Avian Visual Attention in Science and Culture

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Contrasting views of avian attention cause a tension in both laboratory science and popular culture. For much of this century, laboratory science has usually interpreted a bird's "mental life" in terms of impersonal, objective, mechanical "value-free" processes, such as conditioning. At the same time, however, a minority view has held that a bird's mental life bears striking similarities to that of a human, so that empathic understanding of a bird's mental life might to some degree be conceptually meaningful and empirically possible. Similarly, popular culture seems inclined sometimes to adopt an impersonal approach to birds and at other times to interpret a bird's mental life, especially that of bird pets, in more mentalistic or subjective and "value-laden" terms, including empathic understanding, attachment and bonding.

This tension motivates many basic questions. What is the avian mind? Are there profound similarities between human and avian minds in terms of objective, impersonal issues? If so, do these similarities imply there are also similarities in terms of subjective, personal feelings?

Contemporary laboratory research on avian cognition addresses these questions. This research is identifying new similarities between avian and human cognition. As examples of this research, we describe three similarities between avian and human attention, specifically in spatial attention, local/global attention, and selective attention. We explore how similarities such as these between avian and human attention exacerbate growing tensions between value-free and value-laden views on the relation between animal and human intelligence: They amplify unresolved contradictions in science and in Western culture involving the deepest ethical, economic, religious, and political assumptions.

These similarities, contradictions, and tensions are addressed in a class called "The Animal Mind in Nature, in the Laboratory, and in Human Culture," offered in the Psychology Department at the University of Utah. Students in this course study the science of comparative cognition as well as volunteer service at the Hogle Zoo, Tracy Aviary, Salt Lake Dog Training Club, State Division of Wildlife Resources, Hawk Watch International, the Humane Society, or Salt Lake County Animal Services. The course examines ties between laboratory science on nonhuman animal cognition and the larger cultural context. We hope the class promotes greater public understanding of the science of nonhuman animal cognition, and at the same time, we expect that an examination of the influence of cultural beliefs on the development of science ultimately will illuminate theoretical assumptions not yet systematically evaluated or even yet identified by contemporary research on comparative cognition

Chapter Outline & Navigation

I. Introduction

Contrasting views of avian attention cause tension in both laboratory science and popular culture. For much of this century, laboratory science has usually interpreted a bird's "mental life" in terms of impersonal, objective, mechanical "value-free" processes, such as conditioning. The chapter in this volume by Sutton and Roberts (2001) contains a clear historical review of this approach. At the same time, however, a minority view has held that a bird's mental life bears striking similarities to that of a human, so that empathic understanding of a bird's mental life might to some degree be conceptually meaningful and empirically possible. Similarly, popular culture seems inclined sometimes to adopt an impersonal approach to birds and at other times to interpret a bird's mental life, especially that of bird pets, in more mentalistic or subjective and "value-laden" terms, including empathic understanding, attachment and bonding.

This tension motivates asking, What is the avian mind? What objective similarities are there between human and avian minds? Are there corresponding subjective similarities? Finally, is it possible that there is an interaction between the value-free, scientific approach and the value-laden popular approach? If so, can we make any predictions about how these two different approaches may affect each other in the near future?

Research on avian cognition is identifying new similarities between avian and human cognition, three of which we describe; spatial attention, local/global attention, and selective attention. We explore how similarities such as these affect the tension between value-free and value-laden views on the relation between animal and human intelligence and we explore how these similarities amplify unresolved contradictions that have deep ethical, economic, religious, legal, and political ramifications.

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Figure 1

We wish to alert the reader at the outset that this chapter can be viewed rather like a verbal example of a classic reversible figure, such as Figure 1 (left). A reader can see two very different chapters depending on the reader's primary interests. One way of looking at the chapter reveals material on avian visual attention and the relation between scientific literatures on avian and human visual attention. A second way reveals material on the avian mind from the perspective of human culture. A reader chiefly interested in the first way of seeing the chapter should concentrate on section II. A reader interested in the second perspective should concentrate on section III. We feel, however, that neither perspective alone captures our chief point, which is that science and culture interact, with each importantly shaping the other. We hope, therefore, that the reader will try to transcend seeing our chapter as either on the science of avian attention or on how our culture views the avian mind, or even on both of these themes viewed separately, and will try instead to think about how science and culture mutually affect each other.

II. Attention in Science and Culture

Our aim is to present a few examples of research on avian visual attention, show three ways avian attention resembles human attention, and to highlight some dramatic and increasingly problematic issues that similarity exacerbates. We aim to make explicit how polarized are our culture's views on the relation between humans and nonhuman animals, with some individuals, including some scientists in the context of their professional lives, having a dispassionate and impersonal point of view on nonhuman animals, and with other individuals (including some scientists outside of their professional lives) having sharply contrasting passionate and highly personal views, especially of pets. Nonhuman animals, especially pets, seem more "human" in the latter case than in the former. This polarization sets the stage, we suspect, for unhealthful contests between "objective" and "empathic" views of nonhuman animals. Tension between these views is becoming intolerable for some members of the public, who are increasingly resorting to demonstrations, protests, and even civil disobedience of varying levels of violence. We hope that openly acknowledging the polarization will facilitate constructive discussion of its origins, of its scientific and political implications, and possible means of reconciliation, or at least, constructive management of the polarization.

Seldom are there polar opposites that could benefit more from a calm consideration of each other's methods and goals than in the case of personal and impersonal views of nonhuman animals. In the context of today's polarized positions on the relation between human and nonhuman minds, even such a moderate position as the one we just articulated in the previous sentence can seem radical. We therefore hasten to correct two possible misinterpretations of our goal. We suspect the first misinterpretation might arise in the mind of a behavioral scientist: By suggesting that individuals on each side of this polarized dimension consider the wisdom represented at the other pole, we do not mean to advocate the replacement of avian cognition as a science by a kind of folk ethology. We do not mean to suggest that experimental research is irrelevant to progress on understanding how human values shape attitudes about nonhuman animals. Witness the analogous case in which a better scientific understanding of the role of DDT on the environment contributed to shaping the public's values on environmental issues. Nor do we advocate a return to the use only of anecdotes, intuition, or the application of unexamined traditional beliefs to legitimize either any position on the nature of nonhuman animals or on appropriate human values associated with nonhuman animals. We advocate only that it would be useful to ask how the impersonal, logical rigor of science and deeply personal human values might mutually inform each other in the specific context of the role of nonhuman animals in human society.

We suspect the second misinterpretation might arise in the mind of a more general reader. Such a reader might wish for a deeper commitment to a more humane, subjective, personal, emotional, and less rigorously scientific perspective than the one we adopt. We hope such a reader will at least be gladdened by our attempting to raise the issue of human values in a scientific context and will be patient with our aim of only hoping to identify questions, not to answer them.

Consider a set of analogous polarized issues familiar to everyone affected by how cities have developed in the 20th century. Personal and impersonal approaches are frequently in conflict when the future development of cities is discussed, but increasingly, it is seen that they do not need to be. Cities can be viewed as vast, impersonal machines to be understood in terms of numerically described traffic patterns, population densities, reaction times by fire departments to emergencies, the hydraulics of the delivery of safe drinking water, structural integrity of tall buildings, and so on. Alternatively, cities can be seen as human living places where people experience the deepest human cultural values by listening to Mozart's *The Magic Flute,* enjoying picnics in public parks, and perhaps even by discussing the nature of nonhuman animals. While these two visions of cities are often in conflict, just as are the two visions of nonhuman animals, we see no necessary conflict between them. To design cities on a human scale, to improve the quality of life in cities, to reduce environmental pollution, and so on, in a word, to acknowledge human values in the context of city life, does not require the abandonment of, and in fact, we believe requires the use of, meteorological science, structural engineering, computer simulation of traffic flow, the delivery of health care based on biological science, and the full range of science-based technology. Similarly, we believe that a fuller understanding of the human-ness, or lack thereof, of nonhuman animals will require attention to both science and human values. We expect it will not go unnoticed that the question of what a nonhuman animal is, as we have presented it, closely resembles many analyses in the "culture wars" fought over differences between "scientific" and "cultural" approaches (Hacking, 1999). We believe impersonal and personal accounts of the role of nonhuman animals in human society have been in conflict for a sufficiently long time that it is time to try something else. We are optimistic that this particular war can and should be "fought" at the level of tolerant discourse in which participants on both sides struggle to understand and respect the opposing side, not to crush it.

Our more specific goals include the following. We propose to review three ways in which attention has been studied in human cognitive psychology. We then show how these same well-established attentional processes can also be studied scientifically in avians. We note how this research on both human and avian attention is typically seen as largely objective and independent of human values. We note how the very success of this laboratory research, which makes avians seem more like humans, raises currently unanswered questions about the assumption that attentional processes in avians are best viewed solely in entirely objective terms. To emphasize the current unresolved polarization between objective and empathic views of nonhuman animals, we list some mutually incompatible implicit and value-laden assumptions contemporary American culture appears to make about avian attention. Finally, we describe a course in animal cognition for undergraduates at the University of Utah which has attempted to shed light on these contradictory positions and to clarify their philosophical, psychological, and cultural origins. We hope that this course sensitizes students to their own assumptions about animal cognition and to the role of nonhuman animals in the context of human culture. We optimistically hope also that learning about multiple points of view, some of which may be sharply at odds with their own strongly felt but perhaps not exhaustively examined positions, will facilitate students' making choices about their own connections with nonhuman animals and that making these choices will help them by their own personal standards to become more responsible and constructive members of a society in which humans and nonhuman animals interact in countless diverse ways.

Recent research on avian attention has developed mainly along the lines previously laid out by the laboratory science of human attention. We will therefore sketch this human research upon which avian research rests. Before we do so, however, let us consider a non-technical, in fact, unashamedly fanciful example of real world nonhuman animal attention. We believe this kind of intuitive example, described in plain English, can contribute to the development of new experimental tasks and new theoretical perspectives. Let us even permit ourselves, as non scientists often do, to project our own thoughts onto the minds of nonhuman animals. Suppose a seagull flies over a city park on a beautiful summer day, above the heads of various groups of people eating a dizzying array of food, ranging from hot dogs, hamburgers, and potato salad to oysters Rockefeller, smoked salmon, and stuffed artichoke salad. These foods appear to our seagull in a wide variety of visual contexts, including in large and small uncovered and covered bowls with shiny or dull, and transparent or opaque covers, and made of porcelain, glass, plastic, or aluminum. Sometimes the bird sees food in the hands of people and sometimes in small bits and crumbs scattered about the lawn, on tables, or on blankets. Some food is near to the seagull but in settings that might lead to defensive actions by people if the bird were to try to get some for itself, while other food is farther away but appears more accessible. Our seagull is not the only nonhuman animal, or even the only bird on the scene. There are dogs, ducks and geese; some walk near picnic tables and groups of people, while others stand off at a distance. Let us pretend that our seagull has a mental life in which it can visually imagine defensive behaviors on the parts of these dogs and birds as well as by the humans.

