Review article

Talking with Alex*

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Humans are immersed in an ocean of words — we understand them, think with them, repeat them, play with their sounds and meanings, and create novel combinations that are understandable to other humans adrift in our part of the ocean. The skill with which a human uses words in speaking has long been a key element in the perception of his or her intelligence. We have a marked tendency to treat people who are articulate as more intelligent than those who are speak poorly. For example, I am startled when a well-spoken 'customer service representative' on the telephone is unable to spell psychology or to retain a seven-digit phone number. I am surprised in the opposite direction when someone who speaks English poorly, or with a large proportion of uninterpretable slang, suddenly conveys a subtle and discerning point or quickly fixes a complex problem with my computer software.

This language test also has traditionally been used to separate the intellectual ability of humans from that of other animals. Put simply, if other animals can't understand and generate words or signs in sentence-like combinations, we judge them as less intelligent than humans.[1] The language-based divide that we have constructed between humans and other animals is well defended. During the last 30 years, work suggesting language-related communication in species ranging from chimpanzees to sea lions has attracted a firestorm of criticism that questioned its accuracy, efficacy, and importance. Objections have included claims of outright fraud, inadvertent cuing, and dismissal of results as 'mere trial-and-error learning'. Perhaps the most common academic complaint is that the language-like productions of nonhumans lack the grammatical constraints and generativity characteristic of human language.

Why are humans, certainly academic humans, so intent on distinguishing human language reception and production from the abilities of nonhuman animals? One possibility is that language is the key to a number

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of planning and technical abilities that are uniquely human in power and flexibility. Another possibility is that language is the most salient representative of a suite of activities that stakes our claim to moral superiority over 'mere soulless beasts.' A simpler, more pragmatic basis for the divide is that nonhuman animals, even extensively trained chimpanzees, do not freely produce language that is readily understandable by the average human. We are uneasy in judging nonhuman intelligence when we can't use the social tools of conversation and questions to evaluate their social abilities, mental operations, and knowledge.

Such doubts may have been compounded by evidence that the use of a human-like language by nonhumans appears to require remarkably extensive training. It is not a case, like that of Stephen Hawking, of simply finding a translator to release a flood of words and sentences. Instead, the language behavior of animals has depended on repetitive, patient practice over a period of many years to produce facile, reliable signs or words. In fact, language training for nonhumans is notably harder even than producing challenging 'tricks' that seemingly go against natural tendencies, as in shaping three dogs to execute an interweaving tumbling drill while running at full speed, or persuading a tiger to jump through a flaming hoop onto the back of an elephant, with agreement by the elephant. It is little wonder that we yearn for the facility offered by King Solomon's ring or Dr. Doolittle's ability to hear animal's thoughts in English.

Alex

Given such a contentious history of evaluating language production in nonhuman animals, it is no wonder that the case of Alex has created a stir. First, Alex is a parrot, not a chimpanzee or an intelligent four-footed (or flippered and fluked) mammal. Until Alex, most researchers assumed that the best chance of producing language-trained comrades was to begin with animals, like chimpanzees, that resembled us both physically and phylogenetically, especially those animals with similar brain organization. Parrots lack all these attributes. The second surprise is that Alex 'talks'. There is no incrementally trained and difficult to decipher gestural language, no extensive trial-and-error learning of a large set of specific commands and chains of responses. Alex is capable of answering and asking novel questions in a limited form of English.

Alex is a mature male African Grey parrot in the charge of Irene Pepperberg, Professor of Ecology and Evolutionary Biology at the University of Arizona when *The Alex Studies* was written. Dr. Pepperberg and her assistants have been working with Alex for more than 20 years studying his cognitive capabilities in areas such as referential labeling, categorization, abstract categories like same-different and relative size, number, object permanence, intentional action, and the contribution of sound/word play to learning. As a result, Alex can produce and appropriately apply well over 100 English labels, he can recognize numbers, he can answer questions and make requests, and he appears able to predict his own behavior.

If there were an observer's Turing test for distinguishing the dialog of two humans from a conversation between a human and nonhuman, Alex might well pass it. During the day, in well-constructed and monitored training and tests, Alex responds to questions using English utterances. For example, when confronted with a novel assortment of objects of different colors, sizes, shapes, and material, he can answer correctly questions about an individual object, subsets of objects, or the full assortment, such as: 'What shape?', 'What color?', 'How many green rock?', 'What same?', 'What color [is the] three-cornered wood?', 'Is ball smaller [than] three-cornered wood?' Alex can also answer relatively abstract and even 'trick' questions. When asked, 'What matter larger?', he can pick the relatively larger object of a diverse set; when confronted with six blue circles and asked, 'How many larger?', he can answer, 'none.' In addition, Alex makes requests ('Want cork'). If he is offered something else, he often rejects it. Alex asks questions: 'What green'? He produced at least one new word, 'banerry', an apparent combination of banana and cherry). Finally, he appears to make statements about his intentions, such as 'I'm gonna go away', followed by withdrawal. He also makes socially appropriate statements, as when Pepperberg leaves the laboratory at the end of the day, Alex calls to her, 'Bye. I'm gonna go eat dinner. I'll see you tomorrow'.

So how should we place Alex's obvious verbal and mental skills with respect to the traditional human/animal divide? Certainly, Alex is considerably less accomplished than an adult human of his chronological age (more than 20 years), but at the same time he has accomplished far more than the classic 'parroting' for which his kin are famous. In some respects, he seems similar to a 2- to 3-year-old human. How then shall we treat him? I think the work of Pepperberg and Alex strongly suggests there is no clear 'divide' between the language-related abilities of humans and those of nonhuman animals; that is, there is no single point or line separating the abilities of humans and nonhumans into discrete non-overlapping categories. Rather, the data suggest a gap with uneven edges, a profile of language-relevant abilities showing similar and even identical capabilities in some areas, and dramatic differences in others.

Using a profile conception of differences in language-relevant abilities between species has several potential advantages. It replaces the one-zero choice of whether another species is on the human side of a divide with a more analytic statement about areas of similarity and difference in language relevant abilities. (It offers the same advantages in comparing the language-related skills among individual human and/or nonhuman animals). Profiles of different species should be differently shaped; thus, a comparison of humans and chimpanzees would reflect a different pattern of similarity than a comparison of profiles of humans and parrots. We would expect these patterns to be related to differences in evolutionary-ecological requirements and mechanisms for each species. We would also expect changes in profiles as a function of experience.

In the remainder of this essay, I consider more carefully the differences between Alex and his trainers. I first provide some historical context in the form of alternative views of the mental differences and similarities among human and nonhuman animals. I discuss important procedural contributions of the work with Alex and then attempt to characterize how Alex's training relates to traditions of operant conditioning and communication. I emphasize the potential usefulness of a profile view of species differences and close by outlining a personal wish list for a sequel to Pepperberg's book.

A brief history of the mental differences between humans and other animals

The majority of the human species appears to have drifted comfortably alone in its lexical ocean for tens of thousands of years, perhaps even defending their isolation actively against other human-like beings, such as the Neanderthals. Our linguistic isolation has not prevented us from developing an awareness of the determinants of the behavior of other animals, awareness we have used ably in better predicting and controlling their behavior. As inveterate hunters, we learned to read signs and behavior to help us capture prey and avoid predators. As domesticators, we have a long history of making functional agreements with other animals to help feed and defend them in return for their protein, assistance, and companionship. For example, we have selected and trained dogs to protect our herds, attack our enemies, and provide companionship and motivation — very much like children or good friends.

Not surprisingly, in times of sustained plenty, we tend to focus on the beauty, talents, and wonder of other animals. In hard times, we focus increasingly on their contributions to our survival. But even in the most difficult circumstances, humans remain connected with other animals as symbols. The last inhabitants of Easter Island appeared to worship sea birds, seemingly striving to escape the barren prison they had created. In traditional Inuit culture, the best outcome of a human life was for one's spirit near the end of life to enter into a walrus or polar bear. The resultant being was said to dance with joy, the outcome of renewed vigor and perhaps the excitement of becoming physically much better suited to the arctic. Many humans have spent considerable time and physical resources trying to enter the minds and languages of animals by trances induced by drugs, starvation, rhythmic motion, exhaustion, or viewing the dream world of Walt Disney in a darkened movie theater. King Solomon was said to have a ring that allowed him to understand the language of animals, and a revisionist Dr. Doolittle (in the recent movie version) had a hearing talent that translated animal thoughts into spoken English.

