The animal spots the orphan egg and rolls it back into the nest. One possible interpretation of the behavior is that the bird knows what it is about, but a little discreet tampering with the situation reveals that this is not the case. For example, the bird will retrieve anything even vaguely round, beer cans and volleyballs for instance, but recognizes them as inappropriate once they are in the nest and discards them. More striking still, the object may be removed once the bird has begun the retrieval, and the *now-imaginary* egg will be gently rolled back into the nest nevertheless. The bird is simply a well-programmed machine, wired to recognize one or more simple but normally diagnostic cues for "eggness" and to execute a complicated motor program in response.

A host of ethologists, beginning with Lorenz, Tinbergen, and von Frisch, discovered that learning may be programmed to occur only with the appropriate combination of context, time, and cues, and can be used to build hard-wired motor programs. For example, many birds learn how to sing, but can learn to sing only their own species' song (Marler, 1970). The bird recognizes its own song and ignores those of other species on the basis of certain diagnostic cues. During a critical period in the life of the bird, the song is memorized. Months later, males begin to practice until they learn to manipulate their vocal muscles in a way that will produce a good copy. This motor program becomes fixed, so that an adult male may be deafened without affecting his song.

The lesson from these discoveries is that complex and seemingly inexplicable behavior may be the consequence of an animal's use of unexpected sensory windows, elegant programming, or "instinctive learning." Most of animal behavior may be explained in this way. We reject these explanations of much of human behavior, though, in favor of the elitist notion that our special niche in the world is one in which things are consciously reasoned out with brute intelligence. G raises the ever-intriguing possibility that this strategy may not be confined to our species – that the creatures which throng the stage of life around us may not all be simply the elegant, microcomputer-equipped robots of classical ethology, and that somewhere inside their brains may be an abstracted self-image, and an ability to know what they are doing.

By its very nature, the knowledge of what is going on in a mind is private. The three lessons of ethology mentioned above caution us that mere complexity is not itself a reliable clue. The novelty of G's approach is that is suggests two general categories of *tests* for self-awareness. One sort looks at what animals do when presented with problems which evolution could not have anticipated, so that any intelligent output from the animals must represent its own analysis of the problem rather than evolution's. The other method is to engage in a dialogue of sorts with the species in question, and to look for telltale signs for a disembodied consciousness on the part of the other party. The judgements in either case are largely intuitive, but so they often are at the leading edge of science (Kuhn, 1962).

G concentrates on two groups of animals in his arguments: the higher primates, and the honeybees, each the intellectual apex in their respective phyla. The evidence he cites in the first case is already intuitively satisfying, but it is difficult to imagine consciousness being even possible in bees. Nevertheless, in all fairness I must admit that there are aspects of bee behavior which, in our present state of knowledge, lend themselves to the consciousness hypothesis at least as well as to the robot theory (reviewed in Gould, 1975, pp. 187–194). For example, during training with respect to an artifical food source, there comes a point at which bees begin to "catch on" that the experimenter is systematically moving the food further and further away, and Frisch (1967 *op. cit.* G, p. 17) recalls instances in which the trained foragers began to anticipate subsequent moves and to wait for the feeder at the presumptive new location. It is not easy for me to imagine a natural analogue of this situation for which evolution could conceivably have programmed the bees.

Another example revolves around honeybees' hatred of alfalfa. These flowers possess spring-loaded anthers which give honeybees a rough blow when entered. Although bumble bees, who evolved to pollinate alfalfa, do not seem to mind, honeybees, once so treated, avoid alfalfa religiously (Lovell, 1963). Placed in the middle of a field of alfalfa, foraging bees will simply fly tremendous distances to find alternate food sources. Modern agricultural practices and the finite though surprisingly long flight range of honeybees, however, often bring the bees to a grim choice between foraging alfalfa or starving.

In the face of certain starvation, honeybees are said finally to begin foraging alfalfa, but they rapidly learn to avoid being clubbed. Some bees come to recognize tripped from untripped flowers, and frequent only the former, while others learn to chew a hole in the back of the flower and to rob untripped blossoms without ever venturing inside (Reinhardt, 1952; Pankiw, 1967). What has analyzed and solved this problem: evolution, or the bees themselves?