We would like to invite the reader to take every possible poetic license and to imagine being the seagull, being hungry, and having a long history of successfully seeing, obtaining, and eating human food in situations like this. As you fly over the picnic grounds, you see large patterns of food, including entire tables laden with food and surrounded by large groups of people, and you see small individual items of food, like a small piece of smoked salmon that has fallen onto the lawn. You see all this food and you also see lawn, parked cars, trees, large buildings in the distance, and clouds in the sky. You also catch only quick glimpses of some foods, as people open containers, put food onto their forks or into their mouths, or as wind blows small crumbs about the park, while you get prolonged sight of other foods lying on tables.

Is it possible that you, the seagull, might pay attention to different kinds of environmental stimuli and events? Beyond our fanciful, plain English story, is there any sense in which this is a scientifically meaningful question? Our position is that all three of the kinds of attention we will address below in detail may be observed in this example. First, spatial attention might be in evidence in that some regions in space, say those where food is most plentiful, attracts more of the bird's attention than other regions of the park. Furthermore, we might suspect that as the bird flies over the park, it redirects how different places attract more or less attention. Perhaps the bird notices a quick flash of sunlight on a package of popcorn in the hand of a young child as she takes out a handful, and perhaps this happens so quickly as the bird flies over that the bird has no chance even to move its head to see the popcorn more clearly. Nevertheless, the bird notices the popcorn in its container in a context that previously has on occasion predicted the subsequent appearance of pieces of popcorn on the ground. This brief stimulus might therefore be sufficient to cause the bird to circle over the child. This is the question central to spatial attention: How do different spatial locations associated with important events or objects, or cues appearing in some spatial locations but predicting important events in other spatial locations, control how attention gets directed to those places?

Second, local/global attention is in evidence when the bird sometimes pays greater attention to entire patterns of food, such as an entire table spread with all sorts of different foods, and sometimes pays greater attention to particular pieces of food, such a particular bag of popcorn or a particular candy bar. The classic defining exemplar of local/global attention is the familiar case involving forests and trees. If a person is said "not to see the forest for the trees," it is implied that the person is paying attention, for some reason perhaps having to do with past experience as well as current viewing conditions, to trees but that under other conditions the person might pay attention to the forest. In other words, it is implied that one can switch attention between forest and trees. It is also implied that paying attention to either forest or trees somehow facilitates processing of information about the forest or trees, respectively. In our example, our seagull might well from time to time switch between attending to groups of trees and attending to individual trees.

Lastly, we might want to say that the bird selectively attends to some features of complex stimuli more than to other features. For example, the bird might pay greater attention to food than to cars in the parking lot, or more to an unleashed bird dog than to a chipmunk. We might intuitively assume that having paid more attention to the dog than to the chipmunk the bird might then know more about the dog than about the chipmunk: It might see the dog more clearly and it might more accurately remember the dog. We might wonder whether unattended stimuli would even be noticed or remembered at all.

In general, researchers studying attention ask how knowing what an organism pays attention to improves our understanding of the organism's behavior. The traditional assumption, which is not without its problems but to which we will subscribe, is that there is a limited amount of attention an animal has with which to respond to its world; paying more attention to one thing means paying less attention to other things. We assume that paying greater attention to an event facilitates processing the corresponding information, so that the bird will be faster, or more accurate, to respond to an event to which it is paying greater attention, and it will subsequently better remember something to which it has paid greater attention. Because of the limited overall amount of attention a bird is assumed to have, quicker responding to one stimulus might imply slower responding to less well attended stimuli. These are classic starting positions from which researchers study attention, knowing full well that they are only assumptions and might be wrong not only in individual cases but wrong in general as well.

Attention in Humans

Plain English found ample use for the idea of attention long before there was a scientific psychology. When psychology emerged as an academic discipline separate from philosophy and education, little more than a hundred years ago, a pioneering attempt to come to grips with the nature of attention was that of William James, who assigned it a central role in his account of mental phenomena. Within a generation, however, James' view, and mentalistic psychology in general, had fallen into disfavor due to the rise of a behavioral approach that denied that mentalistic processes were scientifically legitimate. More recently, Rorty (1980), Ryle (1949), Skinner (1989), Wittgenstein (1953) and many others have clarified conceptual and philosophical pitfalls in how natural language deals with mental phenomena. For example, annoying conceptual confusions can arise when one accidentally assumes through careless use of visual metaphors based in natural language and popular culture, that a homunculus, an imaginary little person inside the mind, causes a person to attend to something. We respect a behavioral solution to some of these problems and acknowledge the many pitfalls in the use of mental terms. However, the behavioral approach is itself not without its own set of problems, not the least of which is that our scientific understanding of "behavior" may not be advanced beyond that of "attention." Also, we find behaviorism's more restrictive language conventions sometimes heuristically counterproductive as well as philosophically and scientifically problematic (Shimp, 1976). Thus, in the present chapter, we permit ourselves to use mentalistic terms, in part in the belief that they facilitate communication with the nonspecialist to whom this chapter is addressed, and in part in the belief that their heuristic power motivates much or all of the laboratory research that in recent years has revolutionized our understanding of avian attention. As the present volume so clearly shows, we are not alone in these beliefs (also see Allen and Bekoff, 1997; Ristau, 1991). Perhaps most importantly, we suspect that the language of "attention" will facilitate a dialog between scientific and popular accounts of the relation between human and nonhuman animal attention, which is our chief purpose in this chapter.

Let us now look at three examples of the kinds of naturalistic behaviors in humans which in natural language invoke the idea of attention. These examples are spatial attention, local/global attention, and selective attention. Let us look at each in turn.

Spatial attention. Intuition leads us to believe that people do not simultaneously attend equally to all locations in their environments. Some locations are more important than others, and people may attend more to those locations than to others. Imagine, for example, a situation in which the driver of a car rapidly approaches a dangerous intersection where there is cross traffic from both left and right, and especially heavy traffic often appearing from the left. The driver might be aware that some drivers, even though cross traffic has a stop sign, do not stop and that fatal accidents have resulted. The driver might therefore keep her eyes focused on the road ahead and yet also pay more attention than she otherwise would to peripheral spatial locations on the left from which traffic is likely to appear.

Posner and his colleagues (Posner, 1980) and many others have developed experimental methods and concepts by which this kind of attention, spatial attention, can be studied. A common metaphor has been that spatial attention is like a mental spotlight, which swings toward an important location and "illuminates" that location in the mind's image of what either has already happened there or is expected shortly to happen there. It is assumed that when the spotlight illuminates a location in a mental image, an event occurring in the actual corresponding location is processed more quickly or more accurately, so that the spotlight improves processing of events in that location. Posner's method instructs a person to respond quickly and accurately to target stimuli that appear in either of two locations. Just before a target appears, a priming cue appears. This cue may probabilistically predict the location of the subsequent target. When it correctly predicts the target location on a trial, the trial is called a valid trial. An invalid trial occurs when predicted target location and actual target location are different. Typically, targets are arranged in the predicted location with a probability, called cue validity, that is much greater than the probability with which the target appears in the other, non cued, location. The "validity effect" occurs when reaction times to respond to targets are faster on valid trials than on invalid trials; humans typically show this validity effect, which is to say, they use the probabilistic information in priming cues to anticipate the location of the subsequent target. Metaphorically speaking, they swing their attentional spotlights toward spatial locations they judge likely to be important. The careful driver of the car approaching the dangerous intersection would be said to move her attentional spotlight to the left, while keeping her eyes on the road ahead.

Let us consider some additional details of human spatial attention in order both to understand better how it is studied with human subjects and to establish a basis for comparison when we later describe roughly analogous nonhuman animal spatial attention. Consider a few aspects of an experiment by Posner, Nissen, & Ogden (1978). They showed human subjects a target letter X in either of two spatial locations, to the left or right of a central box at which subjects fixated. A subject was asked to press a left key as quickly as possible when the target appeared on the left, and a right key when the target was on the right. A warning signal appeared shortly before the target appeared. This warning cue was either a plus sign, an arrow pointing to the left, or an arrow pointing to the right. The plus sign appeared on a random half of the trials and was neutral in the sense that it had a cue validity of .50, so that it did not predict the location of the subsequent target better than chance. The arrow pointing to the left, however, had a cue validity of .80, so that 80 % of the time when it appeared, it pointed in the direction of the subsequent target, and correspondingly for the arrow pointing to the right. The length of time between the warning cue and the target was varied and was either 0 (no warning cue), or 50, 150, 300, 500, or 1000 msec. All told, several hundred trials were presented. Figure 2 (which is taken from Figure 1 in Posner et al., 1978, page 141) shows average reaction time to press the correct key as a function of the time between the warning cue and the target. (See Figure 2) The top, middle, and bottom curves are for conditions for which the cue validity was .2, .5., and .8, respectively. For present purposes, the two chief results are that 1) reaction times were fastest for valid cues (bottom curve), less fast for neutral cues (middle curve), and slowest for invalid cues (top curve), and 2) this validity effect persisted for at least one sec. Thus, humans direct attention to spatial locations where important events are expected to occur, and this effect persists for at least some short period of time. Our imaginary example of a driver approaching a dangerous intersection, which makes perfectly good intuitive sense, therefore also makes good sense from the perspective of laboratory research on spatial attention.

Local/Global attention. Spatial locations are not the only environmental features that attract attention. Plain English suggests that one can attend either to an entire object or to a part of an object. Gestalt psychology made much of this same idea, in the form of perception of wholes or parts, as in, "He cannot see the forest for the trees." Navon, Robertson, Lamb, their colleagues, and others, have developed experimental methods and theory by which this kind of attention, called local/global attention, can be studied. (See Figure 3) In such an experiment, a human participant is usually instructed to respond as quickly as possible to a target stimulus that appears at either the local or global level of a compound alphanumeric stimulus, such as in Figure 3.

In the case represented in the bottom half of Figure 3, a person might be instructed to respond to a left button when she sees the letter H and to respond to the right button when she sees the letter S. A global letter is composed of many small local letters. The letter H might appear either as a large, global letter composed of many, smaller instances of some other letter, such as many small X's, or as a small, local letter many of which compose some other global letter, such as T. Similarly, the letter S might appear either as a global letter composed of other local letters or as the smaller local letter many of which form a larger global letter. In a typical experiment, a target letter occurs on any one trial at only one level and an irrelevant distractor stimulus occurs at the other level. Over trials, a target letter appears at both levels. It has been found that people can be primed to expect targets at a particular level, in the sense that when most targets appear at a particular level, so that targets at that level become more expected than targets at the other level, or when a priming stimulus precedes a target and probabilistically predicts a target at a particular level, targets at that primed level are processed more quickly and/or accurately (Lamb & Robertson, 1990; Robertson, 1996). Thus, a basketball fan might be said to be primed to attend to a local level when he clearly sees Karl Malone's steal of the ball from an opponent, immediately after the fan's wife draws his attention to Malone, who is a local feature in comparison to the entire pattern of players on the floor. Similarly, the fan might be primed to attend to a global level after his wife mentions that a team has just gone to a different defensive pattern, a global feature characteristic of the entire pattern of players, after which he fails to notice a similar steal by Malone, a local feature.

