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Using the World to Understand the Mind: Evolutionary Foundations for Ecological Psychology

Alan C. Clune

Sam Houston State University

In this paper I argue that when behaviorism began to wane and cognitivism became the more dominant framework in psychology, ecological psychology was also strongly suggested at two different levels. First, ecological psychology, considered in light of evolutionary theory, promised to handle three serious philosophical challenges to behaviorism. Second, this ecological approach promised to explain several anomalies in behavioral research. Ecological psychology, then, although largely overlooked, was and still is a viable alternative to internalist frameworks — such as cognitivism — as a fruitful framework for studying behavior.

Keywords: ecological psychology, evolutionary theory, externalism

At the time of the demise of behaviorism as the dominant mode of doing psychology there were two primary options available for a renewed psychology, an internalist approach such as cognitivism and an ecological approach.[1] The former became the dominant approach. This paper seeks to make the case that there were historical clues as well as good philosophical reasons to take the ecological approach more seriously. The two main goals of this paper, one historical and the other philosophical, are to show that: (1) the ecological approach is strongly suggested by behaviorist studies that were conducted in the latter half of the twentieth century, as long as one views these studies in the light of evolutionary theory; and (2) the ecological approach, if grounded in evolutionary theory, provides a natural solution to traditional philosophical problems that plagued behaviorism.

Requests for reprints should be sent to Alan C. Clune, Sam Houston State University, Department of Psychology and Philosophy, Box 2447, Huntsville, Texas 77341–2447. Email: clunea@yahoo.com

[1]An internalist approach to psychology where an attempt is made to understand behavior in terms of the internal mental states of the individual.

The three following sections set the stage for meeting the two goals. First, I provide a review of behaviorism. Then I point out what is good about behaviorism and externalist frameworks generally. More specifically, I argue that they avoid certain foundational problems with internalist approaches in cognitive psychology. The section that follows describes traditional philosophical problems with behaviorism pointed out by Noam Chomsky and Daniel Dennett. I then detail problems with the behaviorist's theoretical assumptions about the structure of behavior; problems that are evident due to the inability of the behaviorist framework to explain the result of certain experiments that have been conducted over the past fifty years or so. In the remainder of the paper I argue that the ecological externalist approach to understanding and studying behavior can both deal with the philosophical problems and explain the results of these experiments. If this is right, then ecological psychology suggests itself as a viable method of studying behavior.

Behaviorism

In what follows I will use Skinner's operant conditioning as the paradigm case of behaviorism. Operant conditioning is the view that we can have a fully adequate psychology expressed primarily in terms of behavioral responses to overt environmental stimuli (Skinner, 1953, 1969, 1976).[2] The behaviorist holds that any environmental stimulus can be associated in the organism with any slice of the organism's behavior merely in virtue of that slice of behavior being reinforced in the presence of that stimulus. Reinforcing a behavior in the presence of a stimulus, according to Skinner, merely increases the probability that that behavior will occur in the presence of that stimulus. Hence, according to operant conditioning, a stimulus does not produce an automatic reflex as occurs in classical conditioning. Rather, whether a particular behavior occurs in the presence of a particular stimulus will depend on factors such as the individual's history of behavioral reinforcement and whether there is deprivation present (Skinner, 1953, pp. 110–116). Nevertheless, the hope of the behaviorist would be to arrive at law-like relationships such as: if organism O is in the presence of stimulus S at time t_0, *ceteris paribus*, then O will exhibit behavior B at time t_0.[3]

The elements of a behavioral repertoire of an organism can then be used to explain and predict behavior. Suppose that a mouse presses a lever. The explanation for this behavior might be that food reinforced lever pressing behavior

[2]Sometimes the overt stimulus is a "discriminative stimulus," a special kind of overt environmental stimulus which is purposely used by the researcher in controlling behavior and strengthening behavioral responses (Skinner, 1953, pp. 107–110; 1976, pp. 104–107).

[3]Where the *ceteris paribus* clause indicates that the individual's history of reinforcement, state of deprivation, etc., are suitable for the response to follow.

in the mouse and thereby established an association between the lever and lever pressing behavior. The law would be: if $mouse_1$ is in the presence of lever at t_0, *ceteris paribus*, $mouse_1$ will exhibit lever pressing behavior at t_0.

Skinnerian behaviorism suggests that the method available for the behaviorist is to compile histories of behavioral reinforcement for each individual of interest to the psychologist. This, presumably, would mean that each individual would have to be monitored every moment of his or her life. If this could be done, then we would have, for each individual, the information needed to compile a set of laws to explain and predict his or her behavior.

