A Behavioral Look at the Training of Alex: A Review of Pepperberg's *The Alex Studies: Cognitive and Communicative Abilities of Grey Parrots*

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The Alex Studies: Cognitive and Communicative Abilities of Grey Parrots by Irene Pepperberg is reviewed from a behavior analytic orientation. The results of the majority of her experiments are discussed in terms drawn from the general literature of behavior analysis and Skinner's analysis of verbal behavior. We conclude that she has provided evidence of the complex control of vocal behavior that illustrates a functional verbal repertoire of tacts and mands. This book suggests several areas for future research on the methods needed to establish verbal repertoires in species other than humans.

"Can a parrot understand complex concepts and mean what it says?" This question appears on the inside cover of *The Alex Studies* by Irene Pepperberg to attract potential readers. Pepperberg's book continues the tradition of several nonhuman language researchers who published extended reports of their research projects to appeal to a wider audience. Earlier works such as Kellog and Kellog (1933), Rumbaugh, (1977), Terrace, (1979), Patterson and Linden (1981), Gardner, Gardner, and Van Cantfort (1989), and Savage-Rumbaugh and Lewin (1994) used chimpanzees or gorillas. Pepperberg is unique in her choice of African Grey parrots. She is also unique in that she has continued her research with the original participant (Alex) since 1977.

Why Grey parrots? As stated in the preface, "When I began my studies, the capacities of Grey parrots were unknown" (p. ix). She points out that the popular press contained reports of Grey parrots that did more than simply mimic human speech, they used it functionally. Could this be verified in a carefully controlled scientific study? In Pepperberg's words:

How much *did* the birds really understand? How much *could* these birds *learn* to understand? Given an appropriately enriched environment, might parrots turn out to be the great apes of the bird world?

I set out to find answers to these questions. (p. ix)

THE CONTEXT OF EARLY NONHUMAN LANGUAGE RESEARCH

In the late 60s, interest in nonhuman language from a scientific perspective was bolstered by a report that a chimpanzee named Washoe had learned over 130 functional signs in about 4 1/2 years of interaction and specific training with signing humans under controlled conditions (Gardner & Gardner, 1969). Research continued with a variety of approaches using either topography-based responses (signing) (Fouts, 1973; Terrace, 1979) or stimulus selection based responses (selecting unique symbols) as the speaker and listener behavior in a verbal exchange (Savage-Rumbaugh, 1984). It was in this context that Pepperberg launched her own series of investigations with a parrot.

Choosing to study language with any participant other than a human had its costs. Linguists generally consider the simplistic language tasks required of nonhuman participants unrepresentative of human language and were harshly critical of the published findings (e.g., Sebeok & Umiker-Sebeok, 1980). Even the animal researchers themselves were critical of the results reported by others studying the same subject (e.g., Terrace, Petitto, Sanders & Bever, 1979).

In general, language researchers using nonhuman participants used cognitive theory to explain and justify their work. The rationale for teaching human-based communication meth-

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ods to nonhumans was to assess the cognitive abilities of the nonhumans. They viewed human language as a symbolic system founded on cognitive constructs. The typical criticism of each other's work was that an important cognitive construct was not clearly demonstrated by the experimental methodology. In other words, some simpler process could explain the nonhuman's behavior. The point on which they all agreed was that behavioral methodologies (such as matching-to-sample or oddity-matching, differential reinforcement, shaping, fading, prompting, etc.) and principles (such as reinforcement, generalization, conditional stimulus control, discrimination, etc.) were not relevant to their results. If their methods could be construed as operant conditioning and their results produced by contingencies of reinforcement they considered the work flawed. They ignored the behavior analyst's approach to language (i.e., behavior controlled by contingencies of reinforcement and punishment) because it did not address critical cognitive and linguistic constructs.