Despite myriad incarnations of animal-oriented human cultures and subcultures and individual human-animal connections, we have not yet escaped a pragmatic divide separating humans from other animals. This divide appears based partly on biology and partly on apparent mental functioning. In the case of biology, despite fantasies and fairy tales to the contrary, humans don't interbreed successfully with other animals. A critical addition to the obvious impediments of anatomy, behavior, and preference is the absence of enough shared genetic structure for successful fertilization and development. Similarly, despite the ability of trackers, trainers, psychologists, and pet owners to relate to the worlds of other species, no other animal has become a functioning member of our mental and linguistic society, not even the language-trained animals mentioned above. True, individual animals and even some animal groups have been beloved, protected, or feared because of a combination of patronage and cultural status, but they have been only honorary members of our societies and symbols of the power wielded by some humans over others.

Darwin's theory

Does this mean that, after everything is considered, the biological and mental difference between humans and other animals is truly an immutable divide? Darwin's theory of evolution (1859, 1871) and the integration of inheritance into that evolutionary framework (Mayr 1942) provided the first satisfying intellectual basis for understanding the divide as multiple differences in capabilities among human and nonhuman animals. It marked the beginning of defining and clarifying the extent to which humans and other species share a common genetic heritage and mental mechanisms that provide a basis for their behavior.

The first biological point is that despite our focus on the human-nonhuman divide, we are not unique in our isolation from other species. Differences in similar characteristics separate one species from any other:

gene pool, gametagenesis, fertilization, reproduction, and development. The second biological point is that all differences between gene pools are meliorated by phylogenetic history. For example, our chromosomes carry gene sequences from distant ancestors that are expressed in living species as disparate as nematodes, flies, and chimpanzees. Our chromosomes may also carry gene sequences similar to those of other species resulting from similar ecological selection pressures. The third point is that biological differences may be further meliorated by artificial and 'natural' gene insertions, deletions, and alterations. We may be in for changes in profile characteristics that will range from the plebian to significance beyond the imaginations of all but a few fantasy writers.

But what of the profiles of mental characteristics that separate one species from another? How is Darwin's theory relevant to something that is seemingly so much more ephemeral than genes? The first point is that because mental attributes have material neurophysiological-genetic bases, everything in the preceding paragraph concerning the biological differences between humans and other animals extends to our mental differences as well. Thus, we are not alone in showing mental differences with other species. Though humans appear to have unique neurological attributes related to language, many of them overlap with chimpanzees and other mammals (including the alleged language talisman, Broca's area — Rizzolatti and Arbib 1998). It is worth nothing that other notable neurological and behavioral differences exist, as between singing and nonsinging birds, migratory and nonmigratory species, and food-storing and nonfood-storing species. Finally, all mental differences, including language abilities, have been meliorated by phylogeny and convergent adaptation. At the least, speaking and writing are not the only ambassadors of mental life useful for discovering and testing similarities and differences among species.

There is considerable evidence that relations exist between human brains and behavior and the brains and behavior of other species. Admittedly, we are not yet as clear about the constituents of mental behavior as we are about specific structural genes and their developmental and neurophysiological expression. But two things are worth noting. First, because there are no simple physical DNA units that alone produce different forms of cognitive processing or output, it remains important to approach the analysis of conceptual structures through a functional analysis. We observe behavior, impute causation, and test our hypotheses, whether it is the behavior of the organism or the behavior of the brain as seen through techniques such as electrophysiology, voltammetry, or fMRI scans. Second, it is critical to realize that even in the case of structural genes, there is still a good deal unknown about how these units are expressed in and determine differential survival and reproduction. So, even when dealing with genes, we must engage the levels of function, behavior, and environment.

In sum, given Darwin's theory, any difference between species must be based on some combination of phylogenetic and ecological similarities and differences. Further, there is no general divide between humans and other animals; instead there are multiple similarities and differences among specific attributes of different species. With respect to language and communication, the phylogenetic differences between humans and chimpanzees are obviously important. In addition, there are potentially relevant ecological similarities between humans and highly social species like wolves, flocking birds with 'cultures', and possibly, social insects such as bees or ants. The genetic bases of these profile differences are filled in terms of similarities in genes, not only in terms of descent from a proximate common ancestor, but also more distant ancestors having similar ecologies. The bases of particular differences are based on biology and development, plus functional analyses of how specific problems are solved. The basic question is how to articulate these differences, especially as they are relevant to mental functioning.

Darwin and post-Darwinian approaches to mind and language in nonhuman animals

In his book, *The Descent of Man*, Darwin (1871) focused considerable effort on identifying apparent examples in animals of human-like behavior related to mental events such as emotion and purpose and intelligence. Subsequent investigators have followed a variety of paths trying to develop his insights. I will classify them briefly to provide some context for Pepperberg's work.

The anthropomorphic path: Darwin contributed heavily to the tendency toward anthropomorphism (attributing human characteristics to animals) before passing his notes and blessing to the young scientist George Romanes. Romanes (1884) applied the concept of ejective inference to reports suggesting mentation in nonhuman animals to produce a phylum-by-phylum ascent through 47 levels of mental, motivational, and emotional characteristics. The simplest single-cell organisms are at the lowest level, and as the levels get higher, the abilities displayed get more recognizably abstract and human.

In Darwin's hands the general point of providing accounts of human-like behavior in other animals was to find phylogenetically reasonable precursors of important human capacities, such as planning, counting, empathy, and the like. Darwin's primary motivation for writing *The Descent of Man* was to support his view of continuity between other animals and humans against the view of Wallace that natural selection could not account for the emergence of the human brain and related behavior. In contrast, Romanes separated the assumption of conceptual levels of mind from the specifics of evolutionary phylogeny. Romanes was primarily interested in establishing the very first possible presumption of human-like emotions (such as love) and intelligence (such as planning), without regard to phylogeny or ecology. His conclusions were based on the technique of *ejective inference* in which he imagined how he, as a human, would feel in the same circumstances reported for a nonhuman animal. His goal was to construct a conceptual hierarchy of mental levels and then assign phyla, species, and human developmental ages to particular levels, thus developing a mental scale relating all animals with the course of development in humans.

It is apparent that the process of ejective inference necessarily leans very heavily on the observer's cultural experience and assumptions as determinants of the mental life of animals. Thus, if in an observer's culture individuals marry based on selections by their parents after establishing a house and an income, there will be a tendency to see the presence and absence of this pattern in an animal species, complete with appropriate plans and feelings. If other humans are experienced as quarrelsome and vindictive, then so are animals; benign and pleasant, then so are animals; depressed and lost, then so are animals. In short, Romanes's approach was based on the premise that animals necessarily experience emotions, motivations, and calculations that are identical to our own. Thus, we may identify them presumptively and easily. Given that in this view animals are basically limited humans in skins, scales, feathers, and fur, it is little wonder that feelings of love were first found in snails.

Beginning in the last half of the 19th century, a burst of naturalist authors added more detailed observations of naturally occurring behavior in nonhuman animals. Less carefully than Romanes, they presumed that animals felt human emotions, were driven by the same motivations, and made similar plans. For example, Ernest Thompson Seton (see 1991) wrote a series of popular books that presented the animal in its natural habitat, engaging in plans, emotions, and motivations, and ultimately doomed to die at the hands of humans. In the latter half of the 20th century, Walt Disney Studios made cartoons, nature films, and feature films starring talking animals that delighted audiences with their child-like shenanigans and human strengths and foibles. The dead give-away of these stories is that the actions of the animal characters are always more understandable if we assume that they are humans than if they are seen as the nonhuman animals they represent. Subsequently, even careful observers like Jane Goodall and Donald Griffin (1981) sought to enter the world of their subjects with uneven degrees of restraint in their human-oriented inferences.