Even though Skinnerian behaviorism suggests the method of collecting histories of behavioral reinforcement for individuals, actual Skinnerian behaviorists do not attempt this. Instead, using reinforcement, they purposely created behavior in rats, pigeons, and other simple animals using narrowly designed behavioral trials. The goal is to produce behavioral responses of the highest complexity possible in these animals. The motivation behind doing this is to accumulate evidence that not just simple behavior, but all behavior is created by reinforcement. The more success that the behaviorist has in forming complex behavior in simple animals, the stronger is the basis for extrapolating operant conditioning to the explanation of all of human behavior.

What's Right About Behaviorism

What is right about behaviorism is that it promises to overcome two different but related foundational problems with the standard internalist approach in cognitive psychology. The standard approach to understanding the mind in cognitive psychology makes use of the belief-desire model in psychology. This is the view that we can come to understand the workings of the mind — and its connection to behavior — in terms of the interaction primarily between beliefs, desires, and intentions to behave.[4] A typical intentional generalization that would purport to explain behavior on an internalist view, would take the following form: if Tom desires water and believes that he can find water in his refrigerator, *ceteris paribus*, Tom necessarily will intend to go to his refrigerator and get some water.

Depending on what one believes is the job of psychology, there are two sorts of problem with intentional generalizations that take this form and purport to explain behavior. If one holds, as Dennett does, that the task of psychology is to explain what it means to be rational, then one encounters a problem with circularity of explanation, as pointed out both by Dennett (1996, p. 59) and by Skinner before him (1971, p. 200). For, notice that the above form for an intentional law needs another premise. It needs the premise that Tom is

[4]Other intentional states such as hate, disgust, love, etc. might also play a role in explaining behavior.

rational. For, only if Tom is rational and has the mentioned beliefs and desires will he form the intention to go to his refrigerator and get some water. However, if we assume that Tom is rational, then the above intentional law cannot explain what it means to be rational. Such an explanation of Tom's behavior is circular.

If one holds, as does Fodor, that the job of psychology is to explain behavior according to intentional laws, independently of whether the behavior is rational, then one can avoid the problem of assuming rationality in order to explain rationality (Fodor and Lepore, 1992, p. 152). Fodor does hold that most intentional laws explain rational behavior, but that they need not explain only behavior that is rational. Since intentional laws are brute facts about how creatures interact with the world, no further appeal to rationality or anything else is required in order to complete the explanatory power of these intentional laws. Dennett's problem, according to Fodor, is that he "*begs the question against there being intentional laws*" (Fodor and Lepore, 1992, p. 152).

The problem for Fodor is that there are good reasons to suppose that there are no suitably scientific intentional laws. In brief, my position is that either intentional laws will be too fine-grained to be scientifically fruitful or they will be unable to explain the success of subjects' behavior or they will not provide the precision in prediction that is required of an intentional psychology (Clune, in press). Given these problems I would argue that an internalist approach in cognitive psychology is *prima facie* no better off than the externalist approach that I have on offer, and perhaps a bit worse off. Moreover, the externalist approach to explaining behavior that I am proposing seeks law-like relations without making appeal to anything other than observable patterns of ordinary behavior in natural settings. This approach does not encounter the grain or the precision problem when it comes to explaining or predicting behavior.

Three Traditional Criticisms of Behaviorism

There are three traditional criticisms of behaviorism. First, behaviorism is criticized for being unable to explain or predict ordinary everyday behavior. Second, behaviorism is criticized for being a pragmatically impossible program to carry out. And third, behaviorism is criticized for having difficulty explaining or predicting novel behavior. I will elaborate each of these problems below.

In his "Review of Skinner's Verbal Behavior" Chomsky (1967) provides an important criticism of behaviorism.[5] He argues that Skinner has not shown

[5]Chomsky actually provides several criticisms. For a summary of these criticisms, see Plotkin, 1997, chapter 4; Richelle, 1976. For various responses to these criticisms see Barnes–Holmes, 2000; Hayes, 1994; Hayes and Barnes–Holmes, and Roche, 2001; Richelle, 1976; Sidman, Wynne, McGuire, and Barnes, 1989; Skinner, Cautilli, and Hantula, 2003; Stemmer, 2004.

that complex everyday behavior, in particular verbal behavior, can be explained by appeal to operant conditioning. Chomsky claims that all that Skinner has evidence for is that under very constrained laboratory conditions a correlation can be formed between a very simple behavior and a very simple stimulus. Of course, in the laboratory the researcher knows what stimulus is associated with what behavior only because the researcher designs the experiment so that there is only one possible stimulus available to the animal. For real-world situations, Skinner has no way to determine the stimulus–behavior pair. The evidence from such studies therefore cannot legitimately be extrapolated to form a basis for explaining and predicting more complex everyday behavior.