BEHAVIOR ANALYSIS ACCORDING TO PEPPERBERG

Pepperberg sides with the other nonhuman language researchers on the limitations of the behavior analytic approach. She asserts that the "cognitive revolution" was a paradigm shift that led psychology away from "the behaviorist tradition best exemplified by Skinner (1974)" (p. 2). She characterizes the behavioral tradition as simple laws concerned with S-R associations using a limited number of species "because none would react any differently from a pigeon or a rat" (p. 3) (an assertion she attributes to Skinner's 1938 book, *The Behavior of Organisms*). Also, she claims that behavior analysts ignore cognitive skills involved in "learning, remembering, problem solving, rule and concept formation, perception, recognition" (p. 3; Pepperberg quoted Roitblat, 1987, p. 2). She goes on to say, "Despite initial successes, behaviorists found themselves faced with situations their laws could not explain." (p. 3). Oddly, she ignores the source she said exemplifies the behavioral approach, Skinner and his 1974 book, *About Behaviorism*. In that book, Skinner contrasts the cognitive account with the behavioral account of perception, remembering, problem solving, rule and concept

formation as well as other constructs such as knowledge, thought, and understanding. In short, the cognitive accounts were not ignored they were examined and found less useful than behavioral accounts. Pepperberg also criticizes the typical procedures and conditions found in operant laboratories. She describes these as the use of food deprivation, isolating animals in operant chambers to arrange mechanized delivery of stimuli and food consequences for responding, housing participants in individual home cages that limit social interaction, and generally providing an environment quite different from a natural environment. Also, the operant researchers made no effort to communicate with their participants about the experimental tasks and explain what is expected. Because of this, Pepperberg claims the animals only learned from trial-and-error.

Her primary example of the operant approach to teach inter-species communication with birds capable of human-like speech sounds is Mowrer (1952, 1954, 1980). She describes Mowrer's method as giving food, water, and social attention only in the presence of the trainers, who said English words as they gave the bird food. The training involved pairing food with a training stimulus until the training stimulus became conditioned. For example, the trainer might say "hello" to the bird and then give it a piece of food. Eventually, the bird came to mimic the trainer saying "hello." Next the trainers attempted to develop stimulus control of the bird's "hello" response such that it would only occur when another trainer suddenly appeared. She explains:

The idea was that, after a bird emitted vocalizations with some frequency, it could be trained to produce the utterance only in the original, appropriate context (on the appearance of the trainer) by providing the food only when the vocalization was emitted in such a situation. (p. 14)

She noted that Mowrer's method produced poor results because:

His use of food rewards that directly related neither to the task being taught nor the skill being targeted (such as saying "Hello" when the trainer appeared) probably delayed or possibly prevented learning: Most likely birds confounded the label of the object or action to be taught with that of the unrelated food reward. That is,

his birds apparently connected reproduction of human sounds with the inevitable appearance of food (a salient object to a hungry bird) rather than with their actual referents, for example, "Hello" and the appearance of the trainer. (p. 14)

She goes on to explain in a footnote that Mowrer's birds did learn to ask for foods. However, "Failure to learn appropriate use of sounds such as "Hello" conditionally (i.e., at the appearance of the trainer) probably occurred because the bird had learned to use the term instrumentally, to obtain food from the trainer" (p. 330). We can translate her explanation as the bird learned to mand food by saying "hello" rather than mand a greeting from the trainer (the food was probably more reinforcing at the moment than the greeting).

PEPPERBERG'S COGNITIVE SOCIAL MODELING APPROACH

Pepperberg is critical of using an operant methodology to study communication in social species, especially birds, because she says it ignores the social context that governs social interactions and the natural social function of a bird's vocal responding. She argues that one needs to observe birds in their natural setting and bring as much of that social context into the laboratory as possible to produce meaningful outcomes. For her the social context includes such things as "the quality and quantity of input during interaction, the relative status of individuals who are interacting, the environment in which interaction occurs, and the feedback a learner receives for attempting the behavior it is learning" (p. 17). Without this context a lab bird could learn a particular vocal response form but fail to develop a functional repertoire involving this response form.