Selective attention. The "cocktail party effect" is a common illustration of selective attention; a guest at a cocktail party who focuses attention on the conversation in which she is participating while simultaneously ignoring, and consequently feeling unaware of other conversations in the same room, is still able to switch the focus of her attention from the current conversation to another, particularly if some important piece of information, such as her own name, is mentioned in an unattended conversation. Many early models of selective attention focused on this effect and characterized attention as a selective filter, allowing some environmental information to be processed further while filtering out other, less useful information. Such a filtering mechanism may be invoked when it is assumed that the mind has limited processing resources. This limitation has been seen as implying a need to select important information for processing, while ignoring relatively unimportant information and thereby conserving cognitive resources. One common method of demonstrating selective attention in the laboratory is the dichotic listening task, where different information is presented simultaneously to a participant's left and right ears. Participants have often been shown to attend to information in one channel much better than to that in the other. Thus, selective attention is demonstrated when participants can attend to one source of information, while ignoring, and remaining relatively unaffected by, the other. The cocktail party effect is almost a defining exemplar of this process of selective attention.

Below are some wav files demonstrating various dichotic listening conditions. Trying listening to both channels or just shadowing one at a time.

Number - Same / Number -Male/Female / Extended Passage Male/Female

Used with permission of Dr. Steven Schmidt, Middle Tennessee State University

Selective attention has also been demonstrated in many other ways in humans, including in almost countless experiments using visual instead of auditory stimuli. We choose here to demonstrate the phenomenon in terms of a "randomization" categorization task developed by Ashby, Gott, Lee, Maddox, and others, to study "ill-defined" categories in humans (see Chase and Heinemann 2001; Huber, 2001; Urcuioli, 2001).

"Ill-defined" categories would intuitively seem a poor choice if one hoped to obtain a clear, unambiguous understanding of the categorization process. Indeed, such categories have the seemingly unpleasant characteristic of not having any single feature or set of features by which one can unambiguously determine the category to which an exemplar belongs. Why would anyone study ill-defined categories, when they could study tidy, logical, and generally agreeable well-defined categories? The answer is that real-world categories may seldom, if ever, be well defined (Douglas and Hull, 1992; Rosch & Mervis, 1975; Wittgenstein, 1953), and ill-defined categories permit the evaluation of a wider range of theories of categorization.

In a typical version of the randomization task, a participant categorizes a series of two-dimensional stimuli as belonging to one or the other of two ill-defined categories. The categories are ill defined in the sense that there is no feature or combination of features that guarantees membership in a category. Indeed, in the task we describe, the very same stimulus can at times belong to one category and at other times to the other, rather like a Gestalt reversible figure, that can be seen now as a vase and then as two human faces directed toward one another, as in Figure 1 above (Wittgenstein, 1953).

Figure 4 (which is taken from Figure 1 in Herbranson, Fremouw, and Shimp, 1999, page 114) provides a way of looking at the nature of the randomization task. This Figure is actually from an experiment with pigeons described below, yet serves to summarize the corresponding human procedures which are our focus in this Section. (See Figure 4) The top panel shows two ill-defined categories, A and B, in the form of two overlapping normal bivariate distributions. The distributions are drawn in what is referred to as the "stimulus space," in which each point corresponds to a specific two-dimensional stimulus, such as a rectangle. The horizontal and vertical coordinates of a point correspond to the width and height of a rectangular stimulus and the third coordinate corresponds to the probability with which the stimulus is shown to a subject given a particular category. The top panel shows two equal-likelihood contours corresponding to points that are equally likely to occur given a particular category. The bottom panel shows two such equal-likelihood contours along with a diagonal line which is the optimal decision bound, the set of points equally likely to occur given either category. Optimal performance by a subject in the divided attention, or "tall/wide" task consists of categorizing rectangles corresponding to points above the line as belonging to category A and of categorizing rectangles corresponding to points below the line as belonging to category B.

A common way to implement the randomization task is to define the two dimensions along which stimuli vary as the widths and heights of rectangles or of other geometric figures a human participant observes. Two important versions of the task are the "tall/wide" or divided attention task and the "one dimension" or selective attention task. Let us consider each in turn. In the tall/wide task, a rectangle taller than it is wide is optimally categorized as belonging to one category, and a rectangle wider than it is tall is optimally categorized as belonging to the other. (An optimal categorization is a choice of the response alternative with the higher probability of reinforcement.) If a participant optimally categorizes individual rectangles, then the participant may be said to divide attention between both dimensions, because optimal categorization requires integrating information from both dimensions.

Figure 5 (which is taken from Figure 2 in Herbranson et al., 1999, page 117) shows greater detail for the task involving divided attention. The Figure shows the degree to which the two ill-defined categories overlapped: The prototypes or average rectangles for each category are shown as heavy points in the center of two equally-likely contours, one drawn at one standard deviation from the prototype and one at two standard deviations. The bottom panel of Figure 5 shows the actual prototypes for the experiment.

Consider an experiment that showed humans perform in nearly optimal ways on this task (Ashby and Gott, 1988). In their Experiment 1, three humans viewed stimuli on a computer monitor. The stimuli consisted of two lines, one vertical and the other horizontal, joined at the upper left corner; the stimulus contained a corner and two edges of a rectangle. (See Figure 5) Each stimulus belonged either to category A or to category B. Each category had a corresponding bivariate distribution that was approximately normal. The subjects saw exemplars of each category equally often, on the average, and on any particular trial, the category was chosen by essentially tossing an unbiased coin, and then the stimulus was obtained by randomly selecting a sample from the corresponding bivariate distribution. A subject viewed each stimulus and categorized it as belonging to either category A or B by pressing buttons that corresponded to the categories, as in left for A and right for B. At the end of each trial, a participant was informed to which category the stimulus on that trial actually belonged. Each of the participants was given a few hundred training trials. For present purposes, we wish to examine only one of the several important theoretical questions Ashby and Gott analyzed.

Specifically, let us ask if humans were able to learn to categorize two-dimensional stimuli in nearly optimal ways. Figure 6 suggests an answer. Figure 6 shows how one person categorized the stimuli on 300 individual trials. (See Figure 6) Categorization of a stimulus as belonging to category A or B appears as an "x" or as a filled circle, respectively. Figure 6 shows that the great majority of stimuli categorized as belonging to A are above the straight line with a slope of one and the great majority of stimuli categorized as belonging to B are below this line. Thus, stimuli taller than wide were usually categorized as A and stimuli wider than tall were usually categorized as B. This is the outcome roughly corresponding to the optimal solution represented by the straight line with slope of one. (See Ashby and Gott (1988) for details.) The person for whom results are displayed in Figure 6 therefore appeared to have used information from both dimensions of stimuli, height and width, and integrated this information in a nearly optimal way. This person therefore may be said to have divided attention between the two dimensions of height and width.

Selective attention may also be demonstrated with this randomization procedure. This version of the task uses the same set of stimuli but uses different sampling distributions to define the two ill-defined categories. In this task, rectangles continue to vary from trial to trial in terms of both width and height but only a single dimension, say width, is relevant to the definition of the categories. (See Figure 7) Let category A consist of angles the widths of which are greater than some specific width, and let the other category consist of angles the widths of which are less than this same value. Let height vary from stimulus to stimulus as before, but let it be irrelevant to whether a stimulus belongs to category A or B. To perform optimally in this task, a participant needs to categorize exclusively on the basis of width and to ignore height. Figure 7 shows the stimulus space and optimal decision bound for such a task.

It is of course possible to switch dimensions in such a task and to make height relevant and width irrelevant. Figure 8 shows the results from one human performing on such a task, with the criterion height indicated by the horizontal line. Figure 8 shows that the person did in fact strongly tend to categorize angles shorter than the criterion height as belonging to one category and taller than the criterion as belonging to the other category. (See Figure 8) Thus, the person selectively attended to the relevant height dimension and ignored the irrelevant width dimension. The randomization task has been used to show that humans often closely approximate the optimal solution in this and other versions of the randomization task (Ashby and Gott, 1988; Ashby and Maddox, 1998).

These three examples of spatial attention, local/global attention, and of divided and selective attention, illustrate just a few of the ways in which human attention can be scientifically studied and how laboratory research can clarify our intuitive ideas about attention. These examples are selected to enable a reader to appreciate better the parallels we now wish to draw between human attention and nonhuman animal attention.

Avian Attention in the Laboratory

The idea that a nonhuman animal can "attend" to anything at all has a checkered past in classical philosophy and Western thought. Contrast the sympathetic position of Saint Francis, who so often is portrayed with ostensibly happy birds flying about his head and perched on his shoulders, with that of Descartes, who is reputed to have laughed at the sounds emitted by animals upon which he was operating without anesthetics. His laughter derived from his thorough belief that animals were machines and from the resulting laughable absurdity in the similarity between human cries of pain and the sounds emitted by his animal machines. This Cartesian dualism continues to play an important, but not correspondingly explicit, role in contemporary culture and science, in part perhaps because Descartes' position was inspired by theological issues that are rarely discussed in scientific circles. The animal mind initially was seen as a legitimate and important part of the science of animal behavior (Romanes, 1898). The idea from Darwinian evolutionary theory, that there should be some form of mental continuity across species very roughly corresponding to anatomical continuity, was adequate motivation for early animal behaviorists to search for indications of animal intelligence, including attention. They found what they were looking for.

This initial outburst of enthusiasm for the scientific study of mental life in animals was quickly suppressed, however, by consequences of inadequate scientific skepticism: Early in the 20th century, for example, "Clever Hans," a horse touted to be able to count and communicate with its trainer by appropriately tapping its hoof, was found instead to rely only on unintentional gestures of humans who knew when the horse should stop tapping

(Candland, 1993). A conservative reaction set in that suppressed not only the use of anecdotal evidence based on natural language and culture, but the development of empirical methodology by which complex behaviors could be scientifically investigated For subsequent generations, it was an uphill scientific battle to investigate a cognitive process in a nonhuman animal. The usual presumption was, and still is, that the virtue of parsimony is on the side of "simple" explanations in terms of a non cognitive, purely mechanistic, behavioral position (Shimp, 1999). For example, when the concept of memory was explicitly advocated as a legitimate concept in the experimental analysis of animal behavior (Shimp, 1976), it caused explicit discontent (Branch, 1977), and researchers studying short-term memory often had to show that a "simple" linear chaining, associative learning account failed before they were permitted to interpret results in terms of memory. Correspondingly, when one now wishes to interpret phenomena in terms of the concept of attention, one often must first show that an account in terms of memory is not plausible. Thus, what is simple has changed; first, it was conditioning, then it was expanded to include memory, and now, attention seems to be becoming part of an acceptably parsimonious system. "Simplicity" itself is anything but simple (Hacking, 1999; Goodman, 1977), the criteria for determining what "simple" means are virtually never made explicit (Shimp, 1999), and even when they are, their appropriate use may be contingent on many contextual assumptions that remain only implicit (Hanson, 1969; Goodman, 1977).