I find G's suggestions for language-related experiments too technically challenging to be practicable, but I have another experiment to propose. In his charming book *Rationality*, Bennett (1964 *op. cit.* G) develops logical criteria for real, self-conscious rationality. He uses bees as the counter example, though by the time he wrote the book they had been found to do most of the things he says they cannot (reviewed in Gould, 1975, pp. 187–194). His arguments lead him to propose as the unique characteristic of rationality what he calls an "R-denial": denying the truth of a statement because, logically, it *cannot* be true – that is, the ability to recognize an abstract lie as a lie. Now bees do not normally lie – in view of their close genetic relationship to one another and their common goal of sustaining the hive and its queen, it would be maladaptive to do so. Under special circumstances (Gould, 1976), however, foragers may be made unwittingly to lie about the direction of a food source. Bees learn the topography around the hive before beginning to forage. If a colony were placed next to a lake and forager dances made to indicate a familiar food source out in the middle of it, would experienced recruits be fooled into leaving the hive, or, having left, would they search seriously in the lake? If they did, would a subsequent set of dances to another food odor that was apparently still in the lake again elicit a machinelike response? Since throughout evolution foragers have never lied, it seems unlikely that the bee's on-board computer could have been programmed for this eventuality.

My own combination of biases and intuition leads me to doubt that bees know what they are doing. If the examples mentioned above can be taken at face value, however, I must suppose that evolution is capable of such subtle feats of intellectual engineering to deal with unpredictable situations that it is difficult or impossible at present to distinguish the programming of a 1-mg bee brain from some sort of insect free will. If this is the case, how, I wonder, can we talk so confidently about any qualitatively different sources of human behavior?

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by **Patricia M. Greenfield**

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***Developmental processes in the language learning of child and chimp** [SR&B].* I shall be approaching this commentary primarily from the point of view of a developmental psychologist, comparing the linguistically mediated tool use and exchange by chimpanzees described by SR&B with comparable developments in human children.

An interesting contrast with children is the apparently greater difficulty for chimps of simply labeling an object in comparison with naming the same object when it is needed as a tool. Indeed, my research has indicated that the linguistic encoding of an instrument or tool is extremely rare in the one-word stage of children, and its first appearance is months after the first appearance of a simple label (Greenfield and Smith, 1976 *op. cit.* SR&B). Our study of the development of linguistic functions in two children in the one-word stage also found that the earliest labels precede the earliest instances of naming something in a request context.

All of this would seem to indicate that the difficulty of the two sorts of semantic function is reversed in children and chimps, with chimps (1) more easily learning to use language to request than to name and (2) showing more interest in tools than children do. The first contrast is the more interesting, for it suggests that a primary difference between chimps and people is the chimps' difficulty with symbolization *per se* – forming arbitrary relations between signifier and signified, making one thing arbitrarily stand for another. For the chimps, there seems a relatively long period in which they learn more easily when the word to be acquired is embedded in or part of an action context. The behavior of the more language-experienced Lana does indicate, however, that awareness of arbitrary symbols eventually develops even in chimps, for Lana was immediately able to transfer her tool words from the request to the labeling context without further training.

As SR&B point out, the stage of action-embedding parallels our description of the pure performative stage in child language. In pure performatives, sounds are part of action contexts; sound pattern and referent are not clearly separable. The arbitrary connection between sign and referent does not yet exist. The parallel should not be stretched too far, however; the chimps' requests for tools involve using a word to trigger an action of another person in a specific situation. The chimp's early tool vocabulary is less tied to the animal's own action than the child's pure performative (e.g., saying "bye-bye" while waving). The chimp's vocabulary does appear, however, to be more tied than the child's to the *total* context in which a new word is introduced. Children seem to have a greater tendency to abstract a *part* of the context in which a word is introduced. They then use this abstraction as the basis for further uses of that word, correct or incorrect. But there may be an earlier stage in which human children do not abstract either; Piaget (1951) describes the earliest word uses of his children as totally tied to one particular context.

There are, however, a couple of other possible explanations for the chimps' difficulty with labels. From the procedural information presented, it seems as though the chimps had to produce labels in response to a question like "What's this?" (or some other verbally presented request for a name). In the original tool-request situation, in contrast, the chimps were to name the tool in response to a nonverbal situation: seeing a hiding place baited with food. In our study, we found that a child's spontaneous use of a given semantic function in one-word form occurred first in response to a nonverbal context, only later in response to a verbal one. For example, the children in our study could spontaneously label entities before they could use the same words to answer the question "What's this?" If this same progression exists in chimps, it could also explain why labels were so difficult for them to learn under the conditions of this study.