She cites social modeling theory involving cognitive constructs as the theoretical guide for her work and the model/rival technique adapted from Todt (1975) as the best methodology for bringing the critical social cognitive features to the laboratory. She describes the general model/rival method as follows:

... humans assume roles played by psittacine peers in the wild.... In Todt's procedure, one human is exclusively the principal trainer of each parrot, asking questions and providing increased visual and

vocal attention for appropriate responses. Another human is exclusively the *model* for the parrot's behavior and simultaneously the parrot's *rival* for the attention of the principal trainer.... Todt's parrots learned the model/rival's response often in less than a day, in striking contrast to the slow and sparse acquisition in operant paradigms. (p. 16)

The social modeling theory she describes draws heavily from Albert Bandura's social cognitive theory of learning (Bandura, 1986). This theory is rich in language-mediated explanations of learning and is generally applied to the complex human social behavior of language able humans. In her opinion "Social modeling theory thus provides a framework for devising optimal training procedures, but does not delineate how its tenets are to be put into practice" (p. 24). She selects only those aspects of the theory that are general enough to apply across species. According to Pepperberg, the theory addresses learning at two levels:

One level separates learning situations into three functionally distinct categories: two types of active input—social modeling and social interaction—and the passive phenomenon of observational learning. A second level involves determining the optimal form of input for a given type of learning. (p. 21)

She considers the social modeling training situation very different from a typical operant learning paradigm. The social modeling situation is described as more dynamic. The trainer adjusts the modeled acts (social modeling) based on how the participant responds on a trial-by-trial basis, and talks to the participant (social interaction) about what they are doing and why. Social comments are used to motivate model responding. She characterizes the operant paradigm as the participant "learns to respond to a few simple stimuli (e.g., a ball, a block) with actions acquired by trial and error (e.g., point to one item rather than to another) and is rewarded with an unrelated item (e.g., food)..." (p. 21).

As we move from the theory that guides Pepperberg's research to the actual procedures that she uses to operationalize this theory, it becomes clearer how the principles of behavior analysis are operating in her methodology. Rather than trying to translate Pepperberg's social cog-

nitive concepts into behavioral terms we examine her methodology in detail and report what she does in behavioral terms drawn from the research laboratory and terms drawn from Skinner's analysis of verbal behavior. Pepperberg has published much of the data in this book in a variety of professional research journals. We only discuss the information as she reports it in this text and only the material that has direct relevance to the study of verbal behavior. Some of the description of the experimental rigor relevant to a scientific journal may have been omitted to make the book more readable for a wider audience but Pepperberg provides references to her published work for the interested reader. We do not address nor debate the details of the extensive references to cognitive theory and concepts but instead focus on the repertoires of Alex and the contingencies that produced them.

The 17 chapters of this book are organized around a series of cognitively oriented questions that serve as chapter headings and take the reader from the background theory and related research (chapters 1 and 2), through the training of specific vocal responses under the control of progressively more complex stimulus conditions (chapters 3–11) to a discussion of how Alex's vocal play or babbling compares to the vocal play of children learning language (chapters 12–13). In chapter 14 she describes her work with two other Grey parrots and restates the importance of contingent social attention inherent in the model/rival method of training. She adds two chapters (15–16) on the physiology of speech in the Grey parrot and ends with a chapter titled "Conclusion: What Are the Implications of Alex's Data?" where she states:

The data in this book are meant to provoke awareness in humans that animals have capacities that are far greater than we were once led to expect, and to remind us that all we need to examine these capacities are some enlightened research tools. How these data are to be used—and interpreted—are, of course, up to the reader. (p. 327–328)

THE TRAINING METHOD DETAILS

Pepperberg describes the environment where Alex lived and worked as one designed to facilitate the development of good vocalizations. The room where they worked was relatively

free of echoes and supplied with the necessary furnishings for both humans and parrots. Trainers were present approximately 8 hours per day and Alex was allowed free time to explore and play when not involved in specific training or testing trials. Food and water were always available to him and he often received special foods from the trainers. His work sessions were around an hour in length but often broken into shorter segments to maintain task oriented responding. There were usually one or two formal work sessions per day. Trainers verbally interacted with each other and Alex during their time together such that a social environment was maintained. This social environment was critical to the model/rival (M/R) approach employed during training. As described earlier, the M/R technique involves humans modeling behavior for the parrot. Pepperberg states:

In a typical interaction, the bird is on a jungle gym, its cage, or the back of a chair, and observes two humans handling some objects in which he has already demonstrated interest (perhaps has used them as preening implements). While the bird watches, one human "trains" the second human. The trainer presents an object, asks questions about the object (e.g., "What's here?" "What color?" "What shape?"), and gives praise and the object itself as a reward for a correct answer ... the second human is the *model* for the bird's responses and a *rival* for trainer's attention. The model/rival occasionally errs (produces garbled utterances, partial identifications, etc., that are similar to mistakes being made by the bird at the time). Disapproval for an incorrect response is demonstrated by scolding and temporarily removing the object from sight. (p. 26)

The interaction is repeated with the roles of trainer and model/rival reversed. The bird is not always included in the interactions but if he begins to participate is addressed directly in an involving manner. If he emits the same response as the model/rival he is praised and given the object to manipulate.

METHODOLOGICAL ISSUES AND THEIR IMPLICATIONS

The social features of the training procedure and data recording allow for less experimental control than would be found in the typical animal experiment involving operant chambers

and computer controlled data collection. While Pepperberg considers this necessary to produce the critical repertoires, it has implications for a causal analysis. In other words, we can describe the general relationships between particular responses and the stimulating circumstances but cannot say what features of the procedure were necessary to produce these relationships.

Another aspect that confounds the identification of the controlling variables is that each experiment is embedded within other ongoing experiments and/or learning interactions. This makes it difficult (if not impossible) to determine exactly what was required to produce the reported repertoires. An example of this is in the description of how Pepperberg and her trainers responded to the problem of Alex's tendency to stop working during a session:

For Alex, this problem was resolved through concurrent training or testing on various other capacities in any given session. During training on same/different, the concurrent tasks involved number concepts (Pepperberg, 1987a), additional labels (Pepperberg, 1987b), photograph recognition, and object permanence (Pepperberg & Kozak, 1986)." (Pepperberg, 1988, p. 557).

Thus, Alex was exposed to different experimental tasks within and across sessions. It is difficult to draw conclusions as to what impact each training task contributed to the results obtained. If one is only interested in demonstrating that a particular complex repertoire can be trained with an organism then this is appropriate. However if one is interested in arguing the value of critical features of a training protocol (as Pepperberg does when she asserts the value of specifics in the M/R technique) then a more systematic method is required to demonstrate the control of critical elements.

Perhaps because multiple experiments were being conducted simultaneously, some of the reported training and testing apparently spanned large amounts of time. We write "apparently" as the timelines for the studies were derived from the book with great difficulty—one had to scour each chapter for timeline references and extrapolate from those scant references. In one case what she refers to as testing spanned roughly a year.

A third methodological issue is related to

Pepperberg's use of the terms training and testing. Her distinction between training and testing conditions is probably more structural than functional. For instance, Pepperberg describes Alex's typical day as consisting of about 8 hours of time in which he was allowed to explore the lab and interact with trainers. She writes:

At various times throughout the day Alex received foods (e.g. fruits, vegetables, nuts) that the trainers appropriately labeled, but without the repetition that accompanied formal instruction. He was also trained to respond to a limited number of commands, such as "climb" and "go perch." ... I also monitored Alex's vocalizations between training sessions. Initially I kept a daily record of all our interactions, tabulating and sequentially numbering his utterances. For each label in his repertoire, I noted if he produced it spontaneously, subsequently correctly identified the corresponding item and received it as a reward.... (p. 37)

What she calls training sessions were embedded in this 8-hour timeframe, and consisted of one or two sessions, of less than an hour each. If the interactions that occurred during the other 6 to 7 hours are considered something other than training, how does this relate functionally to the training outcomes? It would appear then, that the majority of Alex's interactions with trainers (at least in the initial stages) occurred in a non-structured setting, much in the way children are said to learn language (Hart & Risley, 1995). Many of these training interactions involved the M/R technique with the objective of improving the clarity of Alex's vocal responses such that responses were recognizable most of the time (80% to 90% criteria). Pepperberg notes that "Usually, one or 2 months of work was necessary before he learned to manipulate his vocal tract appropriately to produce a novel sound" (p. 50). These training interactions differed little from the testing sessions in which the M/R method was also used. The data that Pepperberg presents are only based on the test sessions. Note, however, that this minimizes the presumed effect of the two or more months of response clarification work. While it is true that she often singles out the first presentation and reports those data separately, "first" is a bit misleading as Alex often had several months of