The experimental path: An experimental approach to the nature of mind and behavior in animals also began to form in the second half of the 19th century. The experimental approach was more related to the conceptions of medical physiologists and experimentally oriented field naturalists, than to the trend toward anthropomorphism. The focus was on sensory control, learning, and development. Investigators in England (including Lubbock 1882, and Spalding 1972) hypothesized mechanisms causing behavior and used controlled experimental circumstances to test them. In America, Thorndike invented repeatable puzzle problems for animals to solve and lamented, 'Thousands of cats on thousands of occasions sit helplessly yowling, and no one takes thought of it or writes to his friend, the professor; but let one cat claw at the knob of a door supposedly as a signal to be let out, and straightway this cat becomes the representative of the cat-mind in all the books' (Thorndike 1898). Watson (1913) strenuously defended a peripheral behaviorism, and Skinner (1938) developed a flexible apparatus and accompanying procedures that provided a way to investigate and control the effects on behavior of complex stimulus and response contingencies related to reward.

The desire to directly study learning and sensory control of behavior rather than infer human-like mental processes, when combined with a strong motivation to emulate aspects of the successful and exact physical and medical sciences, produced a long tradition of careful experimentation evaluating the learning ability and intelligence of animals (e.g., Hearst 1988, Hull 1943, Kimble 1961, Pavlov 1927). A major component of this approach was the attempt to establish levels of learning abilities in multiple species by testing them on similar problems. Scientists used detour problems, oddity problems, learning sets, probability learning, reversal learning, immediate and delayed matching to sample, same-different discriminations, arbitrary categorization, and counting (Maier and Schneirla 1935; Warden, Jenkins, and Warner, 1935).

In borrowing ideas of standardized apparatus and procedures from the 'harder' sciences, there was also a tendency to borrow positivist philosophy, hypothetico-deductive systems, and a simple mechanical view of the determinants of behavior. The result was a movement to develop general principles in learning as scientists began to reinvent research along the lines of inferred neural connections and simple mechanisms. Animals became furry billiard balls set in motion by the forces of primary needs, the reduction of which provided the reinforcing glue for learning to act in a purposive and efficient manner. Later, animal cognition began to be studied as a reasonably generic substrate that could be flexibly altered by the appropriate application of simple cue conditioning procedures.

The ethology/ecology path: In partial contrast to both the anthropomorphic and experimental approaches to animal learning and mentation, an ethological path emerged near the middle of the 20th century based on studies by field-oriented biologists in near-natural settings. This approach shared with the anthropomorphic path a concern with entering the animal's world, but it emphasized functional analysis and experimentation rather than intuition and presumption as a means of understanding the animal's perceptual-motor and motivational organization. I have termed this the *theromorphic* approach, in which the experimenter assumes the animal's view (becomes the animal), as opposed to the anthropomorphic approach, in which the animal is compelled to become a human (Timberlake 1999). Observers such as von Uexkull (1957) and Lorenz (1981) and experimentalists such as Tinbergen (1951) and von Frisch (1965) combined aspects of behavior and experimental analysis of stimulus features to develop models of the animal's world and motivations.

A second contribution of the ethological approach was its emphasis on ecological function and the evolutionary basis of adaptive species differences in sensory-motor organization and behavior. Laboratory research often focused on behavioral and neurophysiological analyses of niche-related mechanisms underlying behaviors such as spatial learning, food storing, migration, predation, optimal foraging capacities, and communication. In general, these approaches have taken seriously the importance of evolution in the form of phylogeny, selection pressure, and, most recently, culture (e.g., Kamil 1988, Shettleworth 1998).

The anthropocentric path: The last path of the 20th century represented an amalgam of experimental and anthropocentric concerns in studying animal cognition (see Shettleworth 1998). The growth of this field was based partly on a resurgent interest in human problem solving, models of memory, the development of language and language processing, and the concept of information. It was contributed to by the growth of new technologies for targeting brain functioning and an increased knowledge of the neurophysiological substrate of behavior. The result of this 'cognitive revolution' was a renewed interest in studying human-like capabilities in animals, including categorization, abstract classifications schemes, such as same-different judgments, and language learning (Roitblat 1987, Wasserman 1993). In more field-oriented work, the interest has been on human attributes of deception, tool-making, and culture, Unbridled anthropomorphism is sometimes associated with this approach, but for the most part this has been an experimental area focused on cognitive abilities in nonhuman animals. Anthropomorphism has been involved primarily in field studies as a heuristic to guide further observation and experimentation.

The language teachers

A major component of the anthropocentric animal cognition movement was the revitalized study of human-language learning in a number of species, but primarily in chimpanzees. This research was more sophisticated than the Hayeses' groundbreaking and painstaking training of the chimpanzee Vicki to roughly approximate the sound of a few English words (Hayes and Hayes 1951). Subsequent researchers absorbed the lesson that chimpanzees lacked the vocal equipment to form the sounds of human languages and decided that if they wanted an animal to 'talk' with them, they would have to provide an alternative means of communication. They also began to develop systematic tests of the cognitive abilities of their subjects, that testing eventually superceding or at least sharing part of the stage with the desire to discover whether a nonhuman animal could talk.

The Gardners (see Gardner et al. 1989) led the way with the innovative strategy of teaching a version of American Sign Language to Washoe, a young, female chimpanzee. After trying operant techniques based on food reward for correct signed 'utterances', the Gardners hit on social rewards, such as attention and tickling, and established a successful training regime. Washoe signed, held conversations of sorts, declaimed, requested, argued, identified, named, and remembered. The signing was not like that of humans; in appearance, it frequently appeared nonchalant. The ape's hand motions were not directed toward the receiver in the way that human gestures are often used. This is not a surprise given the different emphasis on gaze direction in humans and chimpanzees (Povinelli et al. 1997) and probably would not have surprised a cross-cultural anthropologist, but it seemed notably important to some critics. However, contrary to the most extreme critics, it did not require 'a mother's eye' to discern the gestures, only a practiced one. Nor was Washoe the only pupil. The Gardners and their student, Roger Fouts, expanded the work to include a number of additional young chimpanzees. In general, males were less successful pupils than females, and younger chimpanzees more successful than older.

The Gardners bore the initial brunt of criticisms from defenders of the traditional divide between humans and other animals. The most common criticisms were that: (a) the scoring of the behavior depended on interpretation of the results to make the animal look good; (b) the apparent comprehension of the receiver was based merely on trial-and-error (operant) conditioning of a response quickly followed by reward; (c) the experimenter cued the animal's response in some nonverbal way; and (d) the results were not related to human language because the animals did not produce or respond to systematic variations in the utterance that related to a grammar (i.e., rules of hierarchically based, sequential structure; see Kako 1999, for a specific discussion with replies).

It was a useful time as linguists began to think further about what might pass as language; but it also seemed to be a time for 'throwing out the baby with the bathwater.' What the Gardners had accomplished was to establish at least the beginnings of a shared arbitrary code-based social communication system between chimpanzees and humans. They made simultaneous contact with chimpanzee social behavior and substrates of communication. Somewhat predictably in human affairs, a good portion of the reward for their hard work was to be viewed as barbarians at the gates to be repelled, rather than as innovators to be invited in. After Terrace et al. (1979) summarized the unsatisfying, repetitious results obtained by multiple teachers rewarding the emission of sentence-length sequences of gestural signs by the male chimpanzee, Nim, the American Sign Language approach fell from favor.