One other of Chomsky's closely related criticisms of Skinner's *Verbal Behavior* serves to highlight this problem. When it comes to everyday verbal behavior, Chomsky argues that the only way to determine the stimulus is to wait for the verbal response. For example, an individual might say "red chair" in the presence of a red chair. In such a case we determine the stimulus only because we know what the response means. This is problematic for Skinner because using meanings to determine the stimulus starts to sound like one is incorporating mental states into one's understanding of behavior. Notice, however, that when the responses under consideration are nonverbal, it is much more difficult to determine the stimulus. One has no recourse even to the meanings of the individual's words. And this, again, reveals the problem of matching slices of non-verbal ordinary behavior to slices of the environment.

The problem can also be posed as follows. Given any situation that an organism naturally finds itself in, there are an infinite number of different slices of any one part of the environment which could be the stimulus for a given behavior. And there are also an infinite number of slices of the organism's behavior which might be the behavioral response to some environmental stimulus. Since the behaviorist does not have any criteria for determining which stimuli are associated with which responses, determining for an organism its history of reinforced behavior, which could perhaps in principle serve as the basis for explaining and predicting that organism's ordinary behavior, is going to remain, in fact, impossible.[6]

However, even if it were possible to determine what counts as a stimulus and behavioral response for a given organism at a given time in ordinary situations, it would still be almost impossible, pragmatically speaking, to compile a reinforcement history for a given organism that could explain or predict its behavior (Dennett, 1996, pp. 67–69; Lacey, 1974, pp. 31–32). Compiling a detailed reinforcement history for just one organism would require that one make a

[6]This problem is a version of the frame problem. The frame problem is the problem of determining what knowledge, including background knowledge, is brought to bear by the subject on the subject's ordinary behavior. Here, the problem is what segment of the environment contributes to the subject's ordinary behavior.

record of every reinforced behavior that the organism has acquired over its entire lifetime, make a record of all the values of the parameters which determine the strength of each behavior, and keep these records up-to-date. Compiling such a history is required, on the behaviorist's view, if one is to have the information one needs to explain and predict behavior. But compiling such a history for just one organism would be virtually impossible, not to mention the task of compiling such histories for every particular organism of interest to the psychologist. If this is correct, then the behaviorist cannot in fact determine laws of ordinary behavior. Therefore, it is unlikely that one could successfully carry out the task of psychology in the way that the behaviorist proposes.

The best that the behaviorist can do is to offer empty explanations of ordinary behavior. What does it mean for behaviorist explanations to be empty? The behaviorist appeals to animal experiments to sustain her case for using operant conditioning to explain behavior. These experiments form associations in the organism between simple non-ordinary behavior and simple non-ordinary stimuli. The behaviorist relies on the possibility of forming these associations to extrapolate from this ability to explain these non-ordinary cases of behavior to the hypothetical ability to explain cases of ordinary behavior. The problem is that there is no way to verify that this extrapolation works. Therefore, the behaviorist can claim that operant conditioning explains ordinary behavior, but the behaviorist cannot demonstrate that this is true by testing the hypothesis that it is true. Therefore, its explanations of ordinary behavior are unsubstantiated, or empty (Chomsky, 1967, p.148).

Skinnerian behaviorism also precludes the explanation of novel behavior (Dennett, 1996). The only behavior explained by the behaviorist is behavior which has been previously reinforced in the presence of a particular stimulus. Novel behavior, however, is by definition not something that has occurred previously. If novel behavior exists, and it most certainly seems to exist on a large scale at least in humans, then behaviorism falls short of explaining much of what counts as behavior. An example will help explain the problem. Suppose that Eric is confronted by a hungry tiger in his bathroom. Suppose that Eric has never before been confronted by a hungry tiger in his bathroom. Suppose also that nothing even similar to this has ever happened to Eric. If the behaviorist explanation of behavior is correct, then we would expect that when Eric is confronted by a hungry tiger in his bathroom, Eric will either do nothing or engage in some random behavior. This is because there is no association in Eric between a particular behavior and hungry tigers in his bathroom. But, contrary to what the behaviorist must say, Eric will in fact respond to the tiger in a way that makes sense. He will scream, or turn and run, or give the tiger some beef. In any event the behaviorist could hope neither to explain nor to predict Eric's behavior in this situation.