clarification training prior to this. Another criterion adopted for later studies was that testing would not begin until "... we eliminated his interruptive behaviors. We thus required that three consecutive sessions did not include irrelevant responses of 'tray,' 'green,' or grabbing of preferred items before testing began" (p. 134). This is likely an insight into the typical training method used—that is, the only difference between this criterion and the previous criteria used is that Alex already had clarity of speech for the responses in this experiment. Thus, the researchers trained Alex to emit the correct response (eliminating incorrect responses) then claimed a high first trial accuracy rate (over 80%). In both cases, large amounts of training data are not presented, data of great interest to behavior analysts.

On the positive side, during testing trials Pepperberg is careful to present stimuli that are randomly arranged and either partially, or completely novel to Alex. However, she seldom reports the total number of items in the training set, which has been shown to be a factor in improved performance and generalization (Wright et al., 1988).

Throughout the book, Pepperberg provides training and testing transcripts that reveal interesting information. Although brief, they often supply insight into the behavioral contingencies that probably contributed to the shaping of Alex's verbal repertoires. Reading the transcripts is probably like reenacting Moerk's (1992) review of Brown's (1973) analysis of parent/child interactions (see also Salzinger, 1994). With these transcripts, one can see that antecedents and consequences were manipulated in a manner consistent with discrete trial training.

Another issue has to do with what is recorded as a correct or incorrect response during a trial. Pepperberg asserts that a topography based approach is better than a stimulus selection based approach to assessing verbal competence because the organism can respond with any possible response form rather than be confined to picking from an experimenter selected stimulus array. But when she is scoring Alex on some task, she marks whether he emitted the response of the correct form or of an incorrect form. However, the incorrect forms are all response forms from his trained vocal repertoire of words. That is, she does not consider other incorrect responses forms as relevant to the re-

search question. For example, Pepperberg presents a table (p. 46) which notes Alex's accuracy on "labeling" (or what a behavior analyst would call tacting). Four words were associated with four objects and Alex was taught to say the word when shown the object. The table is labeled "test results" and indicates the total number of presentations that Alex was exposed to, which totaled 58 for "paper," 61 for "key," 60 for "Wood," and 69 for "Hide." Then, the number of correct responses is presented as well as responses that were incorrect, but only those incorrect responses that were one of the 4 response forms being tested (thus, when testing wood, Pepperberg only counted "paper," "key," and "hide" as incorrect responses). From a behavior analytic perspective, the number and type of trials that led to the testing point (a period of approximately 4 months is not accounted for) as well as trials in which some other response occurred, such as preening, not responding, etc. are relevant to explaining the results. In many applied settings, a behavior analyst considers these responses as incorrect and important in determining how to work more successfully with their client. Pepperberg's cognitive orientation probably limits what she will consider as a relevant response. In multiple places in the book, she refers to Alex as choosing among his words for the correct one. For example, Pepperberg writes:

Thus, even though the range of correct responses to queries of "What's same" or "What's different" was limited to 4 choices ("color," "shape," "matter," or "none"), in any one trial he had to choose from among numerous valid responses to other questions such as "How many?" or "What color?" to be correct. (p 87)

So, it is possible that in her view these are the only reasonable responses Alex could make given the circumstances. However, a more functional approach would address the relationship between the stimulus circumstances and a class of functionally related responses. For example, a child who jumps up and down as a mand for water is still emitting a mand, even though we prefer another response form. We would be interested in how the "jumping" form developed.

If one looks past the points mentioned above,

or translates them into more operational definitions, then what Pepperberg has accomplished with Alex is quite remarkable—certainly a much larger repertoire than most non-primate subjects have obtained. In addition, Pepperberg paid close attention to avoiding experimenter bias and cueing, as well as providing generous amounts of novel stimuli for generalization testing.