Even during the period when behaviorism defined the conventional evaluative standards, there were some forcefully expressed opposing views (Krechevsky, 1932; Tolman, 1932), and a rather solitary paper by Reynolds (1961) suggested that the notion of attention need not threaten a behavioral perspective. With the establishment of a science of animal cognition in the 1970's, however, it became much more acceptable in some circles to discuss attention or attention-like phenomena in nonhuman animals (Kamin, 1969; Riley and Roitblat, 1978). The chapter by Sutton & Roberts (2001) in the present volume provides a brief summary of this stage of conceptual and methodological development.

At about the same time, the idea of a "search image" became established within ethology as an explanation for why foraging animals acquire temporary biases in favor of prey that locally appear more frequently (Tinbergen, 1960): This ethological idea is similar to the cognitive idea that a predator adapts to local contexts by learning to attend to, or look for, a type of prey which temporarily is more likely to be found (Fremouw, et al., 1998).

The present volume attests to the many forms of avian attention that now can be studied as legitimate scientific concepts. We focus on three of these, corresponding to the three types of human attention reviewed above.

Spatial attention. Our research on spatial attention was conducted in collaboration with Dr. Frances Friedrich, whose own research involves, among other things, neuropsychological applications of the Posner paradigm for the study of spatial attention in humans. To see if some of the basic phenomena of spatial attention could be obtained in nonhuman animals, we selected pigeons as the experimental participants because they had already been shown to possess many human-like visual capabilities and they seemed likely candidates for having developed ways to deal with how important environmental events occur rapidly in predictably different spatial locations. We set out to see if we could obtain the validity effect described previously.

Our method (Shimp and Friedrich, 1993) generally paralleled that described above for humans but with a few important differences. A pigeon's task was to peck an illuminated left or right target key the location of which varied randomly from trial to trial. A peck to the target key delivered food. Immediately before the left or right target key was illuminated, a very brief (50 msec) white light flashed on either the left or right key. Like Posner et al., (1978), we were interested in the persistence of any spatial attention we might discover, so like them, we varied the time between the occurrence of the priming cue and when the target appeared. This priming cue had a cue validity of .80. That is, 80% of the time, when the cue flashed on the left, the target subsequently appeared on the left, and 80% of the time when the cue flashed on the right, the target subsequently appeared on the right. The location of the cue, in other words, was a reasonably reliable indicator of where an important environmental event, the target, was about to occur. Notice that in the case of the experiment by Posner et al., (1978), the priming cue was a central arrow pointing either to the left or right. In our experiment, the priming cue occurred in the actual spatial location at which targets appeared. This difference between central symbolic cues and cues occurring in the left or right spatial locations is important in the human literature, but symbolic cues have yet to be studied extensively in the case of avian spatial attention. Our basic question was whether valid cues, those appearing in the same locations as the subsequent targets, facilitated processing targets in those locations, in comparison to invalid cues, which appeared in the locations opposite to those of targets.

The answer was, Yes. Figure 9 shows reaction time as a function of the time between cue and target. The figure shows that reaction times to respond to targets preceded by valid cues (bottom curve) were faster than reaction times to respond to targets after invalid cues (top curve), and this validity effect persisted for some duration of time. (See Figure 9) This is the chief defining feature of spatial attention, so that we now know that pigeons, as well as humans, display that attentional phenomenon. While not all the outcomes were exactly like those from humans, the parallels were amply close to justify continued examination of mental continuity between nonhuman animal and human spatial attention. Subsequently, spatial attention has been demonstrated also in rats (Bushnell, 1995).

Local/Global attention. We again chose pigeons to explore whether a nonhuman animal can display a human perceptual phenomenon, in this case, shifts of attention between local and global levels of perceptual analysis. Figure 3 displayed above in Section II shows the stimuli we used.

We arranged compound stimuli on computer monitors in experimental chambers in which the pigeons performed (Fremouw, et al., 1998). Each stimulus a pigeon viewed had two "levels," a local and a global, and on each trial, a target appeared at one or the other level. If a bird had targets consisting of the letters H and S, these could appear either as global letters made up of local distractors (irrelevant characters never appearing as targets) or as local letters forming a global distractor. If H appeared on a trial, a bird got food if it pecked the left key, and if S appeared, it got food if it pecked the right key. Distractor letters were T and E. Both targets, H and S, appeared equally often (click here see an interactive demonstration of this procedure). The level at which they appeared, however, was systematically varied over conditions, in some of which targets appeared on a randomly selected 85% of the trials at the global level and targets at the local level appeared the other 15% of the time. Every few days, a condition was changed so that the level at which targets appeared more frequently was reversed. We asked if, as in the corresponding human experiments, biasing targets at a particular level facilitated an animal's processing of targets at that level, as reflected in faster responding to those targets. Figure 10 shows that birds did in fact respond faster to local targets than to global targets when targets appeared more frequently at the local level. Similarly, reaction time was faster to global targets than to local targets when targets appeared more frequently at the global level. We found that the familiar process of human local/global attention obtains also in nonhuman animals (however, see Cook's chapter (2001) for a different set of results with similar stimuli). Thus, local/global attention, like spatial attention, is not a purely human phenomenon, and the concept of mental continuity is once again strengthened. (see Figure 5)

Selective attention. There are many ways to demonstrate selective attention in nonhuman animals. In this case, we again chose pigeons for their visual capabilities. We demonstrated the phenomenon of selective attention in terms of the randomization categorization task described above for humans. It will be recalled that two common versions of this task are the integration version, or the "tall/wide" version that requires an individual to integrate information from two characteristics of a complex stimulus, which is the divided attention version, and the "one dimension" or selective attention version. In our experiments, we showed pigeons rectangles, and in the tall/wide task, a pigeon optimally categorized a rectangle taller than it was wide by pecking the left key, representing one category, and optimally categorized a rectangle wider than it was tall by pecking the right key, representing the other category.

Figure 5 represents our specific version of the "tall/wide" task (click here see an interactive demonstration of this procedure) . Figure 11 shows the results for one of four birds. This particular bird was the "best" in a technical sense beyond the scope of the present brief summary. (See Figure 11) Recall that optimal categorization would lead to a bird's calling rectangles represented by points above the bold diagonal line with a slope of one exemplars of one category, and rectangles represented by points below the line as exemplars of the other category. Individual points and circles represent a bird's individual categorization responses. Figure 11 shows that the bird's responses tended in general to conform to the optimal rule. We discovered that pigeons, like humans, divide attention between the two dimensions and perform in nearly optimal ways on this task (Herbranson, et al., 1999).

The selective attention version of our task used the same set of stimuli but used different sampling distributions to define the two ill-defined categories. Figure 7 displayed above in Section II describes the specific arrangements for our selective attention task. In this task, rectangles continue to vary from trial to trial in terms of both width and height but only a single dimension, say width, is relevant to the definition of the categories. One category might consist of rectangles the widths of which are smaller than a particular value, and the other category would consist of rectangles the widths of which are greater than this value. Thus, to perform optimally in this task, a pigeon needs to categorize exclusively on the basis of width, and to ignore height, which it will be recalled, continues to vary from trial to trial. Figure 12 shows the results for one of four birds in this version of the randomization task. (See Figure 12) Again, the Figure shows the results from the bird that satisfied a technical criterion to the best degree. The Figure shows that the bird categorized rectangles in rough agreement with the optimal rule represented by the bold vertical line, and accordingly, it may be said to have selectively attended to the dimension of width and to have ignored the dimension of height. One bird, not shown, did not conform to this rule. In general, however, taking all four birds into account, as in the case for divided attention, we found that pigeons, like humans, approximate the optimal solution in the selective attention version of the randomization task (Herbranson et al., 1999).

Implications for "Mental Continuity"

We have displayed three similarities between human and avian attention. These similarities are what late

19th century and early 20th century animal behaviorists and other advocates of Darwinian mental continuity were looking for. Early animal behaviorists lacked the necessary scientific methods and concepts by which to demonstrate mental continuity to the satisfaction of skeptics who saw nonhuman animals in purely mechanical terms. The modern experimental methodology we have described seems to provide the necessary tools and seems to satisfy many, if not all (Budiansky, 1998; Kagan, 1998) observers, about the possibility of nonhuman animal cognition. Of course, those researchers who feel that any language that includes terms like "attention" is misguided would wish to rephrase all of the preceding discussion of attentional processes. The discussion could be rephrased in terms of shaping, stimulus control, discrimination learning, generalization, reinforcement contingencies, and so on. For the reasons we described previously, while we respect the reasons why some individuals would want to use a different language for research on attention, we believe that on the whole a "cognitive" or even mentalistic language is more helpful.

We believe these three examples of similarities between human and avian attention imply a duty to look for still more evidence for mental continuity corresponding to continuity of biological structure and function. Just as the natural world encourages some continuity in anatomical and neuroanatomical structure, and in processes of digestion, locomotion, and so on, it appears to encourage certain forms of continuity in cognitive functioning.

The Sky is the Limit

The very success of this volume in portraying an abundance of similarities between human and avian visual cognition might mislead a reader into thinking much more is known about avian cognition than seems to us to be the case. The sky is still the limit for what there is yet to be learned about the avian mind. We doubt that the science has even begun to identify some of what the future will show are many of the most exciting questions. Little is known about the nature of avian mental life in comparison to results from human neuropsychology, research on aware versus unaware processing, or metamemory. A very small beginning has been made on awareness, self awareness, metaknowledge, and other matters related to the nature of memory (Clayton and Dickinson, 1998, 1999; Inman and Shettleworth, 1999; Shimp, 1982, 1983; Shimp, Fremouw, Ingebritsen, and Long, 1994), but the difference in progress between research on these issues in humans and nonhumans is pronounced. We think this lack of knowledge teaches humility. It also sets the stage for the rest of this chapter. If we knew just what a pigeon was seeing, thinking, and feeling, we would feel better informed as to what appropriate cultural connections there could be or should be between humans and pigeons. Absent much information about who, so to speak, a pigeon is, it is exceptionally difficult for us to know how we should interact with it.

