding of the attentional significance of gaze direction. In other words, we sought to determine (among other things) if tracking line-of-regard could be dissociated from an intentional understanding of visual perception. In order to test this, we administered our typical procedures to the subjects, but instead of occasionally confronting them with trials in which one trainer could see and the other could not see, we confronted them with occasional trials in which one trainer was attending and the other was distracted. Thus, on predetermined probe trials, the subjects entered the room and saw two trainers configured as shown in Figure 3a. As the dissociation hypothesis predicted, the subjects entered the room and turned their heads and looked up to track the trainer's gaze. As a group, they showed this effect on 61% of all probe trials – a rate 9 times higher



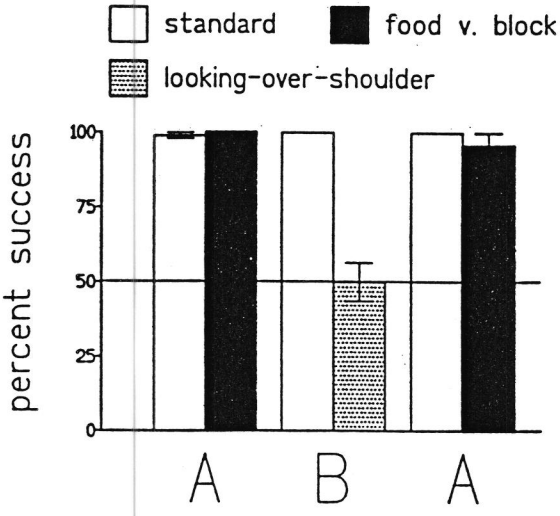


Figure 1. (a) Looking-over-shoulder treatment; one of eight treatments used to determine if young chimpanzees will request help from the trainer who can see them; (b) Results from looking-over-shoulder treatment. Subjects (N=7) were perfect on **standard** *trials involving one trainer standing passively on either the right or left, and on choosing between two trainers, one offering food versus one offering block of wood. The same subjects chose randomly when choosing between one trainer looking over his or her shoulder (and hence who could see them) and one who was facing away (and hence could not see them) (data summarized from Experiment 3, Povinelli & Eddy, unpublished manuscript). Dotted line represents chance level performance. Bars represent the average scores of the seven animals, for either 4 (food v. wood, looking-over-shoulder) or 8 (standard) trials, ± SEM.*