Fortunately, overlapping this dramatic decline in time was the development of two other directions in the study of language-related skills in chimpanzees. The first involved automation of physical communication codes to escape issues of prompting and misreporting data, and the second focused primarily on the investigation of more specific cognitive skills than the general question of whether chimpanzees could learn and produce a human language. The Rumbaughs (Rumbaugh 1977) maintained the study of language behavior in chimpanzees using Lana, Sherman, and Austin by automating the teaching and testing by using an electronic board with signs in the form of visual symbols in rows and columns of keys. The chimpanzees were taught to use the board as a bi-directional communication channel with a trainer. This approach was later expanded to two boards in an attempt to get a pair of chimpanzees, Sherman and Austin, to communicate with each other. This project eventually moved toward more free-form human interaction following the inadvertent education of a young Bonobo chimpanzee, Kanzi, through watching his mother being trained with a keyboard.

In an important move for the field, Premack (1988) avoided dealing directly or definitively with the necessary attributes of human language by teaching Sarah (yet another female chimpanzee) an arbitrary communication code based on colored plastic pieces arranged on a board. Most importantly, Premack and his students used the code that they had taught Sarah to generate tests of her cognitive abilities in labeling, categorizing, and perception of causation. Premack subsequently became interested in the role of language-code training in increasing the mental capabilities of chimpanzees and whether chimpanzees had a theory of mind, e.g., the ability to consider the knowledge and intentions of another animal in deciding one's own course of action.

The Alex project

It was against the background of predominantly primate research on language that Irene Pepperberg started working with Alex in the late 1970s. She apparently was inspired by the work on great apes by the Gardners, Premack, and the Rumbaughs, and she profited from the nature of the resultant linguistic and experimental criticisms. Pepperberg was trained as a physical scientist, beginning her academic career as a theoretical chemist. Starting from such an independent viewpoint, it is not surprising that her work differed from previous research in several ways. I briefly discuss three important changes below.

Focus on birds and cognition

Pepperberg from the beginning was more interested in birds than in primates and in cognition more than in language. Based on the dust jacket of the book (not necessarily the most reliable of sources, but seemingly accurate in this case), she disagreed with the common view that animals could be arranged in a hierarchy of intellectual levels (a la Romanes 1884). In this view, species and phyla were ranked on a basis similar to the measurement of I.Q. in humans, namely their ability to score well on tests of particular cognitive/mental abilities. Pigeons (the representative of birds), although better than fish and frogs, were clearly inferior to mammals, even the lowly rat, in terms of their ability to form successful concepts in tests such as oddity discrimination, probability maximization, and learning set formation (the improvement in performance after multiple exposures to similar problems).[2] Surely, a bird as large-brained and capable as the parrot should outdo the rat, perhaps even placing birds on a par with the great apes in terms of learning ability. Perhaps more to the point, because of their vocal capabilities, parrots might even outdo great apes in terms of language learning and speech production. They would certainly have a better start than apes in learning and generating human phonemes, words, fragments, and sentences.

Interestingly, Pepperberg says very little about an ultimate concern with language. Most of the time, she disavows such an interest in favor of

Premack's (1988) strategy of attending to the cognitive skills of mind rather than bogging down in the question of language. She lists her long-term goals as: encouraging a reevaluation of animal capacities, improving the lives of captive parrots, preventing their habitat destruction and capture, and enabling development of better animal models for human dysfunctions (pp. 327–328). At the same time, though, a quick review of the chapter headings of her book indicates a strong interest in exploring language-related skills and production, including chapters on sound play and label learning, and accuracy and mechanisms of speech production. Although these chapters are interesting, the rationale for their presence in the book is not clear.

Training with English

Given Pepperberg's stated aim to focus on cognition instead of language, it seems a bit unfortunate that she immediately leapt back into the conceptual quicksand of language competence by interacting with Alex using English. It might have been better, working with a species with such remarkable vocal learning and production capabilities, to develop an arbitrary special purpose 'test language'. As it was, the use of English raised a red flag for experimental psychologists traditionally concerned with over-interpreting the cognitive abilities underlying what Alex was doing. Thus, the differences and similarities between Alex and humans were simultaneously illuminated by using an English-based vocal code and obscured by the extra meanings that humans attach to English words and the suddenly salient question of whether Alex is on the human or nonhuman side of the traditional language divide.

Anyone who watched the chimpanzees of the Rumbaughs or Premack saw an animal specifically and carefully trained to respond to arbitrary discriminative, causally linked stimuli. In this context, the meaning of the response was provided by the training circumstances and procedures. The data on their abilities had more immediate importance for their work than on overall concerns about a human-animal divide. The same cannot be said for Alex because the words bring all manner of connotations and denotations to mind that are not the least bit limited to Alex's training circumstances and procedure. With his first English word, Alex immediately became part of our linguistic community. When Alex says 'I'm gonna go get dinner, I'll see you tomorrow', it is difficult not to automatically assume that Alex understands and is using these words in the same way with the same referents that we would. But it seems more likely to me that he is simply repeating a sequence of 'parting' sounds he has heard from

Irene in the past, but this possibility is not directly addressed. Pepperberg and Alex may inhabit a common world in the case of this utterance, but we can't tell. I'm sure Pepperberg would agree that the assumption of such commonality must be tested and clarified.

Let me illustrate the power of using a familiar language in an animal experiment. As a graduate student, I was working late in my office when I heard someone down the hallway periodically yelling every 30 seconds or so. What he was saying was muffled sufficiently by distance and walls so that I couldn't make it out. After trying to ignore these repeating outbursts and continue working, I finally went into hunting mode and traced the sound halfway down the hall into a suite of cubicles used for the introductory psychology laboratory. In one room, I found an undergraduate who apparently had missed his afternoon lab session, training his rat to lever press in the presence of a discriminative stimulus (lever presses in the presence of a discriminative stimulus were rewarded; lever presses in the absence of the stimulus were not). Ordinarily, the discriminative stimulus was a light bulb above the chamber, but it had burned out and the student didn't know where they were kept. So being resourceful (and perhaps a bit puckish), instead of going back to the dorm without completing the lab, the student hit on using the word 'Press' as the discriminative stimulus. The rat was essentially trained by the time I arrived. Each time the student yelled, 'Press!' (I'm not sure why he yelled, perhaps he wanted to make sure the rat knew he was serious), the rat would press the lever, eat the food, and engage in sniffing around the food tray and a little grooming until the next 'Press!' command was forthcoming.

The scene was comical because, despite compelling appearances to the contrary, I knew that the rat did not understand the command, 'Press!' in the way that I understood it. The student could have yelled 'Don't Press' and rewarded the next lever press, and the effect would have been perhaps clearer and even funnier — we could have titled the scene 'two-year-old rat" or 'teen-age rat.' Still, because the rat responded to the command 'Press!' by pressing the lever, it was difficult for me to avoid the conclusion that the rat understood and responded to an English word the way that I would. This imputation of human-like understanding to animals is common in owners watching pets respond to a few commands or to their names. It is even more difficult in the case of Alex who can hold a passable short conversation about stimuli on which he has been trained. The reception and production of an understandable language automatically produces assumptions of a common framework of motivations, expectations, and social interaction rules. Only to the extent that these frameworks are comparable can our assumptions hold any hope of being accurate. These difficulties may underlie some of the meaning of Wittgenstein's (1973) remark that if lions could speak, we wouldn't understand them.

On the other hand (and there is a *very* important 'other hand' here), there are a variety of important advantages to using a common language like English as a protocol for interacting with Alex (these advantages are drawn mostly from Pepperberg): (1) It enables researchers to communicate directly to their subjects the precise nature of the questions being asked without extra training. As a result, testing can go more rapidly because the animal need not determine the nature of the question through trial and error, and multiple questions can be easily asked about the same stimulus array. (2) It takes into account research showing that social animals respond more readily, and often with greater accuracy, when placed within a social context. (3) It enables researchers to compare test data not only between humans and other animals, but also among various nonhuman species. (4) The complexity of English provides an open, arbitrary code that can create an enormous variety of signals; such variety allows researchers to examine the nature, and not just the extent, of the information perceived by an animal. (5) Two-way communication also allows rigorous testing because animals can be required to choose a response from their entire repertoire rather than from a subset relevant only to the topic of a particular question. (6) As Premack argued, an animal that learns a language code may also respond in novel and perhaps more analytic and competent ways than a subject trained entirely through operant or Pavlovian conditioning. (7) Teaching words as labels for a type of environmental event may mean that you are necessarily teaching something more general than an instance, like a concept. (8) The use of English as the training and testing language makes it easier to find trainers.