Skinner's view seems to be that Eric will do something random, analogous to a random mutation in genetics. If it gets reinforced (analogous to selection in natural selection), then it will become part of his history of behavioral reinforcement (Skinner, 1976, pp. 127–128, 246–247). But this is unlikely from an evolutionary standpoint because random behavior is not likely to be successful. If this is how it happens, then it would be surprising that creatures like Eric had ever got a foothold in the world.

There have been some recent attempts at developing a post-Skinnerian behaviorist account of novel behavior (Epstein, 1996; Hayes, 1994; Sidman and Tailby, 1982). If successful, then the original criticisms of behaviorism on this issue may be vindicated. I am doubtful of such a vindication. Nevertheless, I will show that an ecological approach can deal with novel behavior.

The Behaviorist's Problem Explaining Learning Experiments

In addition to the above difficulties with achieving the goals of behaviorism, the behaviorist also has problems with its theoretical assumptions about the structure of behavior. In particular, the behaviorist assumes that the structure of behavior is determined independently both of the species of organism and of the properties of the environment. Incredibly, the behaviorist holds that the structure of behavior is entirely plastic. In more precise terms, underlying the behaviorist position are the following three assumptions:

(1) In an organism from a given species there are no limitations on what behavior can be reinforced in the presence of what stimuli.
(2) In an organism from a given species there are no stimulus–behavior pairs that are more easily reinforced than any others.
(3) Any particular stimulus–behavior pair is just as easily established in one species of organism as it is in another.

An implication of these three assumptions is that the structure of behavior is determined entirely by operant conditioning. The organism's behavioral potential is a blank slate ready to be written on by whatever stimulus–behavior pairs happen to be reinforced during the life of the organism.[7] This sort of assumption has its roots, of course, in British Empiricism and lives on in the

[7]Strictly speaking, Skinner did not think organisms were blank slates. He did hold that some behavior could be attributable to genetics. However, he held that behavior influenced by genetics was wholly separate from what was acquired via operant conditioning. The two kinds of behavior did not influence one another. Moreover, he held that eventually all behavior due to genetics would be replaced by operant conditioning in the organism's life-time. So as far as that portion of behavior that is attributable to operant conditioning, the organism's behavioral potential is like a blank slate ready to be written on by operant conditioning. See Skinner, 1984.

social sciences and in mainstream cognitive science.[8] The problem for the behaviorist is that these three assumptions have been challenged by the results of experimental research over the past fifty years.[9] As we will see, operant conditioning often fails to work as expected (Breland and Breland, 1961).

For ease of later explanation, I will begin an explication of these experimental results by separating them into two categories. The first category of results, which I will call the "within-species" category, consists of those results inconsistent with assumptions 1 and 2. I call them within-species results because in the experiments that produce these results the species of organism is the same while what changes is the environmental situation confronting the organism.

The second category of result, which I will call the "across-species" category, consists of those results inconsistent with assumption 3. I call them across-species results because in the experiments that produce these results the species of organism changes while what remains the same is the environmental situation confronting the organism.

To begin, then, the within-species results of certain empirical tests of danger avoidance in rats are inconsistent with assumption 1 (Bolles, 1970; Bolles and Beecher, 1988, p. 11). In one test a rat is placed in a box with an electric grid on the floor which can administer shock to the rat. The rat is allowed to avoid the shock as long as it rears on its hind legs. Hence, there is a means available to the rat to avoid shock. According to assumption 1, the rat should be able to learn to avoid being shocked in the way that is made available by the experimenters, but as it turns out, it cannot. It could learn what was dangerous in its environment and what was not, but it could not learn to escape in the way made available by the experimenters. Rather than learn to avoid shock by rearing on its hind legs, the rat kept attempting to flee the box by climbing the walls. The researchers speculated that this strategy is perhaps what would generally work in the rat's typical natural settings upon encountering a dangerous situation typical of these settings. Nevertheless, the rat clearly did not have the sort of flexibility in its learning capacities implied by assumption 1. Whether the rat can learn to avoid dangerous situations, then, is a function of the environmental situation that it confronts. And this implies that whether the rat can learn to escape is a function of the sorts of environmental circumstances to which its behavior has been adapted during its evolutionary history.