The Animal Mind and the University Curriculum: Historical Trends

If not even behavioral scientists researching the avian mind know "who a pigeon is," it is scarcely surprising that college students are conflicted about the avian mind. Students sometimes see birds, and animals in general, especially their own pets, as highly similar to humans, and in this sense, they take a very strong position on the idea of mental continuity; students at these times are prone to see animals as having mental lives much like their own, and may believe they share an empathic understanding with their pets. Some students at other times seem less interested in, and concerned about, nonhuman animal mental lives, and seem instead to adopt a more Cartesian view that nonhuman animals are essentially mechanical and are irrelevant to questions about human mental lives. We have already seen above how these same differences in student opinions about the animal mind have been reflected in different scientific views about the animal mind. How the animal mind has been presented over the past few decades in classes in animal learning, conditioning, and cognition at the University of Utah has reflected many of these differences. Emerging trends can be seen in how these classes have evolved, and if we speculate and extrapolate these trends, we may glimpse important features of the future of avian visual perception and of animal cognition.

Consider an example which, though hypothetical and oversimplified, captures some of the pedagogical challenges which over the years the course on learning and conditioning has faced. Many students have pets. Let us imagine that a student has a pet parrot, Hector. She loves Hector, and often wonders what Hector is thinking and feeling. She is a psychology major, and when she spies a course on animal learning listed in the university catalog, she signs up, hoping vaguely that, among other things, she might learn something about her pet bird. Let us speculate how such a student might have reacted to various versions of the course at the University of Utah that have been offered by several different instructors in the past 35 years or so.

Psychology classes in conditioning and learning in the 1960's generally presented an impersonal, value-free and positivistic picture of science. In this context, Cartesian dualism was easy for a student to understand. In a word, a bird was a machine, despite all intuitive appearances to the contrary. From this perspective, anything apparently mental was unscientific. A student was not encouraged to think about the relevance of the course to her pet except in terms of conditioning or the shaping of behavior, such as control of a parrot's behavior through reinforcement of squawking at or intimidating people. The problem was that her pet belonged to the real world, which by the reductionistic standards of laboratory science, was messy and excessively complex. According to this view, the laboratory was the place to understand legitimate approaches to the animal "mind." and a student quickly learned to ignore plain English and the concept of the mind as not only entirely unscientific but as inimical to the development of science. In particular, the notion of "attention" was viewed with such suspicion by the laboratory science of nonhuman animal behavior that the term usually did not appear in undergraduate texts or the scientific literature. The student left the class having learned technical material about learning and conditioning, with some practical information deriving from behavior analysis. The student learned little about the emotional or perceptual life of her pet, and may have acquired the habit of not considering empathic understanding as relevant to a scientific understanding of her pet. She learned a rather forbiddingly technical behavioral language, and learned also that to talk in plain English about her pet's mental life was forbidden. The student might have left the class thinking the science of animal learning had little or nothing to say about the very behaviors of her pet that meant the most to her. In this sense, science and everyday life seemed deeply at odds with each other: They not only dealt with different features of an animal's life, they did so in a way that often seemed to involve disparagement by scientists of students' intuitive ideas about animal minds.

The 1970's saw here and there a mild loosening of the ban on cognitive terminology, especially regarding the acceptability of "memory." A growing realization of the relevance of evolutionary biology, and therefore of real world animal behavior, contributed to the understanding of basic learning processes and contributed also to a growing tolerance for more complex behavior, such as foraging and caching. Nevertheless, despite an emerging trend to explore mental continuity across species, the science tended on the whole to focus on elementary laboratory behaviors, and our imaginary student might not have felt much differently about the relevance of a course on animal learning to understanding her pet than she would have in the 1960's.

In the 1980's, the laboratory science of animal cognition continued to emerge as a discipline in its own right and to strengthen its conceptual links to the powerful field of human cognition. There were still more demonstrations of similarities between animal and human cognition. The idea of attention was developed further in the context of the phenomena of learned helplessness and blocking, and began also to appear in new contexts, including visual search, where perception was sometimes described in quite human-like terms (see Blough, 2001).

An increasing number of studies appeared on presumably emotional aspects of animal life, including phobias, aggression, frustration, reproduction, territoriality, mate selection, bonding, and many others. Yet, the single most dominant focus was still on an emotionally detached intellectual capability. We suspect that our hypothetical student in a class on learning and cognition might still have been nearly as disappointed in the 1980's with the relevance of the course to furthering her empathic understanding of her pet parrot as she would have been in earlier decades.

We feel it may be important at this point to interject that we do not propose that the success of a course in animal learning and cognition should necessarily be evaluated in terms of whether students feel the course improves their understanding of or empathy for the everyday behavior of their pets. We do predict, however, that such a course will have a reduced impact on a student's subsequent behavior as a citizen if it fails to contact the student's intuitive ideas about nonhuman animals. After all, the student's intuitive ideas are acquired through everyday life in his or her culture, so that if there is little or no contact between intuition and the course, the implication is that there is little contact between the course and the surrounding culture. We are doubtful that that kind of intellectual and emotional isolation between a science and its surrounding culture is beneficial for either.

Is the mental life of animals portrayed differently in the late 1990's? Indications of mental continuity have been demonstrated in still more ways, including our three specific examples of attention described above. Perhaps our imaginary student in a class on animal learning and cognition accordingly might feel a somewhat stronger link between the course and her feelings and thoughts about her pet parrot. The beginning student in many American psychology departments is probably somewhat less likely to be chastised for talking about memory and attention, so that at least, the concepts to which she is exposed in the class are more likely to be framed in a language more conducive to motivating her to think about the relation between the course and everyday behavior of her pet.

We would summarize the field of animal cognition as still largely, although certainly not exclusively, focused, however, on intellectual functioning independent of issues of emotionality, personality, or social processes. This is despite increasingly many counter examples. See, for example, De Waal (1999) for a sharp exception to the general rule. The kind of empathic understanding a pet owner may be seeking is not prominent in the contemporary scientific study of the animal mind. The historical indebtedness of animal cognition to experimental psychology as experimental epistemology is obvious: The image of an animal that emerges from such texts and courses mirrors the prototypical image of humans in contemporary human cognition: It is still that of an information-processing machine to which feelings and emotions, especially positive feelings appear relatively seldom (Seligman, quoted in Ruark, 1999). We acknowledge that some see this as a virtue (Kendler, quoted in Ruark, 1999) because they believe it preserves the objectivity of science. We think, however, that it is problematic that the science, including its textbooks, scarcely acknowledges the enormous, incalculably diverse roles played by nonhuman animals in our society. The present volume on avian cognition exemplifies how little contact the field of avian cognition has with these non-scientific roles that are quite central to the normal functioning of our culture. From the perspective of arousing student interest based on what students already know and feel about their pets, the field of animal learning and cognition is still "narrow" by virtue of adhering to a particular kind of "objectivity," historically associated with positivism and the machine metaphor for the mind, nonhuman animal or human.

We ourselves are scarcely immune to the virtues of this objectification of the animal mind. Our own three examples of research on avian visual attention reveal their intellectual heritage in a science that acts as though it is independent of the surrounding culture, including human values. The science of animal cognition, like so much of contemporary science, continues to derive mainly from the belief that science and human values can be, and quite probably should be, kept separate. The politicization of animal cognition, we predict, would not be generally welcomed by most practitioners of the rigorous laboratory science on the animal mind. Notice the tension that therefore immediately arises. Scientific practice in animal cognition tends to be based on the assumption that science should be objective, dispassionate, and neutral, and therefore should stand apart from everyday human political society, which involves passionate battles over basic human values. Yet, scientific practice in animal cognition also demonstrates dramatic similarities between nonhuman animal and human minds, so that it becomes more problematic to assume that there is no set of "animal values" analogous to human values or that human values pertain only to humans without our having to examine any of their possible implications for the role of non human animals in human society. We shall next discuss some difficult questions this tension poses, the tension, that is, between the study of the animal mind by a rigorous, dispassionate science, on the one hand, and the human values of the culture within which that science is evolving, on the other.

III. Nonhuman Animal Cognition and Human Values

We showed above that the content of a course on animal learning, memory, attention and other cognitive processes has changed over the years from a strictly behavioral approach to a much more mentalistic-sounding approach. We think such drastic changes are likely to be driven not just by the internal logic of laboratory research but also by external, cultural forces. What is the cultural context within which human scientific understanding of the animal mind is developing? How does human society portray how laboratory science investigates animal behavior? Is it possible that human values embedded in human society affect how the science of the animal mind develops? If so, can we actually identify any ways in which changing human attitudes toward this laboratory science might contribute to changes in that science? We feel these questions need to be addressed. At the present time, there is scarcely any organized attempt to answer them. In this section we therefore begin to speculate about these and other issues, in the hopes that we thereby will promote more systematic investigation of them.

Consider some examples of how culture might affect the science of the animal mind.

First, animal facilities and animal care management in the Psychology Department at the University of Utah are not unique in being vastly improved over their condition of 30 to 35 years ago. There is improvement in terms of physical health of the animals and of reduced health risks of those who work with the animals. There is also improved oversight in terms of daily animal care, justification for proposed research, ensuring appropriate euthanasia methods, and so on. Our facilities have greatly benefitted from the Institutional Animal Care and Use Committee, the American Association for Accreditation of Laboratory Animal Care (AAALAC) accreditation, consequences of the Animal Welfare Act, and so on. It would be vainglorious and inappropriate self congratulatory behavior on our part to claim that the improvements we have experienced in our facilities are due purely to our own activities. It is clear that the public's interest in animal welfare has partly facilitated bringing about these improvements in the housing and care of animals used in laboratory research on the animal mind. This example suggests a link between culture and the infrastructure of science. If there is a link at the level of infrastructure, why could there not be a link at the direct level of theories of the nonhuman animal mind?

Second, consider that in the popular press, "conditioning" is often viewed as dehumanizing. Conditioning was originally accepted in the 1920's and 1930's by many hopeful members of the public who, thanks in part to proselytizing popular articles by Watson and others, saw in conditioning an egalitarian perspective in terms of which a human democratic society could be dramatically improved simply by changing the environmental context within which children developed and in which adults worked and played. Skinner (1971) enlarged on this optimistic view in his book, *Beyond Freedom and Dignity*. More recently, however, conditioning has perhaps more often been associated in the public mind with Orwell's *1984*, Burgess's *Clockwork Orange,* countless science fiction books and movies involving brain washing, and the mechanical, automaton view of the human condition in terms of which there is no free will and in that sense no control over one's life by one's inner mental life. Novels and movies portray evil or misguided scientists controlling behavior by means of conditioning methods. When machine and human values collide, the cultural results are often appalling, as in the diverse cases of Mary Shelley's *Frankenstein*, Stevenson's *The Strange Case of Dr. Jekyll and Mr. Hyde*, and in the recent novel by Bakis, *Lives of the Monster Dogs*. Is it not possible that this negative popular image of conditioning has contributed in many different ways to the reduced centrality of conditioning in laboratory science on the animal mind? We certainly would not want to argue that the public has an entirely negative view of conditioning, for such is certainly not the case. Indeed, the public no doubt has a favorable view of some aspects of applied behavior analysis by virtue of successful behavioral treatment programs based on behavior therapy, token economies, and other methods to treat drug addiction, alcoholism, and various behavior disorders. However, it does seem to us that the undeniable loss of centrality of conditioning in the scientific study of animal intelligence may to some degree derive from pressures emanating from the public.