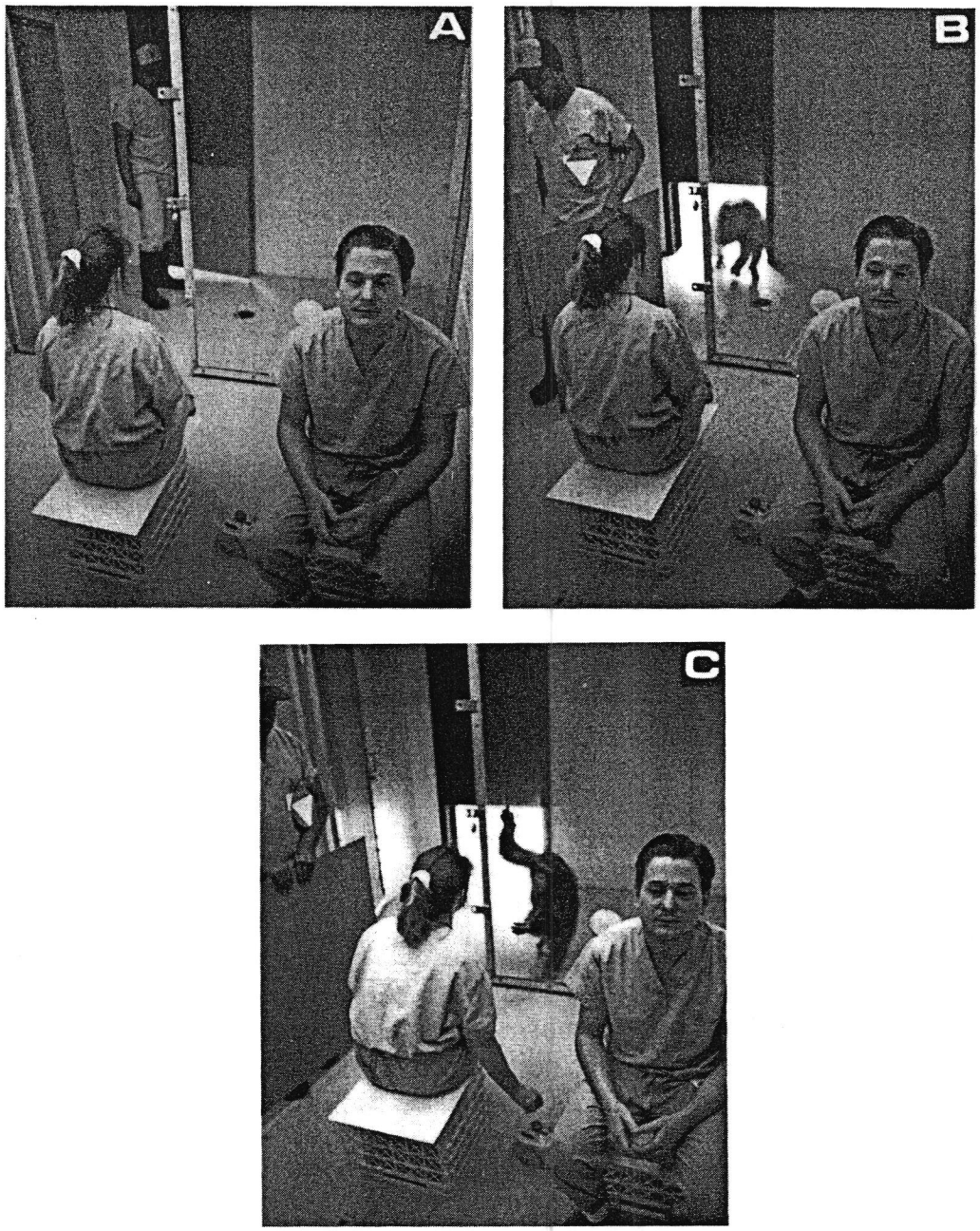


Figure 2. Young chimpanzee choosing between one trainer facing them and another facing away. Although as a group the subjects were correct from trial 1 forward in this treatment, it was the only one of eight treatments in which they showed a disposition to request food from the trainer who could see them. Additional experiments revealed that their preference here was probably not due to an appreciation of visual perception.

than ambient glances on surrounding control trials ($p < .0001$; details of the methodology, blind coding of videotapes, and statistical tests are provided in Povinelli & Eddy, unpublished manuscript). *Nonetheless, despite their obvious tracking of the trainer's line of regard, none of the subjects showed a discrimination when it came to requesting food from one of the trainers!* In other words, although the subjects responded *as if* they understood that the distracted trainer's attention was focused at a point somewhere at the end of their line-of-regard, when it came to choosing between this distracted trainer and another who was attending, the chimpanzees behavior revealed that they did not really appreciate the 'connectedness' dimension of visual perception at all.

Were the chimpanzees somehow disoriented after tracking the gaze of the distracted trainer and thus unable to respond appropriately? We tested this by conducting a separate manipulation in which the subjects were confronted on predetermined trials with two trainers configured as in Figure 3b – that is, a distracted trainer offering food, and an attending trainer offering a block of wood. We reasoned that if the process of tracking the distracted trainer's gaze (turning around to look into the corner of the ceiling) was interfering with their main responses, then the subjects ought to have performed randomly under this manipulation as well. In fact, they did not. The subjects still tracked the distracted trainer's gaze as often as they had originally, but they performed without a single error in their main response, choosing the trainer offering food on every single probe trial. Thus, turning and following a trainer's distracted gaze did not interfere with the subjects' choice between the one offering food versus the one offering a block of wood. We therefore concluded that the subjects' random performance in the first test was not due to the fact that they tracked the gaze of one of the trainers, but rather that they did not really understand the attentional significance of that gaze in the first place.