Also inconsistent with assumption 1 is the fact that pigeons can learn to satisfy their biological need for food by pecking at a key, but cannot learn to

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[8]See the following work of connectionists working on artificial intelligence: McClelland, Rumelhart, and Hinton, 1992; Smolensky, 1988.

[9]See Bitterman, Lordo, Overmier, and Rashotte, 1979; Bolles and Beecher, 1988; Domjam, 1983; Fitts and Deininger, 1954; Fitts and Seeger, 1953; Hinde and Stevenson–Hinde, 1973; Hommel and Prinz, 1997; Seligman and Hager, 1972.

meet other of their needs in the same way (Bolles, 1988, pp. 10–11; Moore, 1973, pp. 171–174). For example, the pigeon cannot learn to avoid electric shock by pecking at a key, but can easily learn to avoid electric shock by moving to a safe location, lifting its head, flying from perch to perch, and treadling. As with the rat experiments described above, these latter responses are what generally work to avoid danger in settings which are typical for the pigeon to encounter in its natural environment and thus in its evolutionary history (Moore, 1973, pp. 173–174). Nevertheless, these results imply that stimulus–response links cannot be established between just any randomly chosen stimulus and behavioral response.

Other within-species experiments on rats which test for the capacity to learn to avoid dangerous situations have results which are inconsistent with assumption 2. One set of tests showed that rats can learn very easily to run back and forth to avoid an electric shock (Theios, 1963). However, another set of tests showed that teaching a rat to press a bar to avoid a shock is very difficult (Bolles and Beecher, 1988, p. 10; D'Amato and Schiff, 1964). Results such as these imply that some stimulus–response relations within species are more easily established than others. The differences in the capacity of the rat to learn to avoid electric shock is a function of the environmental situation that the rat is required to manage in order to avoid the shock. These differences are due most probably to that fact that, during its evolutionary history, the rat has been required to handle different kinds of environmental situations differently; and to the fact that the rat has little flexibility in the danger–avoidance capacities that it has evolved to possess. Other animals known to exhibit similar violations of assumptions 1 and 2 during learning include the octopus, the cat, the Siamese fighting fish, and the male stickleback fish (Bitterman et al., 1979, pp. 473–474).

Tests for differences in capacities across species have produced results that are inconsistent with assumption 3. For example, there are experiments with chickadee that show that they can remember the location of hundreds of hidden seeds (Gould and Marler, 1987). Humans, however, start to forget the locations after hiding about twelve seeds. Taste aversion experiments also reveal differences between rats and both humans and birds which violate assumption 3 (Bolles, 1988, pp. 97–116). In these experiments it was found that, whereas humans and birds can easily learn to associate visual stimuli of food with an acquired illness, rats can more easily learn to associate taste stimuli of food with illness. The problem is that rats, unlike humans and birds, cannot with ease learn to visually recognize that a food is one which has previously made them ill. These results show that learning does not always occur, relative to one mode of perception, as easily in one species of organism as it does in another. Results that violate assumption 3 indicate that differences in learning capacity across species are a function of inherent sorts of differences across species.

The conclusion from an examination of these experiments, as we saw, is that assumptions 1–3 are false, and that therefore it is wrong to assume that the structure of behavior is determined independently both of the species of organism and the properties of the environment. Rather, the structure of behavior is a function of the species of organism and of the kind of environmental situations that typically confront the organism in its environment and thus of the kind of environmental situations which have typically confronted the organism throughout its evolutionary history.

If this is correct, then the behaviorist is wrong to hold that operant conditioning alone can serve as a basis for explaining and predicting behavior. Operant conditioning is too coarse-grained to provide this basis. For, the explanation of behavior offered by operant conditioning glosses over within- and across-species differences, differences that clearly matter for explaining and predicting behavior. What needs to be done, then, is to search for explanatory principles for behavior within a framework that guarantees that within- and across-species differences are not ignored. An evolutionary framework strongly suggests itself here because such a framework acknowledges at the outset that different species are going to be hardwired differently according to what sort of learning capacities they need to survive in their niche.