There is enough detail in the book to interpret Pepperberg's training procedures of Alex's vocal responding from a verbal operant perspective. Most of her training methods indicate that Alex developed an extensive mand and tact repertoire. We will be applying the commonly accepted definitions of these terms as derived from Skinner (1957) and the operationalization of these terms as often reported in this journal. A tact is a verbal response whose form is controlled by a nonverbal discriminative stimulus and maintained by conditioned reinforcers and a mand is a verbal response whose form is controlled exclusively by a particular motivative operation and is consequted by a specific reinforcer related to that motivative operation.

MAND TRAINING

After 26 months of training, Pepperberg states that Alex had "achieved a rudimentary form of communication" (p. 51). While she does not supply many details of those first utterances, they appear to be mands. This early training with Alex used the M/R technique to produce distinctive vocal responses for preferred items. When the desired vocal response occurred to the displayed, preferred item, it was immediately given to him for play. In addition, during informal sessions Alex was immediately given access to any object that he correctly named. Pepperberg called these consequences "referential rewards." This training is almost identical to typical mand training. This makes sense as mands are generally the first verbal operants to appear in a child's repertoire (Sundberg & Partington, 1998; Skinner, 1957). In at least one instance, Pepperberg and her associates used a form of motivative operation to evoke a response from Alex. Apparently Alex often used a cork or paper to clean his beak shortly after eating. As described in one of the transcripts, Alex was given a banana af-

ter which he said "cork" and was given a cork. He then used the cork to clean his beak.

While Pepperberg notes that "color labels" (a form of abstract tact) were trained in the first 26 months of Alex's training, it appears his vocal responses functioned more as mands than as abstract tacts. The references to color early in Alex's training were always in combination with some other object that he was given after the label appeared. For example, given the prompt "What's this?" Alex might respond "hide" and immediately be given this preferred object. Given the prompt "what color?" Alex was required to respond "green hide" which also resulted in the hide being given. This was also true for other relations trained, for example when asked the shape of an object he would reply "3-corner wood" or "4-corner wood" and receive the object. At the very least these appear to be part mand and part tact indicating joint control by specific motivative operations and nonverbal antecedent stimuli. From these data Pepperberg concludes: "Alex had indeed learned to form categorical classes" (p. 61).

Later in the book (chapter 11) Pepperberg talks of training the use of "want" for the same reasons that behavior analysts train that usage: "A child who can emit 'I want' before a specific topography can help an instructor discriminate between a response that is a tact and one that is a mand" (Sundberg & Partington, 1998, p. 250). Of course Pepperberg does not refer to the elementary verbal operants in this manner, but her reasons for inserting "want" in Alex's vocal repertoire are the same. "... We modified our procedures slightly so that a bird would work with objects in which it has little interest. A bird that uses 'want' can request alternative objects for its reward" (p. 31).

Interestingly, Pepperberg refers to some of the behavioral literature demonstrating functional independence between some of the verbal operants (e.g., Twyman, 1996). However, she does not conduct her research in a manner that addresses this question. It took approximately 9 months of training to establish the use of "want" in Alex's repertoire. Once this was trained it allowed Pepperberg to arrange a new contingency—presenting Alex with an item that was less preferred, ask him to name it, and then give him a more preferred item that was requested using the "want ____" response form. The consequence for a correct response was now social praise and the opportunity to

get a more preferred item. This change in procedure meant that the particular correct response form was less controlled by the preferred object and more controlled by the antecedent, nonverbal discriminative stimulus. Under these conditions the response was more likely a tact.

TACT TRAINING

Initially, Alex was taught object tacts. For example when shown a piece of hide, and prompted with "what's this" the correct vocal response was "hide" (with some shaping of vocal approximations). Of course, he was also given the hide. Early training focused on his preferred items, so what was called "labeling" was probably under greater mand control. As mentioned earlier, even when training colors, a strong mand component was present because Alex received the preferred object to manipulate. He learned to combine the color as well as the object name to get the object. For instance he was asked "what color" when shown a piece of green hide, and was given the green hide only when he said "green" or "green hide." However, when the functional use of "want" was added to Alex's repertoire, pure tacts could be trained. Under conditions in which an item was less preferred (the motivative operation for another object was stronger), Pepperberg required Alex to tact a feature of the displayed object but then allowed him to request a more preferred object, which was immediately given to him. This occurred relatively early in Alex's training history, roughly starting in 1981, which preceded many of the more complex discriminations we describe below. Notice that some of the discriminations that Alex learned in this stage were conditional on the type of prompt presented. Early on "what's this?" was likely a simple verbal prompt for Alex to respond with the name of the object being shown (e.g., "hide" or "3-corner green hide"), but later, when "what color" and "what shape" were introduced, the response Alex emitted was conditional upon the verbal prompt ("color" or "shape") and one of the object's nonverbal features (e.g., "green" or "3-corner").