Third, while popular culture in some ways may take a dim view of conditioning, it also sometimes takes a very favorable view of animal intelligence, broadly defined. The public seems to take delight in both anecdotes and scientific studies suggesting new and unsuspected forms of animal intelligence, especially when accompanied by the possibility of some sort of feeling of empathic understanding. Some of the most beloved American literature of the last 100 years has involved sentient and verbal nonhuman animals, such as in E. B. White's *Charlotte's Web,* Charles Schulz's *Peanuts,* Albert Bigelow Paine's *The Hollow Tree Snowed-in Book,* etc., etc. The public is exposed to a constant barrage of human interest stories about animals in newspapers, on radio and television, and the number of programs devoted to naturalistic behavior of animals is correspondingly enormous. We would not be at all surprised if the public's interest has contributed to the rise of the scientific field of comparative cognition. The field is still to this moment, however, strikingly independent from the enormous, incalculably diverse roles played by nonhuman animals in human society. The present volume on avian cognition exemplifies how little contact the field of avian cognition has with these non-scientific roles that are quite central to the normal functioning of our culture. The emotional issues so prominent in popular culture addressing nonhuman animals, as in the charming recent book on the emotional role of dogs in human society, *A Pack of Two* (Knapp, 1998) and in many other related books such as *When Elephants Weep* (Masson and McCarthy, 1995), *The Human Nature of Birds* (Barber, 1994), *The Minds of Birds*, (Skutch, 1996), *Diary of a Pigeon Watcher* (Schwerin, 1976), *Next of Kin* (Fouts, 1997), *Adam's Task: Calling Animals by Name*, (Hearne, 1987), *Why We Love the Dogs We Do: How to Find the Dog that Matches Your Personality* (Coren, 1998), *Great Apes*, (Self, 1997), *Timbuktu* (Auster, 1999), *The Animal Estate* (Ritvo, 1987) and *Inside the Animal Mind* (Page, 1999). Countlessly many shorter pieces address these issues. One of shortest and best is by E. B. White (1940/1966) on dog training. Little contact as the field of comparative cognition has with this virtually boundless literature on the emotion lives of animals, we feel comparative cognition makes stronger and more immediate contact with it than does the literature on a remorselessly "objective" form of conditioning. The public's interest in animal intelligence may therefore promote a cognitive approach to the animal mind more than a conditioning approach, especially in view of a perhaps somewhat negative view of conditioning in general.

Fourth, consider a few ways nonhuman animals contribute to human welfare. A) Animals play a role in humans' everyday emotional lives. Animals are increasingly seen as providers of emotional support for the aged and for both children and adults in hospitals. In terms of human safety and social integration, guide dogs for the blind are widely respected and admired. It is hard to see Descartes' purely mechanical attributions about animals at work in situations like these, where emotional intimacy and attachment between animal and human implies that many people believe animals, dogs especially, can understand how we feel. Admittedly, dogs are a special case because of their social structure and pair bonding, but the general possibility that animals have rich emotional lives that could, and sometimes do, facilitate our own, is clear. B) The use of animals in biomedical research, while controversial, remains for many a literally life-giving role. C) Even more controversial is that animals contribute to human society by providing food and clothing. Note that this contribution seems at sharp odds with the contribution to human welfare through bonding and other positive emotional dimensions. We believe it is one of the as yet unresolved contradictions in our society that we see nonhuman animals in impersonal and unfeeling ways that permit us to ethically justify many of the ways in which we use animals for our own benefit, and simultaneously, we see animals in sufficiently personal ways to permit them to provide powerful emotional support. D) Nonhuman animals in American society contribute to public welfare through entertainment in movies, circuses, and so on.

Fifth, one of the strongest determinants of how we perceive nonhuman animals is probably to be found in our religious beliefs. An illuminating example is provided by a recent volume (Larson, 1997) on the 1925 Scopes trial in Dayton Tennessee, in which a high school biology teacher was tried and convicted for breaking a Tennessee law banning the teaching of Darwinian ideas about human evolution. The author, E. J. Larson, provides a wonderfully interesting account of how fundamentalist Christian beliefs and attitudes shaped Tennessee state law on teaching about the relation between human and nonhuman animals. It is worth noting in passing that different cultures view this relation in dramatically different ways. A cross-cultural analysis could be conducted either in historical terms or in terms of different contemporary cultures. We expect an exploration of ancient Egyptian, Native American, Hindu, Buddhist, as well as Christian and Jewish views would illuminate radically different and therefore highly interesting cultural differences in attitudes and beliefs about animals. It would be interesting to investigate whether different religious beliefs have contributed to differences across cultures in the development of a laboratory science of the animal mind.

Sixth, consider the discussion, pro and con, on the political, ethical, economic, and philosophical movement for animal rights, animal welfare, and animal law (e.g., Orlans, Beauchamp, Dresser, Morton, and Gluck, 1998; Petrinovich, 1999; Preece, 1999; Preece and Chamberlain, 1993; Regan and Singer, 1989; Singer, 1990). This movement may have facilitated the improvement of animal care in animal shelters (Tuber, Miller, Caris, Halter, Linden, and Hennessy, 1999) as well as in research laboratories, and the movement's political goals can be expected to have further implications for scientific research involving nonhuman animals (Plous, 1998). It is hard to imagine a researcher studying the animal mind who has not already been affected by this movement and all signs point to greater impact in the future.

Seventh, our culture is famous for its rapid growth in technology, especially as relating to computers. It seems inevitable to us that the technology of the surrounding culture affects the kinds of experiments researchers choose to conduct with nonhuman animals. For example, of the three experiments on attention we described earlier, we could have conducted only one, that on spatial attention, with technology generally available to the behavioral scientist before roughly 1980. We think it is reasonably clear that nonhuman animal research using complex visual stimuli and reaction times could not have been conducted before the arrival of inexpensive laboratory computers. Since complex stimuli having specified quantitative properties are essential to much research on avian visual cognition, this is equivalent to saying that avian cognition is highly dependent on the surrounding culture, specifically, on the culture's technological resources. This is but one of many examples one could give of how research in one domain depends on techniques and ideas developed elsewhere in a culture.

In summary, human society's beliefs about animals are incredibly diverse, and seem to offer ample opportunity to encourage some approaches to the scientific study of the animal mind and to discourage others. Human society is in many ways sharply self contradictory in its positions on nonhuman animals, with some beliefs compatible with a Cartesian machine-like and value free view, and some human-like and value laden. We suggest that a more careful and in-depth historical and cultural analysis of these beliefs may contribute to an understanding of why the scientific study of animal intelligence changes the way it does.

Integrating Science and Human Values in the Psychology Classroom: A Service-Learning Course

We have seen that there are increasingly many demonstrable similarities between nonhuman animal and human minds, that the scientific study of the animal mind tends to focus on dispassionate, intellectual characteristics, that there seems to be a historical trend away from conditioning and toward cognitive accounts of the animal mind, that human society makes use of animals for, among many other things, highly personal emotional needs, and that there are many powerful cultural beliefs that might affect the development of a science of the animal mind. Let us now examine a method we have begun to use to study interrelations among these diverse scientific traditions and cultural forces. Our method is a Service-Learning course on comparative cognition offered at the University of Utah. The course is called "The Animal Mind in Nature, the Laboratory, and Human Culture."

We wish to caution the reader against the optimistic but we fear unrealistic hope of developing a coherent picture of these interrelations. We merely wish at present to describe a way in which to begin to discuss them in an academic setting. At present, we believe we will need to accept that so many of these relations are in such stark opposition to one another that an attractively coherent account may not be possible, at least not for the foreseeable future.

Our class has two mutually defining components. The first is the usual academic component of a class in animal learning and cognition. In this part of the class, which consumes nearly two-thirds of a semester term, a student learns basic methods, facts, and theories, with a relatively strong dose of intellectual history, including 17^{th} to 20^{th} century philosophy of mind. We sometimes try to illuminate the diverse scientific perspectives by contrasting behavioral and cognitive accounts. We usually use the computer simulation technique as embodied in Catania and Shimoff's *Behavior On a Disk* to illustrate operant conditioning phenomena, and we discuss journal articles on laboratory studies of short-term memory, spatial memory, visual discrimination, the three types of attention described above in sections II - IV, problem solving, transposition, and choice behavior, and naturalistic behaviors such as navigation and caching.

The second component of our class is the service-learning component. Students in our course participate not only in traditional academic lecture and discussion sessions, but also integrate the traditional course content with real world experiences as volunteers at community organizations directly involved with nonhuman animals. Students volunteer three hours per week at a placement they choose from a list we provide. Volunteer activities have involved several different types of activities. Some activities are designed to facilitate the development and implementation of "behavioral enrichment" methods at the local aviary and zoo. Some students, for example, are assigned the task of inventing and constructing novel devices and "toys" to encourage more naturalistic behaviors by birds in captivity at the Tracy Aviary. Another category of activity involves collecting observational data to facilitate the development of ethograms to show how animals in captivity spend their time engaged in different behaviors in different locations in their cages. Students have recorded observational data from gorillas and chimpanzees. Students particularly empathized with Gorgeous, a lowland gorilla who recently died of causes due to extreme old age. When Gorgeous and a student looked into each other's eyes, a student acquired a whole new meaning of animal cognition. The observational data collected at the zoo will be used in the design of improved facilities now in the planning stages. A third category of activity involves serving as a "greeter" at the Salt Lake County Animal Shelter, where members of the public need to be instructed in the policies and functions of the Shelter, illegal exchanges of animals in the shelter parking lot need to be prevented, and grieving pet owners searching for their lost pets need to be consoled and informed about shelter policies. The shelter's chief goal is to educate the public on the issue of responsible pet ownership, and students volunteering at this placement learn a good deal about public policy and ethical issues involved in pet ownership, and they directly share both traumatic and joyful experiences with pet owners. Students observe and empathically experience the despair when pets are not at the shelter when owners come to look for them. Students who describe such experiences in class may be so overwhelmed that they cry at the memory of the joy or despair experienced by both the owner, and apparently, an animal pet. The "animal mind" is not a dispassionate and purely intellectual issue to a student who has shared such personal experiences. Still other volunteer placements have involved students' helping to train dogs at the Salt Lake Dog Training Club. Students who do not wish to directly interact with animals have had the opportunity to become involved with the State Division of Wildlife Resources, where students observe meetings held to determine public sentiment about possible new state wildlife policy and to educate the public on new policies. Students consult with Utah State staff to suggest ways to coordinate state wildlife management policy with the public's wishes. Students observe the public's considerably emotional reactions at some of these public meetings held to establish or review public policy on hunting and on the return of injured or illegally trapped animals to the wild. Students clearly see in such cases how public policy on nonhuman animals affects the everyday lives of members of the community in ethical, economic, and political ways.