If we are correct, and gaze-following can (and does) occur in the absence of an appreciation of the intentional significance of that gaze, then how do we explain the occurrence of the behavior? Collectively, we interpret our results from these studies to mean that young chimpanzees automatically track the visual gaze of other organisms without a concomitant appreciation of the attentional implications of that gaze. That is, they do not appreciate that visual perception is 'about' something. Instead, we regard the Scaife/Bruner effect as an example of how natural selection has shaped the behavior of organisms to attend to the eyes because of the benefits the behavior provides (see also, Tomasello, in press). To place our argument into the context of Baron-Cohen's

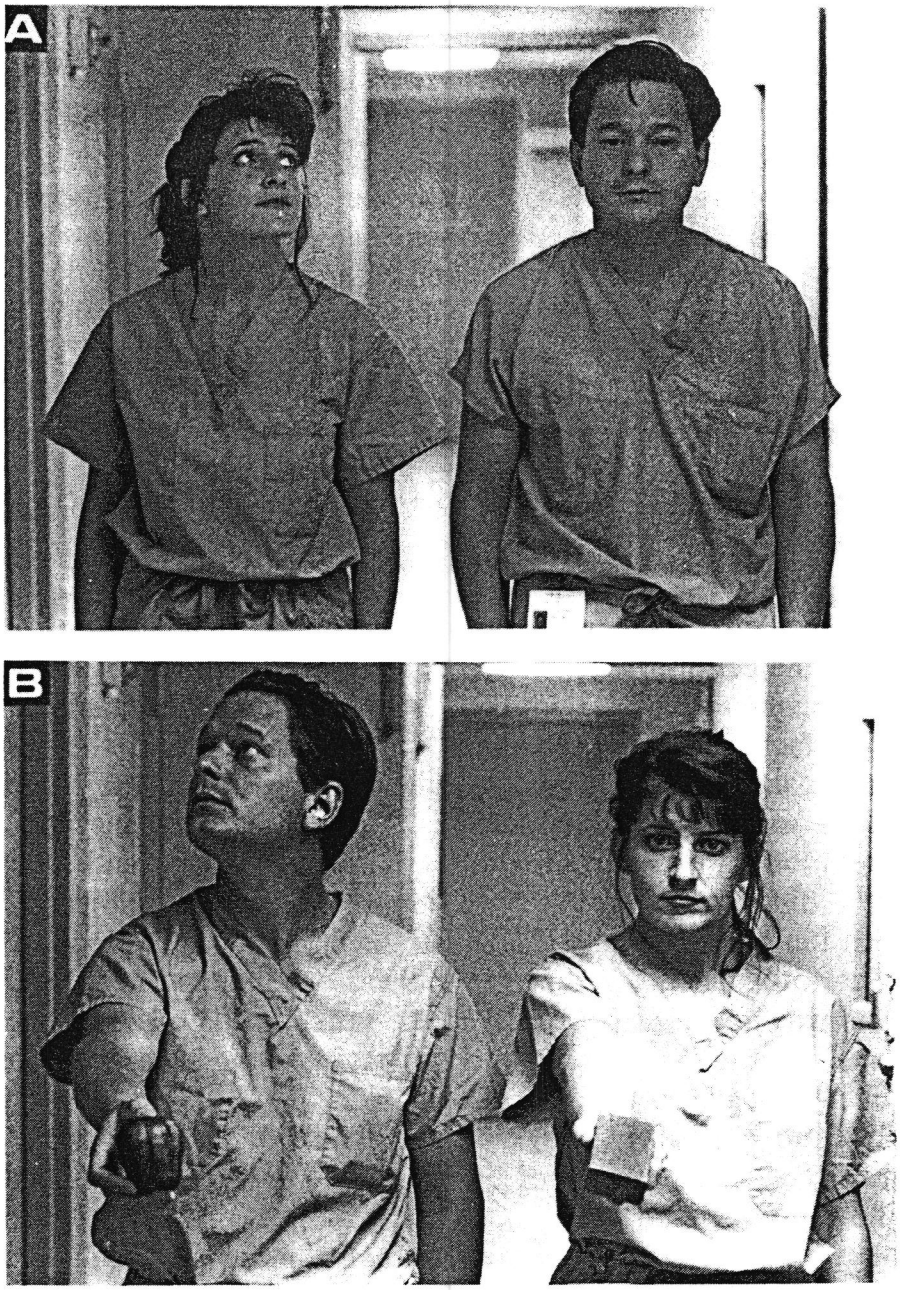


Figure 3. Stimulus configuration for (a) testing for the Scaife/Bruner effect and (b) testing to determine if subjects could display the Scaife/Bruner effect and still choose correctly between two trainers when no mental state attribution was required.