Pepperberg soon moved into more complex conditional discriminations. She demonstrated that Alex could respond fairly accurately to questions asking, "what same" or "what different" after training and testing. In these cases,

Alex was presented with two objects that either varied or were similar along three dimensions: color, shape, and material. For example, a typical trial might consist of presenting a triangular, red piece of hide, along with a square, blue piece of hide. If asked "what same?" Alex would get the objects if he said "matter." Pepperberg gradually increased the novelty of the stimuli presented to Alex, from well-trained objects, to slight variations of those trained, to mostly novel objects. Over the course of 9 months, Alex was able to reach between 70% to 86% accuracy on this task. Pepperberg accepts this as sufficient for mastery of the task. Interestingly, Alex performed better on the novel objects than on the familiar objects, a performance that Pepperberg attributes to the more interesting (and presumably reinforcing) nature of the novel items. This illustrates the mand component that is prevalent throughout her research.

Shortly after training same/different, Pepperberg added what she calls absence of information as a controlling variable for the response "none." The training/testing was very similar to the same/different training/testing, with the exception that for some trials the objects were identical and on other trials the objects differed on all dimensions. In these conditions, when presented with two objects that are the same matter, shape, and color, and a prompt of "what different," Alex was taught to say "none," and if all features of the two objects were different, then when asked "what same" he should also respond with "none." Training on "none" took 3 months, and testing occurred over the course of a year (but note the earlier comments on training and testing, in both cases Alex was learning the task). So, after one year and 3 months Alex reached between 72% and 85% accuracy on the task with similar and novel object pairs. In this case accuracy was lowest with the novel objects. Pepperberg writes, "The data suggest that Alex has at least limited use of the concept of nonoccurrence or absence ..." (p. 94).

Next, Pepperberg reported on training "numerical concepts" with Alex. Basically, this involved presenting a specified quantity of a particular object, then requiring Alex to label the quantity and type of object. For instance, when presented with three corks that were handheld, and prompted with "how many" or "what's this" he received some form of rein-

forcing consequence for the answer “three cork” (the object label was required). It was unclear how long such training took, but Pepperberg wrote, “Training on ‘five’ began only after testing began on ‘two’; training on ‘six’ began 2 1/2 years after Alex acquired ‘five ...’” (p. 101). Thus, training spanned many years, but the actual cumulative training/testing time is unclear. Alex was trained/tested on the quantities of 2 through 6 and reached accuracies of roughly 80% correct with familiar objects. When novel objects were introduced and displayed on a tray versus being handheld, Alex was required to only tact the number of objects without the name, since he had no names for them. After training on this task, Alex reached between 75% and 80% accuracy. When the pattern of the object presented was switched to a random array of the same object (versus the original orderly arrays), Alex’s accuracy ranged from 76% to 77%, so it was unlikely that the stimulus pattern formed by the object was controlling the quantity tact. Next, Pepperberg increased the conditionality of the discrimination. Alex was required to name a subset of an array of heterogeneous items. For example, 3 corks may have been displayed in an alternating or random pattern with 4 keys. When prompted “how many keys,” Alex was required to say “four key.” Then, increasing the conditionality of the stimulus control further, Pepperberg required Alex to report the number of specific objects from among an array that contained 4 subsets of items. For example, Alex was prompted “how many red wood” with an array of various quantities of red wood, blue wood, green key, orange hide. Alex reached 67% to 100% accuracy on the task.