Another possible explanation of the chimps' difficulty in learning object labels lies in the role of extrinsic versus intrinsic reinforcement in language learning. In the label-training procedure the chimp was asked to name an object and rewarded with praise or food if correct – an *extrinsic* reinforcement condition. In the tool-request situation, in contrast, the chimp was given the tool he had named (even if it was the wrong tool for the situation); here, the consequences had an *intrinsic* relation to the chimp's language behavior. In the naturally occurring language acquisition process of children, extrinsic reinforcement seems to play almost no role at all (e.g., Brown, 1973). At the same time, students of child language have pointed to the potential importance of intrinsic feedback that gives the child information about what he has been taken to mean (Ryan, 1974). This type of intrinsic feedback is provided in the tool-requesting situation, where the chimp is given a tool corresponding to the name he produces on the computer keyboard. In the object-labeling situation, in contrast, he could be given food as a reinforcer, no matter what object name was produced. If this extrinsic reinforcement was interpreted by the chimp as intrinsic, the procedure could actually be confusing. The chimp might conclude that the referent of *blanket*, one of the labels in the study, was the food reinforcer. Finally, after-the-fact reinforcement for correct symbol selection in the label-learning procedure seems to have replaced an initial stage in which symbol and referent are systematically paired. Such a stage existed in the tool-request procedures, but not in the object-labeling one.

Each of these different explanations for the greater ease of learning and using vocabulary in the tool-request procedure would have different implications for the language acquisition process in chimps and its comparison with its human analogue. But more information from the authors about the object learning procedure is needed before it is possible to rule out any particular explanation.

A parallel between chimps and children appears in the concepts implicit in their errors of word use during the acquisition of particular lexical items. Thus, SR&B report a confusion between words denoting members of the tool category (e.g., between *key* and *stick*), but not between tool names and food names. This pattern indicates the functional category "tool" as the basis for the lexical confusion. Similarly, Braunwald (in press) reports examples where her own child spontaneously extends tool names to other tools that fulfill a similar function (e.g., *broo* for broom is extended to refer also to dust mops). Function is certainly not the only basis of children's lexical extensions and, in fact, it is often difficult to separate function and form (as in the broom/dust mop examples). What is clear, however, is that the surface behavior of child and chimp is not very different in some cases of lexical extension.

Perhaps the most striking parallel between child and chimp is the necessity for a prelinguistic sensorimotor understanding of various forms of action and communication for the symbolic encoding of actions and desires to take place. Evidence on this point continues to accumulate for children. For example, using the child's response to offers in order to study the transition from sensorimotor to linguistic communication, we found that offers (of an object or an activity) were initially made by the mother on the sensorimotor level alone, then simultaneously on both the linguistic and sensorimotor levels, and finally on the linguistic level alone (Zukow, Reilly, and Greenfield, in press). Correlatively, at the early stages, children would generally not respond to offers unless all the sensorimotor elements were present (e.g., the mother says "Do you want a cookie?" while holding out the cookie to the child). Response to a linguistic offer depended on having the sensorimotor information simultaneously available. Recently Bruner (personal communication) has found the same pattern of development from sensorimotor to linguistic for the child's expression of requests to the mother. In the interanimal communication experiment reported here, the animal differs from the human child in not having prior experience in which a second chimp fulfills his requests. Hence, it was necessary for the human experimenter to direct one chimp's attention to the other chimp, in order to get the chimp to address his request to another animal. Here the experimenter acted like the mothers in our study, using attention-getting devices to transform initially unsuccessful communications into successful ones.

These parallels and divergences between the developmental processes of child and chimp are important in establishing the full nature of linguistic communication and in identifying what is uniquely human therein. Knowledge of parallels is also important in preventing premature conclusions about chimpanzee language-learning limitations. When many of the chimp's limitations of today turn out to have been analogous to early stages in the child's acquisition process, we should not be surprised when tomorrow the chimp follows the child in taking the next step on the road to mature linguistic communication.

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by **Marjorie Grene**

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Basic concepts for cognitive ethology. Ethology, as Griffin (1976 *op. cit.* G, SR&B) has argued, was founded under the aegis of behaviorism. But behaviorism was Cartesian dualism with its mental sector atrophied. Now that experimental psychologists, as well as some philosophers, have undertaken investigations that bypass the Cartesian dichotomy and analyze the cognitive powers of animals, including ourselves, without that embarrassing impediment to understanding, the need to articulate adequate concepts to guide such work brings the interests of philosophers into convergence with those of experimentalists.

1. The conversations of Sherman and Austin [SR&B]. Work of the kind reported by SR&B represents not only "a large step" for their experimental animals, but for human theorists as well. Concepts like "intentionality," "propositionality" (from Steklis and Harnad, 1976 *op. cit.* SR&B, p. 451), "comprehension," and "symbolic representational capacity" should indeed become pivotal to the study of cognition. The context in which they are used and the development of experimental design under their guidance illustrate, for this commentator, the fruitful interaction of theory and experiment that a fresh perspective in science can encourage, and offer, at long last, support for the biologically biased epistemologist in the study of animal cognitive behavior. For a philosophical account of intentionality that parallels SR&B's usage, see, for example, Føllesdal (1969) and Searle (1979).

"Awareness" seems to me rather more difficult. Granted, one no longer wants to deny awareness to other animals, any more than to human beings. Granted