Although these reasons vary in importance on a number of dimensions, I agree with Pepperberg that the advantages of using a language 'code' in training Alex are considerable. However, I think the careful realization of how these advantages contribute to an analysis of the profile differences and similarities between humans and parrots will require much more attention to discerning the way in which Alex is using English. For example, in her chapter on intention, Pepperberg says 'Thus, whether or not his [Alex's] queries 'What that?', 'What color?', and so forth are intentional, we treat them as such.' This assumption I view as pragmatic; it is useful in shaping and differentiating Alex's responses.

That Alex can ask as well as answer questions and use the answers is an important finding, suggesting shared referents. But if we want to better understand the characteristics of the profile differences between Alex and humans, we need continued critical examination of the interaction of Alex and humans. For example, does Alex generalize the questioning technique to other tasks or circumstances, such as asking what's for dinner or what someone is eating? Does he ask questions about causation? Or ask questions for which he knows the answer? Does he question the trainers and observers about the color of novel referents, such as clothing? Does he model questioning for novice trainers or other parrots? Can he be trained to express intentionality in the absence of immediate action?

The lack of focus on such questions is understandable, given the work and training necessary to answer them and the limited time and human resources available. But such questions seem an appropriate extension of Pepperberg's assumptions and procedures. They also relate to her apparent concerns with the relation of Alex's vocal productions to speaking a human language. For example, she spent one chapter examining the parallels between Alex's uses of sound play ('babbling') as a precursor to learning new words, a phenomenon that is documented in human infants. In another chapter, Pepperberg analyzed the extent to which Alex's 'talk' uses the same articulations as those in English-speaking humans. Despite lacking lips and teeth, and having different laryngeal (syringeal) structure, Alex makes similar voiced/voiceless distinctions among consonants and manages variants of labial, alveolar, and velar stops, and the front/back distinction for vowels. These seem important primarily as precursors to comparing Alex's utterances to spoken English.

In short, I appreciate the many clever and serious advantages that English provides in facilitating a specialized interactive protocol of labels, questions, and commands that work effectively in training. It is especially beneficial that all the trainers know the code in advance. Using a human language also explicitly encourages interest in language development similar to that of human infants. But the other side of this picture is that the use of English code can obscure the profile differences between humans and parrots, encouraging the presumption of inappropriate parallels to human language behavior and bearing all sorts of explicit and implicit social meanings that may interfere in perceiving appropriate parallels.

The reader should be clear that I am not questioning the accuracy of Alex's test data. The protocols are explicit, generally well conceived, and repeated often. These issues also have little relevance to Pepperberg's conclusions about specific cognitive capabilities. The problem becomes most salient in trying to clarify the profile differences between Alex and humans, assembling a model of Alex as a functioning organism, and in clarifying distinctions among associations, information processing, and cognitive processing that Pepperberg (1998) has proposed elsewhere. Although Alex is well trained in the use of English words as labels, the observers have much broader exposure to English. They bring this language background to bear on interactions with Alex, and most appear relatively automatically to interpret Alex's behavior in a human communication context.

The importance of ecology

A third change that Pepperberg made relative to the great ape research was her initial explicit attention to biology and evolutionary ecology in choosing her subject and designing her procedures. For example, she noted that parrots are an excellent choice for a language experiment because they are highly social, long-lived birds that recognize individuals. Further, they engage in a great deal of flock-related social calling when they enter and leave social groups. The African Grey parrots in particular seem to engage in lots of complex learned dueting in the social circumstances of pairing and flocking. In terms of interest in the small novel objects that she began with, parrots have good color vision and extensive response repertoires for exploring a large variety of potential food items. They can use their beak, feet, and tongues in complex ways, and they appear to do so readily in exploring novel stimuli and manipulating objects.

A key to facilitating Alex's training, the model-rival procedure, appears rooted firmly in an ethological/observational analysis of the parrot's social behavior, its ability to imitate, its tendency toward vocal interactions in pairs and small groups, and its ability to modify its vocal output as a function of outcomes in such a setting. Another important issue is the use of referential rewards. In nature, animals typically communicate about objects with which they are interacting, thus providing coherence between labels and words that is usually missed when attempting to use food rewards to reinforce learning. In the model-rival procedure, Alex first observes demonstrations of the task by two trainers who switch between the roles of trainer and trainee. He also receives rewards shaping specific utterances. The critical importance of the multiple facets of this procedure is suggested by the much poorer results obtained when Pepperberg attempted to train new parrots or Alex using videotape and more streamlined reward features.

The model-rival procedure seems to be an exceedingly well-done combination of training procedures related to the grey parrot's socio-ecology with a precise, integrated, reliable, and non-disruptive reward procedure. It can be used to facilitate attention in an inattentive pupil by means of withdrawing attention by directing the body away from the parrot or toward the model/rival. It provides multiple learning inputs in the form of several live models and encourages imitation. It provides social support and interaction for a potentially highly social animal, and it allows the trainer to immediately sanction vocalizations in a way that encourages them to happen again.

Two things relevant to the model-rival procedure might be worth considering further. First, because it is a relative free form of interaction organized around some simple rules, it might be worthwhile to examine whether all trainers explicitly follow the same interaction rules and what the effect might be of changing them. There appears to be a tendency for trainers to throw in repetitive and unique elements, presumably to hold Alex's attention to the object about which they are asking. It would be worthwhile to ask how minimalist this interaction could be on both vocal and nonvocal levels. It would also be interesting to explore more precisely how verbal emissions are acquired and modified by other parrots in more natural circumstances. This could serve not only as a check on the niche-related relevance of procedures and phenomena that Pepperberg has developed in the laboratory, but also might suggest some modifications of her techniques.

A disappointment from my point of view is that after her species and procedures were set, Pepperberg appears to have dropped further considerations of ecology and evolution in favor of an anthropocentric approach focused entirely on general human-related cognitive processes and concepts (see Pepperberg 1998). There are reasons for doing this, including the development of ties with the animal cognition movement and the motivation to place Alex in a comparative framework pioneered by the ape-language researchers. It is worth noting, though, that Savage-Rumbaugh et al. (1998) has introduced ecological relevance in the form of developmental timing in ape-language acquisition, albeit in the inductive manner of observant experimental psychologists rather than based on an initial focus on adaptive behavior.

The basic experimental technique of psychologists involves tuning their apparatus and procedures to produce vigorous and successful responding. In many if not most cases, the increase in effectiveness is because they have made contact with niche-related mechanisms, mechanisms adapted to produce adaptive behaviors in appropriate environments (see Timberlake 2001). For example, recall that the Gardners initially depended on food reward in training Washoe, but soon hit on social attention and play (especially 'tickle') as much more flexible, effective, and non-disruptive than the most painstaking food contingencies. Also, note above that Savage-Rumbaugh et al. (1998) made rapid progress in ape-language learning by recognizing the importance of family relations and early experience. Training the mother of Kanzi, even though she was not an apt pupil, provided appropriate input to produce learning in her young offspring (Savage-Rumbaugh, Shanker, and Taylor 1998).

In the case of Alex, it seems very relevant that parrots interact via sounds in flocks, smaller groups, and pairs. It would be interesting if there were motivational and/or reward effects on production and learning. For example, manipulation of objects and food reward would seem to go together, but suppose the reward were access to a social group or a mate: Would Alex's label learning facility and production show changes? Are his categorical judgments related to particular types of object or context? For example, could he generalize the category of 'three-corner' to large structures, such as might be seen while flying, and are there limitations on extending the category to shadows, composite outlines, or painted shapes. The point is the importance of how parrot cognitive abilities relate to the ecological function of feeding, reproducing, flocking, and specific predator avoidance, and how these niche-related mechanisms interact with the laboratory circumstances.