framework, we can see at least two contexts in which selection might have forged this behavior. First, Chance's (1967) arguments concerning the importance of paying attention to who is looking at whom clearly could set the stage for significant fitness payoffs in terms of social competition to those social organisms that develop algorithms for calculating and then following (with or without understanding why) the gaze of other members of their group. The second context in which selection may have shaped this behavior is in terms of the predation pressures faced by most organisms. Indeed, Alexander (1974) has argued that group living evolved solely as a response to predation pressures. One theory of the advantages of group living is that it allows for early detection of potential predators (van Shaik, van Noordwijk, Warsono, & Sutriono, 1983). A possible proximate mechanism by which this could happen is if social organisms took advantage of sudden shifts in eye gaze and/or head orientation on the part of other group members as signals of impending danger. Those organisms which tracked their conspecifics line-of-regard might detect predators substantially sooner than those who did not. Note that these are cues which, by definition, are not available to solitary organisms.

Gaze tracking and "joint visual attention"

Baron-Cohen concludes his argument by suggesting that by 14 months human infants have developed an "attention-goal" psychology which is made possible by the Shared Attention Mechanism. He argues that the Shared Attention Mechanism "is held to be necessary for the development and production of joint-attention behaviors" (p. 530). The approximate age of 14 months is based up the fact that by this age infants display joint-attention behaviors. Furthermore, Baron-Cohen interprets gaze-following (the Scaife/Bruner effect) as one of the two "clearest" examples of joint-attention behaviors. As we noted above, however, this effect can be dissociated from an understanding that visual perception is "about" something. The other joint-attention behavior he isolates occurs during episodes of "protodeclarative" pointing. Baron-Cohen finds these behaviors indicative of a Shared Attention Mechanism precisely because they involve the infants alternating gaze between the adult's eyes and either the object with which they are both interacting, or the object at which the infant is pointing but at which the adult is not yet looking. We would propose, however, that even in such cases the evolutionary prepotence of eye contact may lead the infant to look at

two places in rapid alternation (at an object it desires, and a pair of eyes to which it is attracted), without at all representing the mental state of attention that lies behind those eyes, or that the eyes interact with another's attention to give visual perception the property of "aboutness." We are not suggesting that this must be the case. Rather, we offer our recent findings with chimpanzees as evidence that it might be.

What are the implications of this hypothesis for Baron-Cohen's model? If the hypothesis we outline is correct, then two possibilities arise. First, the Shared Attention Mechanism may be present at 14 months, but just not in such a manner as to take into account the exact role of the eyes in grounding attention. Thus, long before the infants understand the particular role of the eyes in linking an organism's mental state of attention to the world, they may use more general indicators of interest such as posture and head and whole body orientation, to attribute a mental state of attention (see Baldwin & Moses, 1994). The second possibility, of course, is that Baron-Cohen's Shared Attention Mechanism does not develop until considerably after 14 months of age, even though infants are acting in ways to create 'joint-attention' behaviors by that age.

Thus, we find Baron-Cohen's model intriguing in both its specificity and evolutionary focus, but we also caution that the behaviors taken as clear evidence of an appreciation of the 'aboutness' of visual perception, may turn out to be a tightly canalized behavior which evolved independently of aspects of a psychology which appeals to mental states as causes of behavior. In short, although as adults we track the visual gaze of others and simultaneously attribute attention to them, 14-month-old human infants and young chimpanzees may only do the former. If true, more sensitive measures of the development of a Shared Attention Mechanism (with intentional properties) will be needed.

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