Students in each placement setting see academic course material from lectures and readings applied in the real world, and try to interrelate academic course content with broader cultural issues. In addition to becoming familiar with how laboratory science views animals in a relatively detached, unemotional way, students empathically experience many of the community's diverse interactions with nonhuman animals. We feel that one of the most valuable consequences of students' efforts to apply laboratory material to their service-learning experiences is their better appreciation of the difference between scientific and everyday approaches to nonhuman animal behavior. Students acquire sharper awareness of critical implications of scientific skepticism for the attributions they customarily make about knowledge, perceptions, and "awareness," in nonhuman animals. They acquire a new sensitivity to the scientifically problematic nature of their easy attributions about their pets. And, they acquire a new sensitivity to the difficulty of knowing whether any of their usual beliefs about their pets are scientifically correct, or even meaningful. That is, the juxtaposition of scientific and everyday accounts of nonhuman animal behavior sharpens a student's awareness of the difference between them. We feel this sharpened awareness facilitates a student's appreciation of the corresponding difference between scientific accounts of human behavior and "pop psychology" accounts.

We try to ensure that each student learns about the service-learning experiences of other students. On a regular basis, class meetings are set aside for group discussion of student placement activities. Students keep journals in which they describe their volunteer service; each week they write a journal page describing their experiences in the past week, reflect on those experiences, and interrelate them to the academic objectives of the course. Each student also writes a paper due at the end of the academic term which addresses some issue of deep personal concern to the student. The main criterion for the selection of a topic is that it address some issue involving nonhuman animals a student finds to be deeply involving, emotionally uplifting or disturbing, or some issue that confronts a deeply held belief. Topics therefore vary widely, and include ethical issues involved in the use of nonhuman animals in laboratory research, including issues deriving from genetics research and cloning, ostensible occurrences of attentional phenomena in animals observed at the zoo, limitations on what one can know what another person or an animal knows or feels, possible evolutionary explanations for why family pets do or do not emotionally bond with family members, the emotional and psychological needs met by hunting, the relation between animal abuse and spousal abuse, ethical issues involved in keeping animals in caged environments, traditional Native American compared to Christian views of nonhuman animals, and many others. We feel that these student papers are successfully sensitizing students to interrelations between their own personal values and laboratory research on the nature of animal intelligence.

In short, students are encouraged to *personally experience* culturally pervasive but often individually unexamined relations between animals and humans, and to consider the reciprocal implications of cultural beliefs for the laboratory science of the animal mind and of the science for cultural beliefs. Students seem generally to agree that these experiences bring the academic subject matter of comparative cognition alive and make the personal, emotional aspects of the roles of animals in human society clearer. The value-laden nature of some of these roles becomes much clearer when students personally experience them. It becomes clear that personal religious positions are critical to how students react to these roles. Generally, students begin to seriously consider that what they perceive an animal to be depends in part on culture and on intensely held personal beliefs, as well as on what contemporary science says an animal is by virtue of laboratory results on attention, memory, and learning. While a student's intellectual growth along these lines makes comparative cognition appear much more complex, it also makes it appear much more interesting and more relevant to the student's own life.

The Structure of this Chapter Exemplifies the Tension Resulting from Polarized Views on the Animal Mind

There is a central tension in the "culture wars" or "science wars" between the sciences and the humanities. This tension is so severe at times that it can wall off entire academic departments from each other, say

Neuroscience from Women's Studies. One part of this tension is sometimes focused on the basic nature of the human condition, with some being partial to an objective "scientific" view and with others preferring to make "values" central to the definition of a human being. We hope we have reminded the reader that a related and equally strong tension exists between the idea that nonhuman animals are machines, on the one hand, and the idea that they are creatures supporting human empathy, on the other. This tension is addressed by a growing scientific and philosophical literature from which a satisfactory means of resolving it may emerge in the future (Allen and Bekoff, 1997; Petrinovich, 1999; Preece, 1999). Today, however, there is no such way, and therefore this chapter is essentially two inadequately connected chapters, with the inadequacy reflecting how our culture fails to integrate the two perspectives on what a nonhuman animal is. First, we describe laboratory research on human and avian attention. This research typifies a common "value-free" approach according to which science is objective, impersonal, and is seen as relatively independent of the morass of conflicting human values in the surrounding culture. Second, we describe how people feel about nonhuman animals, especially pets, and we contrast this subjective and personal view with the scientific view. Our service-learning course addresses and clarifies the extreme tension between these two views, but we are acutely aware that there are no tools available, either for the reader or for the authors, by which the two views can be reconciled and the tension released. We offer no way to synthesize these divergent views. This chapter reflects these sharply polarized views and of necessity it too displays unresolved tensions and contradictions. We hope a reader will be able to accept this tension and to be able to profit from it in the sense of having a clearer appreciation of how science and culture offer contrasting and, we trust, mutually informing insights on nonhuman animals. We hasten to note that we make no claims to being the first to identify this tension: Many readers happily familiar with the *Far Side* cartoons by Gary Larson will have already experienced it.

A Prediction

The scientific study of animal intelligence, including visual attention, typically makes an implicit distinction between intellectual and emotional components of an animal's life, in the sense that the science usually acts as though its proper goal is a purely objective analysis of the nonhuman animal mind. When such a scientific goal is framed within Western culture, it implies emotions, vague feelings, and other quintessentially subjective phenomena should be excluded, because otherwise they are likely to cloud an otherwise pristine and objective portrait of animal intelligence. Furthermore, the science most often views itself as best separated from human values as they appear in the highly emotional world of everyday politics. We admit this characterization oversimplifies the science because in fact much biobehavioral research attempts to integrate intellectual functioning in learning and memory with processes that surely involve emotional features, such as reward, fear, mate selection, and many other functions, and researchers and professional organizations of psychologists are increasingly calling attention to the value of nonhuman animal research for general human welfare. Nevertheless, we feel that on the whole, the science prefers to treat animal intelligence as sharply distinct from intrinsically subjective processes. In short, the science often implicitly assumes that animal intelligence can be studied apart from any nonhuman animal emotional life. The corresponding assumption in the study of the human mind is highly controversial: human intelligence is increasingly seen not as something which can be studied apart from subjective features of human life but instead as dependent on subjective elements of human culture, including human values. A corresponding position on the nonhuman animal mind would acknowledge that animal intelligence depends in some way on subjective elements. We expect this latter position to become more prominent because research continues to encourage the position that human and non human cognitive processes have much in common.

It is not a commonly discussed possibility in the contemporary science of the animal mind, at least not the avian mind, that the metaphors, analogies, and plain English phrases used in that science depend on extra scientific culture for their meanings. Hacking (1999) describes several examples of this dependency in the social and behavioral sciences. One in particular is applicable here and highlights both the point we wish to make regarding avian cognition and the kinds of potential pitfalls that rightly worry rigorous scientists and scholars interested broadly in philosophy of mind. Hacking (1999, p. 64) writes that "We are not surprised to hear that the results of primatology bear strong traces of their discoverers. We can well imagine what Donna Haraway (1989) and others have taught us in detail: accounts of the behavior of primates reflect the societies of the scientists who study them. We all know the bad jokes about British apes with stiff upper lips, ruthlessly enterprising American apes, hierarchical and communitarian Japanese apes, promiscuous French apes. Primates, perhaps, have been a field for working out ourselves as much as describing animal communities." We take away two messages here. First, it would not be surprising that as the study of the avian mind progresses, and in particular as increasingly many similarities are discovered between the avian mind and the human mind, the picture that emerges of the avian mind will resemble in part the culture of the scientists constructing that picture. Second, as a result, it will be increasingly important for scientists responsible for this picture to scrutinize it carefully for any features of themselves. This scrutiny will be necessary to uncover what we suspect will be the inevitable unexamined assumptions inadvertently left in the picture as a residue of the culture in which the scientists work. We are not at all certain that the scrutiny will in fact reveal all these residual assumptions, but the effort will contribute to a better understanding of the relation between the human cultures in which behavioral scientists work and emerging scientific pictures of the avian mind. We therefore feel the science of the animal mind can benefit in several ways from a more systematic examination of its dependence on surrounding cultural beliefs, considering the obviously vast economic, political, and ethical values, beliefs, and assumptions about nonhuman animals in our culture.

In summary, we anticipate the future will see a more careful scrutiny of how cultural beliefs about the lives of nonhuman animals affect the development of a science of the nonhuman animal mind, and more generally, of what we might call the "animal condition." We anticipate that this more careful scrutiny will facilitate determining how the mental lives of nonhuman animals and of humans are similar or different. We are inclined to believe that human culture is a pervasive and powerful determinant of how even scientists trying very hard to work independently of it view the nonhuman animal mind . We predict culture will therefore continue to influence how scientists conceptualize and prioritize the problems they study. In the short term, we may see, for better or worse, a continuing shift of the science of the nonhuman animal mind, including the avian mind, in a direction compatible with the surrounding culture's view of the relation between humans and non humans. At the same time, it is to be hoped that culture's view will continue to be influenced by the science of the nonhuman animal mind. We hope in this chapter to have called attention to the value of asking what will be the resulting interaction between science and culture.

IV. References

Allen, C., & Bekoff, M. (1997). *Species of mind.* Cambridge, MA: The MIT Press.

Ashby, F. G., & Gott, R. E. (1988). Decision rules in the perception and categorization of multidimensional stimuli. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 14,* 33-53.

Ashby, F. G., & Maddox, W. T. (1998). Stimulus categorization. In M. H. Birnbaum (Ed.), *Measurement, judgment, and decision making: Handbook of perception and cognition* (pp. 251-301). San Diego, CA: Academic Press.

Auster, P. (1999). *Timbuktu*. New York, NY: Henry Holt.

Bakis, K. (1997). *Lives of the monster dogs*. New York, NY: Warner Books.

Barber, T. X. (1994). *The human nature of birds*. New York, NY: Penguin.

Blough, D. S. (2001). The perception of similarity. In R. G. Cook, (Ed.), *Avian visual cognition* [On-line]. Available: pigeon.psy.tufts.edu/avc/dblough/

Branch, M. N. (1977). On the role of "memory" in the analysis of behavior. *Journal of the Experimental Analysis of Behavior, 28,* 171-179.