Further issues: Operant conditioning and communication

In this section, I briefly explore the relation of concepts of operant conditioning and communication to Alex's training. My interest here is to reduce the tendency to see these concepts as characteristic of either human or nonhuman animals, and instead to promote their use to clarify the profile differences between Alex and humans.

Operant conditioning

Pepperberg emphatically rejects operant conditioning as relevant to the training of language in general and of Alex in particular. For historical reasons outlined below, I think this rejection is understandable. However, I also don't find her rejection helpful in analyzing the profile differences between Alex and humans. I think there is much to be gained by considering operant procedures and Pepperberg's work in a common analysis.

Pepperberg's rejection of operant conditioning appears based on three lines of influence. The first line, which can be traced to Chomsky, is the argument that the critical characteristics of language cannot be based on the learning of specific sequences of words; instead, there must be an underlying innate grammatical structure used in recognizing and generating novel sequences. In his combative review of Skinner's book on verbal learning, Chomsky (1959) scored major points by treating Skinner's conditioning approach with the same structural arguments that he had developed to critique the traditional sequential analyses of language. Although researchers are still sorting out the nature of the underlying structure(s) assumed by Chomsky, nevertheless, there is no doubt that Chomsky's analysis has been commonly viewed as invalidating an operant approach to language learning.

The second objection to operant conditioning, raised first by the Gardners, is a pragmatic one related to the common practice of using food reward to shape behavior. The Gardners, supported by the zeitgeist of the era in which they began work, and even directly encouraged by a communication from Skinner, persisted for a time in carefully rewarding Washoe with food for making approximations to signs they were teaching. They found that the use of food reward, especially proximate food reward, tended to disrupt rather than facilitate learning and production of signs. When food was reliably available, Washoe tended to abandon signing for behavior and vocalizations related to food searching and social begging, components of the chimpanzee foraging repertoire. The Gardners found that the social rewards of tickling and attention were much more effective than food in shaping and supporting signing.

The third objection relates to the influence of the 'cognitive revolution' that has dominated psychology conceptually during the last 30 years. During this time, many have viewed behaviorism and operant psychology primarily as bugbears to be defeated rather than allies to be joined with. Typically, behaviorism and operant conditioning have been identified with an extreme peripheralism that could not, by definition, deal with broad issues of cognition, much less more specialized aspects, such as language learning. Thus, for Pepperberg and many others, operant conditioning has been viewed as incapable of dealing with language learning because it: (a) lacks a 'preorganized' generative structure for words and sentences, (b) requires food reward, which disrupts rather than facilitates language training, and (c) is presumed too peripheralist to provide a basis for the study of cognition.

On the other hand (and again, there is an important 'other hand'), there are two noteworthy difficulties in Pepperberg's blanket rejection of operant conditioning as a contributor to Alex's training. First, this rejection appears to run the risk of recapitulating aspects of the traditional divide between humans and animals. Pepperberg may be inclined to place the language divide below Alex, separating him from those animals that must learn solely by trial and error. But, as noted previously, I do not believe that such a divide has proved accurate or useful in the history of research in this area. It appears to me preferable to analyze profile differences between specific species rather than to reify differences by ranking species in terms of semi-hierarchical abstract categories, such as communication, intelligence, and consciousness (or even association, information processing, and cognitive processing, as suggested by Pepperberg 1998).

Second, Pepperberg's key methodology, the model-rival procedure, depends heavily on the extensive use of operant contingencies. As noted before, a basic point of the model-rival approach is to take advantage of

Alex's naturally occurring tendencies to modify his vocal utterances and relate them to environmental referents, both based on social feedback. In operant parlance, Pepperberg uses the model-rival procedure to establish the available repertoire and provide environmental support for the discriminated responses that the trainer is rewarding. Within this context, Pepperberg follows good training procedures by treating Alex's utterances as though they were under his control. She rewards those utterances that she wants to encourage by providing contingent events, such as physical access to the correctly labeled item, as well as by approving sounds and postures and the opportunity to go to his 'gym'; she also actively punishes those utterances and behaviors that she wants to discourage by providing disapproving sounds and postures (such as turning away or threatening to leave) and withholding access to the incorrectly labeled items.

In short, Alex's rewards and punishments are consistent and tightly integrated with the tasks of training and testing. They do not evoke attentional tendencies or responses that compete with the task being trained. Further, the trainers keep Alex 'in the game' by a variety of support procedures. If Alex produces a label that is not the correct answer to the trainer's query, that label is acknowledged and often referred to an exemplar that is present. If the correct response is not forthcoming, but seems close, the trainer encourages Alex through commenting or requesting further information, cues that serve as potential discriminative stimuli for at least emitting guesses. If Alex becomes recalcitrant ('slit-eyed and ruffled'), the trainer terminates the session.

So how does Pepperberg's work differ from traditional operant conditioning? I think there are three answers to this question. The first is that Pepperberg began her work with preliminary specific attention to the African Grey parrot's ecological framework. Her application of operant contingencies occurred within a framework of the model-rival procedure based on guesses and previous evidence about the mechanisms and processes of parrot vocal learning and expression. This differs from traditional operant conditioning in that she recognized ahead of time the contribution of mechanisms and processes underlying the functional systems of parrot social communication and foraging and specifically designed her physical environment and procedures to take advantage of them.

This is not to say that operant conditioners have ignored evolution (see Skinner 1966), but their focus in laboratory training has been almost entirely on operant contingencies, predominantly using food and aversive shock. More to the point, traditional operant conditioning paradigms, such as lever pressing in rats and keypecking in pigeons, have managed to produce a fit between the organism and the test environment and procedures similar in many respects to what Pepperberg has accomplished, but the fit appears to have been done entirely inductively rather than partially predictively using a combination of observation, analysis of life-history strategies, and analysis of niche-related mechanisms (Timberlake 1999, 2001).

The inductive approach is particularly clear in Skinner's (1938, 1959, 1961) accounts of his development of operant conditioning. The first step is the design and implementation of environmental and procedural support to increase the probability of vigorous responding — for example, modifying the shape, position, and movement of the lever. The lever could have been any size, located near or far from the food, high or low with respect to the floor. The chamber could have been a variety of sizes and heights. Skinner manipulated many of these variables to determine what worked best for a particular species (pigeons clearly were different than rats). The second step is the establishment of 'setting conditions' such as housing, feeding, reward amount, time of day of the session, and light-dark cycles. Similar explorations occurred to determine the appropriate circumstances here. The third step is to combine apparatus design, procedure, and schedule to produce stable, vigorous, and interpretable responding.

In sum, as Pepperberg appreciated more explicitly, and Skinner realized implicitly, operant contingencies are not simple causal manipulations by the experimenter; rather, they represent an interaction between the stimulus and response contingencies and the animal's organized motivational systems and perceptual-motor repertories (Timberlake 1999). For the quixotic rat, this requires recognition that a hungry rat enters a Skinner box with a repertoire of food-search behaviors primed by deprivation and previous learning about the consequences of behavior in this environment, and engaged and supported by the careful design of the apparatus and procedure. The local presentation of food primes a more focused set of stimulus sensitivities and response components that readily combine to produce responses directed at manipulable stimuli, like a lever, that are followed by the appearance of food. Though the resultant behavior is neither classically reflexive nor precisely instinctive, it emerges because of the engagement of niche-related mechanisms by the environmental circumstances and the operant contingency (Timberlake 2001).

For Alex, the idea that operant contingencies interact with organized motivational systems means explicitly following through on Pepperberg's ecological beginning to establish the repertoire and motivational context with which the contingencies interact. Alex enters Pepperberg's training situation primed for social responding by a combination of housing conditions and by the vocalizations of the trainer. Similarly, Alex is primed for using investigatory responses by a combination of housing and the presence of sets of colorful and manipulable objects of an appropriate size. To the extent that parrot vocalizations are part of both social and feeding systems through basic and learned repertoire, they should be controllable by contingencies that produce social approval and visually and tactilely interesting physical objects.