In Chapter 8, Pepperberg attempts to answer the question posed as the title of the chapter “How can we be sure Alex understands the labels in his repertoire?” (p. 125). She proposes the following as an operational definition (or guideline, as she also calls it) for the task Alex should master: “I require the decision-making process also to include the *capacity to choose*, from among *various possible sets of rules* that have been acquired or taught, *the set that appropriately governs the current processing of given data*” (p. 127; italics were added by Pepperberg). Fortunately, Pepperberg provides some of the details of what Alex actually did, as most of the operational definition is not in

terms of observable, measurable behaviors but inferences made by the experimenter.

In fact, Pepperberg increased the complexity of the task by increasing the depth of the conditional discrimination. For example, she might present the following 7 objects on a tray to Alex: purple key, yellow wood, 3-corner green hide, blue paper, square wool, grey box, and red truck. On each trial he was asked a specific question about the objects such as “What object is grey?,” “What color is truck?,” “What shape is hide?,” or “What object is 3-corner?” There were about 100 objects to choose the set of 7 from for each trial. Alex would answer the question with a vocal response from his current repertoire (e.g., “box” or “red” or “3-corner” or “hide”) and scored as correct or not. Training was conducted for approximately 5 months and testing (one test trial, one to four times per week) for an additional 11 months. Alex reached an accuracy rate of approximately 75% to 89% on questions related to shape or color. Pepperberg then added more complexity to the task by adding an additional layer to the conditional discrimination. In her words, Alex “was asked to label the specific instance of one category of an item uniquely defined by instances of two other categories” (p. 144). Thus he might be asked to name the color (color category) of the 5-corner (shape category) paper (matter category) from an array that had several 5-corner shapes, several colors and several different matters. For example, being presented with 3-corner purple rock, 3-corner orange wood, 3-corner blue paper, 3-corner yellow hide, 4-corner green hide, 5-corner grey hide, and 5-corner purple paper, Alex might be asked: “What color is 3-corner hide?” or “What shape is purple paper?” Alex’s overall scores on this conjunctive task was approximately 77% correct. From these data Pepperberg concludes that understanding of the labels can be inferred.

Next, Pepperberg trained Alex to respond to discriminate larger and smaller items on a relative discrimination task. In this task he was presented with two different objects that generally were different colors and was asked “What color bigger?” or “What color smaller?” Occasionally, he was asked, “What matter bigger?” or “What matter smaller?” when presented with different-sized objects made from different materials. Alex’s overall accuracy on these trials was roughly 79% correct. On a few

trials (11), he was presented with same-sized objects and also asked the larger/smaller question. On 9 out of those 11 trials, Alex responded with "none." Recall that Alex had been trained to respond "none" under different circumstances, namely when asked "what different" with objects that were similar, or varied, on matter, color, and shape.

CONCLUSIONS

The goal of Pepperberg's research is to train and test repertoires that will reveal the cognitive abilities of the parrot—not its language skills. She prefers to hypothesize about cognitive variables to explain the complex conditional stimulus control that her extensive training techniques have produced. She has demonstrated that a parrot can tact features of a nonverbal stimulus that are usually only accessible to verbal humans and some other mammals (chimpanzees, gorillas, or marine mammals) with similar complex training histories.

Pepperberg reports that Alex has (as of 1999 when this book was published) "... a repertoire of over 80 vocalizations, including labels for foods, locations and quantity" (p. 132). From our perspective she has developed effective verbal repertoires in Alex consisting primarily of mands and tacts. Some of the tacts occur under complex conditional stimulus control not yet achieved with other birds in a traditional operant laboratory. Like any other set of experimental results, the validity of her conclusions can only be demonstrated with future replications. Her success with subsequent birds is less impressive but that research has only just begun. Although this book is written for an audience with a cognitive orientation and an appreciation for the basic research questions and methods related to animal cognition, there are several interesting research issues for behavior analysts. For example, from a contingency analysis perspective, what features of the M/R training technique are most critical and why? How might this work be applied to the development of complex conditional discriminations in other species? If behavior analysts carefully read between the lines of Pepperberg's procedural descriptions with an eye to the contingencies responsible for the repertoires they will appreciate the value of this work.

Finally, Pepperberg should be commended

for the wonderful breath of her studies with Alex—as well as the perseverance required for the extensive parrot training that has spanned more than a quarter century.

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