Budiansky, S. (1998). *If a lion could talk: Animal intelligence and the evolution of consciousness*. New York, NY: The Free Press.

Burgess, A. (1962). *A Clockwork orange.* New York, NY: Norton.

Bushnell, P. J. (1995). Overt orienting in the rat: Parametric studies of cued detection of visual targets. *Behavioral Neuroscience, 109,* 1095-1105.

Candland, D. K. (1993). *Feral children & clever animals: Reflections on human nature*. Oxford: Oxford University Press.

Catania, A. C., Matthews, B. A., & Shimoff, E. (1997). Behavior on a Disk (Version 4.0) [Computer software]. Columbia, MD: CMS Software.

Chase, S. & Heinemann, E. G. (2001). Exemplar memory and discrimination. In R. G. Cook, (Ed.), *Avian visual cognition* [On-line]. Available: pigeon.psy.tufts.edu/avc/chase/

Clayton, N. S., & Dickinson, A. (1998). Episodic-like memory during cache recovery by scrub jays.*Nature, 395,* 272-274.

Clayton, N. S., & Dickinson, A. (1999). Memory for the content of caches by scrub jays (*Aphelocoma coerulescens*). *Journal of Experimental Psychology: Animal Behavior Processes, 25,*82-91.

Cook, R. G. (2001). Hierarchical stimulus processing in pigeons. In R. G. Cook, (Ed.), *Avian visual cognition* [On-line]. Available: pigeon.psy.tufts.edu/avc/cook/

Coren, S. (1998). *Why we love the dogs we do: How to find the dog that matches your personality*. New York, NY: The Free Press.

De Waal, F. B. M. (1999). The pitfalls of not knowing the whole animal. *The Chronicle of Higher Education,* *XLV,* B4-B6.

Douglas, M., & Hull, D. (Eds.). (1992). *How classification works: Nelson Goodman among the Social Sciences*. Edinburgh, U.K.: Edinburgh University Press.

Fouts, R. (1997). *Next of kin*. New York, NY: Morrow.

Fremouw, T., Herbranson, W. T., & Shimp, C. P. (1998). Priming of attention to local or global levels of visual analysis. *Journal of Experimental Psychology: Animal Behavior Processes, 24*, 278-290.

Goodman, N. (1977). *The structure of appearance.* Boston, MA: K. Reidel.

Hacking, I. (1999). *The social construction of what?* Cambridge, MA: Harvard University Press.

Hanson, N. R. (1969). *Perception and discovery.* San Francisco, CA: Freeman, Cooper.

Haraway, D. (1989). *Primate visions: Gender, race and nature in the world of modern science.* London, U. K.: Verso.

Hearne, V. (1987). *Adam's task: Calling animals by name*. New York: Knopf.

Herbranson, W. T., Fremouw, T., & Shimp, C. P. (1999). The randomization procedure in the study of categorization of multidimensional stimuli by pigeons. *Journal of Experimental Psychology: Animal Behavior Processes, 25*, 113-135.

Huber, L. (2001). Visual categorization in pigeons. In R. G. Cook, (Ed.), *Avian visual cognition* [On-line]. Available: pigeon.psy.tufts.edu/avc/huber/

Inman, A., & Shettleworth, S. J. (1999). Detecting metamemory in nonverbal subjects: A test with pigeons. *Journal of Experimental Psychology: Animal Behavior Processes, 25,* 389-395.

Kagan, J. (1998). *Three seductive ideas.* Cambridge, MA: Harvard University Press

Kamin, L. (1969). Predictability, surprise, attention, and conditioning. In B. A. Campbell & R. M. Church (Eds.), *Punishment*. New York, NY: Appleton-Century-Crofts.

Knapp, C. (1998). *Pack of two: The intricate bond between people and dogs*. New York, NY: The Dial Press.

Krechevsky, I. (1932). "Hypotheses" in rats. *Psychological Review, 39*, 516-532.

Lamb, M. R., & Robertson, L. C. (1990). The effect of visual angle on global and local reaction times depends on the set of visual angles presented. *Perception & Psychophysics, 47*, 489-496.

Larson, E. J. (1997). *Summer for the gods: The scopes trial and america's continuing debate over science and religion*. New York, NY: Basic Books.

Masson, J. M., & McCarthy, S. (1995). *When elephants weep*. New York, NY: Delta.

Orlans, F. B., Beauchamp, T. L., Dresser, R., Morton, D. B., & Gluck, J. P. (1998). *The human use of animals: Case studies in ethical choice.* New York, NY: Oxford.

Orwell, G. (1949). *1984*. New York, NY: Harcourt Brace.

Paine, A. B. (1910). *The hollow tree snowed-in book.* New York, NY: Harper and Brothers.

Page, G. (1999). *Inside the animal mind.* New York, NY: Doubleday.

Petrinovich, L. (1999). *Darwinian dominion: Animal welfare and human interests.* Cambridge, MA: The MIT Press.

Plous, S. (1998). Signs of change within the animal rights movement: results from a follow-up survey of activists. *Journal of Comparative Psychology, 112*, 48-54.

Posner, M. I. (1980). Orienting of attention. *Quarterly Journal of Experimental Psychology, 32A*, 3-25.

Posner, M. I., Nissen, M. J., & Ogden, W. C. (1978). Attended and unattended processing modes: The role of set for spatial location. In H. L. Pick & I. J. Saltzman (Eds.), *Modes of perceiving and processing information.* Hillsdale, N.J.: Lawrence Erlbaum.

Preece, R. (1999). *Animals and nature: Cultural myths, cultural realities.* Vancouver, BC: University of British Columbia Press.

Preece, R., & Chamberlain, L. (1993). *Animal welfare and human values.* Waterloo, U. K.: Wilfrid Laurier.

Regan, T., & Singer, P. (1989). *Animal rights and human obligations.* Englewood Cliffs, NJ: Prentice Hall.

Reynolds, G. S. (1961). Attention in the pigeon.*Journal of the Experimental Analysis of Behavior, 4,*203-208.

Riley, D. A., & Roitblat, H. L. (1978). Selective attention and related cognitive processes in pigeons. In S. H. Hulse, H. Fowler, & W. K. Honig, (Eds.), *Cognitive processes in animal behavior* (pp. 249-276). Hillsdale, NJ: Lawrence Erlbaum.

Ristau, C. A. (1991). *Cognitive ethology: The minds of other animals.* Hillsdale, NJ: Lawrence Erlbaum.

Ritvo, H. (1987). *The animal estate: The english and other creatures in the victorian age*. Cambridge, MA: Harvard.

Robertson, L. C. (1996). Attentional persistence for features of hierarchical patterns. *Journal of Experimental Psychology: General, 125*, 227-249.

Romanes, C. J. (1898). *Mental evolution in animals*. New York, NY: Appleton. (Original work published 1883)

Rorty, R. (1980). *Philosophy and the mirror of nature*. Princeton, NJ: Princeton.

Rosch, E., & Mervis, C. B. (1975). Family resemblance: Studies in the internal structure of categories. *Cognitive Psychology, 7*, 573-605.

Ruark, J. K. (1999, February 12). Redefining the Good Life; a New Focus in the Social Sciences. *Chronicle of Higher Education* (p A14).

Schulz, C. M. (1968).*"He's your dog, Charlie Brown!"* Cleveland, OH: World Publishing Co.

Schulz, C. M. (1971). *Snoopy and "It was a dark and stormy night."* New York, NY: Holt, Rinehart & Winston.

Schwerin, D. (1976). *Diary of a pigeon watcher*. New York, NY: Paragon House.

Self, W. (1997). *Great apes*. New York, NY: Grove.

Shelley, M. W. (1969). *Frankenstein, or the modern prometheus*. London, U. K.: Oxford. (Original work published 1818)

Shimp, C. P. (1976). Organization in memory and behavior. *Journal of the Experimental Analysis of Behavior, 26,* 113-130.

Shimp, C. P. (1982). Metaknowledge in the pigeon: An organism's knowledge about its own behavior. *Animal Learning and Behavior, 10*, 358-364.

Shimp, C. P. (1983). The local organization of behavior: Dissociations between a pigeon's behavior and self-reports of that behavior. *Journal of the Experimental Analysis of Behavior, 39*, 61-68.

Shimp, C. P., Fremouw, T., Ingebritsen, L. M., & Long, K. A. (1994). Molar function depends on molecular structure of behavior. *Journal of Experimental Psychology: Animal Behavior Processes, 20*, 96-107.

Shimp, C. P. & Friedrich, F. J. (1993). Behavioral and computational models of spatial attention. *Journal of Experimental Psychology: Animal Behavior Processes 19*, 26-37.

Shimp, C. P. (1999). Tolerance in a Rigorous Science. *Journal of the Experimental Analysis of Behavior, 71,* 284-288.

Singer, P. (1990). *Animal liberation* (2nd ed.). New York, NY: Random House.

Skinner, B. F. (1971). *Beyond freedom and dignity*. New York, NY: Knopf.

Skinner, B. F. (1989). The origins of cognitive thought. *American Psychologist, 44*, 13-18.

Skutch, A. F. (1996). *The minds of birds*. College Station, TX: Texas A & M.

Smith, J. D., Shields, W. E., Allendoerfer, K. R., & Washburn, D. A. (1998). Memory monitoring by animals and humans. *Journal of Experimental Psychology, 127*, 227-250.

Stevenson, R. L. (1907). *The strange case of Dr. Jekyll and Mr. Hyde* New York, NY: Scribners. (Original work published 1886)

Sutton, J. E., & Roberts, W. A. (2001). Attentional processes in compound stimulus processing by pigeons. In R. G. Cook, (Ed.), *Avian visual cognition* [On-line]. Available: pigeon.psy.tufts.edu/avc/sutton/

Tinbergen, L. (1960). The natural control of insects in pinewoods: I. Factors influencing the intensity of predation by songbirds. *Archives Neerlandaises de Zoologie, 13*, 265-343.

Tolman, E. C. (1932). *Purposive behavior in animals and men.* New York, NY: Appleton-Century-Crofts.

Tuber, D. S., Miller, D. D., Caris, K. A., Halter, R., Linden, F., & Hennessy, M. B. (1999). Dogs in animal shelters: Problems, Suggestions, and Needed Expertise. *Psychological Science*, *10*, 379-386.

Urcuioli, P. (2001). Categorization & acquired equivalence. In R. G. Cook, (Ed.), Avian visual cognition [On-line]. Available: pigeon.psy.tufts.edu/avc/urcuioli/

White, E. B. (1952) *Charlotte's web*. New York, NY: Harper and Row.

White, E. B. (1966). Dog Training. In *One man's meat.* New York, NY: Harper & Row. (Original work published 1944)

Wittgenstein, L. (1953). *Philosophical investigations.* New York, NY: Macmillan.

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