It is worth emphasizing that Pepperberg did not produce (and perhaps could not have produced) her current training regime by focusing on the traditional use of the three-termed contingency linked to food or shock. What produced Alex's training was Pepperberg deductively and inductively making contact with the social and foraging systems of the African Grey parrot and then doing an excellent job of implementing the contingencies on vocalizing and manipulating the environmental and procedural support. Adding the model-rival procedures created a social system within which Alex competed for attention, and providing access to interesting small objects facilitated contact with manipulation with the beak and tongue. In addition, the rival participants serve as discriminative models for the kinds of actions that they trained Alex to do, thereby taking advantage of Alex's social-imitation skills.

Finally, work such as that of Pepperberg with Alex contributes to the view of contingencies as embedded in the available perceptual-motor and motivational organization and processes of the organism. The way in which the contingency supports and modifies this preorganization determines the final result. *This means that a contingency is not only a means of potentially controlling behavior (using appropriate environmental and procedural analysis, design, and implementation), bit it also is a means for investigating the organization and processes that the organism brings with it to a particular circumstance*. Thus, Pepperberg uses socially tuned and referentially consistent operant contingencies to train Alex to respond in particular ways to his environment, and she uses the same contingencies to discover what Alex knows about his environment.

This double-edged aspect of response contingencies is critical to understanding their implementation. If Pepperberg had treated a rat as she treats Alex, we certainly would not have a talking rat. But it's also true that by rewarding a rat daily with specific kinds of social attention, she might have been able to produce social behaviors, such as attention and approach, interaction with her hand or breath, search for a food having the odor on the experimenter's breath, and perhaps some ultrasonic vocalizations. These results would not necessarily have been carefully and laboriously shaped. The key is to fit the organism to the environment in a way that makes contact with the organism's niche-related mechanisms, those functional mechanisms that were selected because of their contribution to survival and reproduction.

In sum, by anchoring the effects of operant contingencies in the contingency relation, the environmental support present, and the niche-related perceptual-motor and motivational organization engaged by these circumstances, we can find a common ground for training rats to press levers and for training Alex to produce English labels and sentences. The concept of preorganization based on the niche-related mechanisms and capacities that the organism brings to the situation allows experimenters and trainers to use operant contingencies to ask questions about this organization and related cognitive mechanisms of their subjects, the very approach that Pepperberg has exploited so well. From this revised view of the procedures of operant conditioning, what Pepperberg has accomplished is to show how to use operant contingencies and appropriate support stimuli to establish, make use of, and modify preorganized aspects of a communication subsystem that appears to be used by grey parrots in a variety of social circumstances.

A few thoughts about communication

It seems clear that Alex both comprehends verbal labels as a receiver and produces labels as a sender. The labels are mutually referential; that is, they correspond to aspects of the stimulus world that are shared between Alex and his trainers. This would seem to qualify Alex's utterances as a form of communication in most current general approaches (e.g., Evans and Marler 1995). Alex also is able to engage in a reasonable amount of role switching from sender to receiver and back, thereby passing another 'test' for communication. I think Pepperberg would agree that Alex is not communicating in English, broadly speaking. Instead, Pepperberg has taught him to use a subset of English as a semi-private code that enables humans given a small amount of training to interact with Alex to train and test his cognitive abilities. At the same time, Alex's facility with this language-based code, plus the familiarity of observers with the broader English language, inevitably raises the issue of whether Alex and Pepperberg are communicating in an everyday human sense.

Without putting too fine a point on it, the interaction of Alex and his trainers has some of the flexible qualities that characterize human communication. Alex sometimes asks questions, emits what seem like conversational gambits to satisfy his wishes, and may report on his own behavior. But there are several apparent differences that seem relevant to clarifying parrot-human differences. One difference is the nearly continuous vocal 'patter' that Pepperberg produces in training sessions, presumably to keep Alex's attention focused on the material at hand. A related difference is that the dominant form of communication is that of trainers asking questions and Alex responding. It seems appropriate to further explore the importance of these differences from more typical human interactions, both because of their possible relation to conversing with human children or humans with communication deficits and for their relevance to mechanisms related to parrot ecology and neurophysiology.

It is worth pointing out that we should not expect a perfect mesh between parrot and human communication patterns, even with extended training. As Millikan (1984) has argued, there is a proper function of communication within a species based on the selection of common mechanisms related to attention, sending, and receiving. The presence of the common gene pool underlying communicative function means that there will be a common long-term payoff for the development of successful communication within a species. Such a shared payoff for the evolution of communication does not exist for Alex and his trainers. That Pepperberg and Alex were able to establish a shared form of encoding and decoding labels for arbitrary referents without such a co-evolutionary background speaks to an important degree of convergent evolution in humans and parrots in their experiential learning abilities. It would be worthwhile to clarify the extent to which the framework that Pepperberg and Alex have established depends on a generalized learning capability versus adaptations to more specific ecological pressures, pressures that in interaction with phylogeny may have produced humans as vocal caretakers and parrots as vocal collaborators. Relative to other animals taught by humans, there does seem to be something about the characteristics of human and parrot vocal niches that is important to the outcome of the present studies.

A wish list for *Talking with Alex: The Sequel*

I think this book establishes the unquestionable importance of a fascinating research program, and I would like to encourage Pepperberg to produce a sequel. Because the present book covered so many interesting directions, I would hope she continued to follow her multiple interests in writing a second book. However, I also have a small wish list. My first is that Pepperberg discover more about Alex as a parrot, in other words, the relevance of Alex's behavior to parrot ethology, ecology, and evolution. Although a major point of Pepperberg's concerns in this research seems to be its relevance to human language and cognition, I believe the perspective provided by knowledge of niche-related mechanisms and their function and evolution will be invaluable in clarifying the nature of the profile differences between parrots and humans. It should also have relevance to the differences between humans and other species.

One such area already touched on is vocal production and reception. As previously noted, Pepperberg spent parts of several chapters describing the vocal mechanics of how parrots make sounds approximating human speech. It seems relevant to ask how parrots make sounds typical of their own communication patterns and what the limits are of their vocal production and reception mechanisms. Recent work by Suthers and his students on the neurophysiological control of vocal production in songbirds has shown remarkably complex and fine-tuned control of the airflow over dual syrinxes (a larynx equivalent) that overlap in function (see Suthers and Goller 1997). By combining control of the syrinxes and airflow, birds can produce a large array of sounds. Interestingly, blue jays use very little of the potential capabilities of this production system, canaries are solid song citizens, and mockingbirds and brown thrashers are capable of approximating the songs of most other birds. Further, captive starlings reproduce and manipulate much more than the vocalizations of other species, including mechanical sounds like door slams, engines, and sniffles, along with cheers and music (West and King 2001). The imitative abilities of parrots raise the question of whether they have similar mechanics and neural control, and, why, if this is so, they focus so completely on human communication efforts, leaving screen doors and interspersed "sniffles" mostly to starlings. It would seem that parrots may be more tuned to human social interaction.

A related area of concern is the evolution of vocal learning in species of birds and mammals. Eric Jarvis (e.g., Jarvis et al. 2000) has recently reviewed the apparent independent yet convergent evolution of vocal learning in families of birds (including passerines, hummingbirds, and parrots). Other than the surprise for most of us that hummingbirds are vocal learners, his report is significant because of the apparent similarities in the 'cortical' structures that underlie vocal production in these species. Somewhat similar to primate vocalizers, including humans, there are critical midline deep nuclei connected with surface level bands of cells that form an extensive circuit related to production. A functional analysis might yield common selection pressures, especially in terms of signaling for social reasons, such as flocking (banding together) and mate selection.

The ability of parrots to imitate in terms of body structures and behavior also seems relevant and worth exploring. Bruce Moore (1996) reported remarkable imitations by a parrot that he kept. My favorite involves the parrot pacing back and forth in its cage area, accompanying each exaggerated step with production of a squeaking/squelching sound like that produced by a rubber-soled shoe contacting a waxed tile floor.

Occasionally, the bird would pause to interject rhythmic jabbing motions with an outstretched claw, each jab accompanying a word in the utterance, 'Remember Lloyd Morgan!' Moore goes on to discuss the evolution of imitation and speculates on the relation of motor imitation to vocal imitation in birds and mammals.

Another wish would be that Pepperberg make even better use of the plural in her title (*Communication and Cognition in Grey Parrots*). Pepperberg has now accumulated data on a number of parrots that strongly suggests that video is not nearly so effective a training tool as human interaction (the demonstration included Alex trying to learn something as well, so the point is more general than simply a lack of initial experience with vocal learning). Still, it is appropriate and important to know to what extent Alex is unique. Also, if several parrots reach a certain level of vocal expertise in a human code, it makes possible the investigation of group interaction, social rewards, and questions related to a shared language. The results could have relevance to individual differences, sex roles, and social structure.

Also, starting from the strengths of Pepperberg's approach, it might be possible to move even further into Alex's world. The model-rival technique is a fundamental tool that can be justified in terms of the ecology and evolution of parrots. But this justification does not form a completely adequate explanation at the levels of function and mechanism. Why, indeed, does the model-rival technique work? It seems on the surface to be an effective combination for an animal with imitative skills that responds to rewards in a social context. Is this related to the report of a friend of mine that he found it easiest to teach his children to ski if he took along one of their friends? Or is it why autistic children can respond to this approach?

It seems important to ask whether the effectiveness of the model-rival technique is related to Alex's particular development or whether it is rooted in something general about the social-ecological niche to which African Grey parrots are adapted. What evolutionary and genetic basis might there be for vocal learning of the type that Alex has performed? What might be the niche-related function of the underlying mechanism(s)? Most parrots are flocking birds, and these flocks usually involve unrelated animals. Presumably, such flocks have advantages, such as predator avoidance, defense of young, perhaps sharing of foraging information, all together enough to overcome their disadvantages (such as attracting attention from predators, using up food resources more rapidly, exposure to disease, and competition for nesting areas and mates).

Finally, it would be interesting to provide more attention to profiles of potential ecological similarities and differences between humans and parrots. In comparison with other animals, humans are unusually social and unusually vocal. Some songbirds, such as mockingbirds and starlings, are capable of producing a great variety of novel and well-learned vocal utterances. Still other animals appear to have complex social relations, such as chimpanzees and baboons, along with social carnivores such as wolves and dolphins, long-lived herd animals such as elephants, naked mole rats, and, of course, the social insects such as bees, wasps, termites, and ants. Only a few species have both complex social organization and extensive sound-related production and learning capabilities. Parrots appear to be one of those species. Dolphins are another (e.g., Herman et al. 2001). Dolphins have a complex auditory language that they use in social relations, but it appears strongly tied to the auditory production and reception system used in underwater recognition and navigation. Perhaps most to the point, we have not adequately deciphered it, so, as in the case of Alex, we are dependent on encouraging them to learn our signals so we can ask them to perform behaviors that reveal how they understand them. But exploring the behavior of such disparate social sound-makers should provide considerable perspective on the evolution and function of communication and the language-related profile differences between specific species.

Conclusion

This book makes clear that Pepperberg is a persistent, analytic, and gifted experimenter who has dedicated a good portion of her adult life to the training and testing of the language and cognitive abilities of an African Grey parrot. Because she did not have a great deal of precedent to follow in her work with Alex, and an unlimited budget has been out of the question, she was forced to borrow, adapt, and invent techniques as she went along. In my opinion, she began auspiciously by rationalizing her approach and procedures on the basis of parrot social-ecology. She combined this with a critical pragmatic sensitivity to what contingencies and supporting stimuli and behaviors worked well. The result was an effective training and testing technique, the model-rival procedure. Using modeling and imitating behavior combined with imposing consistent contingencies on his vocalizations, she has established beyond useful doubt that Alex has a number of interesting and important language-related cognitive abilities, including: labeling stimulus configurations with vocal sounds, showing an ability to use their referential nature, classifying stimuli in multiple abstract categories, recognizing the referents of numbers and shapes, inventing new labels, and, perhaps in some cases, using a string of words to predict his behavior.

Pepperberg's choice of a simplified English-based vocal code for working with Alex is also an accomplishment, although it has more mixed effects. That an English vocal code is shared between Alex and the trainers makes possible more flexible probing of Alex's cognitive capabilities, and it facilitates finding and training experimenters. But there are definite drawbacks to using such a human-based code. It tends to restrict concern with Alex's cognitive capacities to those used by humans. Although the training procedures make use of parrot ecology and appear to engage niche-related mechanisms, Pepperberg lacks a more specialized code designed to probe Alex's world more carefully. It is important to know how his niche-related mechanisms interact with the complexity of the training regime that Pepperberg has developed.

Another drawback is that observers and trainers alike may find it difficult to avoid interpreting what is happening within a human framework, rather than in a shared or primarily parrot-oriented framework. This is particularly true in dealing with strings of words that Alex emits, such as 'I'm gonna go eat dinner'. It seems very important to find out more about the niche-related bases of the mechanisms that Pepperberg has so aptly engaged. It might be argued that there is nothing wrong with interpreting Alex's utterances with a healthy dose of anthropomorphism as though he were a full-fledged English speaker. (At least, it might be argued, this would be an antidote to the recalled strictures of aspects of behaviorism). But I don't think the issue is whether there has been too much or too little attribution of human states to other animals. The issue is what unique qualities of parrots contribute to the data that Pepperberg and Alex have produced. More specifically, which aspects of the world of Alex and the world of parrots promote this kind of cognitive differentiation and vocal learning, and which do not? The answer to this question would begin to place the work with Alex conceptually, instead of just procedurally, in a functional evolutionary framework.

In short, I think Pepperberg has made an excellent start on the Alex story. She continues to provide evidence articulating the language-related profile differences between parrots and humans, as well as producing perspective on aspects of the profile differences among humans, parrots, and chimpanzees. I would like to see language profiles of the human and parrot, including a bit less emphasis on anthropocentric cognitive capacities in favor of more concern with niche-related mechanisms. Still, when her work is combined with previous and continuing work on other language-trained animals, it is clearly no longer possible to dismiss as 'not true language' the signings of the Gardners' Washoe or the symbol manipulation of Premack's Sarah or Savage-Rumbaugh's Kanzi or the ability of Herman's dolphins to understand the ordering effects of functional prepositions or the distinctions between body parts and left and right (Herman et al. 2001). Language is not simply present or absent.

It would be fascinating to have King Solomon's ring or Dr. Doolittle's abilities so we could talk more easily and extensively with nonhuman animals; but neither of these advantages could tell us all we need to know to understand the similarities and differences between Alex and ourselves. The general mental divide between humans and animals is being slowly turned into profiles of differences and similarities in multiple characteristics that make sense within evolutionary, genetic, ecological, and neurophysiological frameworks. To be sure, investigators are still interested in many of the same general issues of mind that Darwin addressed in his book on the descent of humans, for example: intelligence, consciousness, purpose, language, and communication. In many cases, we seem to be filling in a checklist of whether animals have human attributes. Fortunately, research like Pepperberg's helps provide tools for a more analytic approach to the nature of the language-related profile differences between humans and other animals.

Notes

1. For our purposes here, it is not relevant that there may be atypical humans, altered at conception, or damaged before or after birth, who cannot produce or recognize words or signs as constituents of a meaningful signal. Clearly, the human species has been selected for mechanisms enabling the ready combining of relatively arbitrary auditory and visual symbols to convey complex and subtle meanings in a social context, and that is the level I am addressing.
2. Though this approach has sometimes been ridiculed in retrospect, there is nothing intrinsically wrong with it. It could be improved by paying more attention to specialized mechanisms and the justification of particular tests. I invite the reader to consider that if an avian predator set the tests, they would give much greater weighting to sensory capabilities related to processing wind velocity and recognizing prey from the air, and to fine motor skills related to searching, chasing, and capture. The result would certainly be a different scale of intelligence.
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