Failed Attempts to Explain Within- and Across-Species Learning Differences

In what follows I will briefly present and criticize possible non-evolutionary approaches to explaining within- and across-species differences in learning adeptness. Within-species differences in learning adeptness might be explained by differences in the objective complexity of the environmental situations that the organism finds itself in. However, an appeal to the objective complexity of the environment simply does not explain all the differences that we find in learning capacities within-species. If it did, then one would expect that for any given species of animal, if there are two environmental situations roughly equal in complexity, then an animal from this species ought to be able to learn to perform the task required of it in either situation equally well. However, this is not what we find. Consider the rats who can easily learn to avoid shock by running back and forth but cannot easily learn to do the same by pressing a lever. This is true even though rats can easily learn to press levers in order to obtain food.

There are also experiments with cats which show that they can learn quite complex manipulative, manual responses in order to obtain food, but cannot learn to groom themselves in order to obtain food (Thorndike, 1898). In this case it seems that cats can more easily learn a task which is required to be performed in a *prima facie* more complex environmental situation than they can learn a task which is required to be performed in a *prima facie* less complex environmental situation. These within-species results clearly suggest that there are constraints on animals' capacities to learn which are not explainable merely in terms of the objective level of complexity of the environmental situation.

Across-species learning differences might be explained by differences in uniform learning adeptness across species. According to this line of reasoning, some species of organism are uniformly better at learning than others (Bolles and Beecher, 1988, p. 240). However, given the results of the experiments described above, it seems highly unlikely that differences in learning adeptness found across species can be explained merely in terms of differences in the uniform learning adeptness across species. For if it were true that an organism's having a higher learning adeptness than another organism enabled it to perform any learning task better than that organism, then one would expect that humans would be better than chickadees are at remembering where they put things; for, humans *prima facie* have a higher uniform learning adeptness than chickadees. But as we saw, humans are less adept than chickadees are at this kind of task.

In addition we have evidence which suggests that, even if there are differences in uniform learning adeptness across species, they do not necessarily play a significant role in determining the learning adeptness for a particular task. Hence, there must be some other feature of the species that plays a role in this determination. To illustrate, consider again the difference between humans and rats when it comes to learning food aversion. Humans are better at learning to avoid certain foods on visual cues than are rats.[10] On the other hand rats are just as good at learning to avoid certain foods on taste cues. If objective learning adeptness were highly significant for learning food aversion, then we would expect that humans (who are *prima facie* better learners) would be better at it than rats. However, humans and rats are, it seems, equally adept when it comes to food aversion learning. This shows that differences in uniform learning adeptness across species, if they exist, do not necessarily translate into differences in capacities to learn to perform the same task. And this suggests that other factors (besides the uniform learning adeptness of the species) play a role in determining an organism's capacity to learn tasks.

In summation, then, it seems that we cannot expect to explain within-species learning differences by appeal to the objective environmental complexity confronting the organism, but it is still the case that within-species learning differences must be explained in terms of differences in some objective feature of the environmental situation confronting the organism. Also, we cannot expect to explain across-species learning differences solely by appeal to differences in uniform learning adeptness across species, but it is still the case that across-species learning differences must be explained in terms of differences in some objective feature of species.

[10]We can rule out that this is because humans have a more highly developed visual system than rats. For even some organisms with the same level of visual development as rats (e.g., guinea pigs) are able to learn food aversion by visual cues (Bolles and Beecher, 1988).

Evolutionary Theory and Within- and Across-Species Learning Differences

My proposal is that we can explain within- and across-species differences in learning adeptness if we take an evolutionary approach to understanding the structure of behavior. We know from evolutionary theory that each species of organism is adapted to a subdivision of the environment called a niche. The organism is adapted to the environment by virtue of possessing certain innate characteristics which are conducive to its survival in the face of whatever set of environmental properties defines its niche.[11] The kinds of properties which define niches are multifarious and could include one or more of the following sorts of features: having a particular color of leaf, a particular odor, a particular predator, a particular pattern of food distribution, a particular density of branch, etc. One of the ways in which species adapt to the environment is through behavioral capacities. The kinds of properties that define adaptive behavioral capacities might include being able to perceive green, being able to avoid snakes, and being able to search under a stone. The structure of behavior, then, can be understood in terms of how these kinds of behavioral capacities have been matched to the above mentioned kinds of environmental features.

Moreover, since the organism never confronts its whole niche at once, it is reasonable to suppose that the organism has evolved into its niche in virtue of adapting to various kinds of environmental setting (or subdivisions of its niche) which are common for it to encounter. According to this suggestion, the niche is divisible into kinds of environmental setting that the organism has evolved to manage well. If this is right, then the organism has evolved to possess a distinct behavioral capacity which is ideally suited for managing each distinct kind of environmental setting within its niche. Hence, the structure of behavior, for a given species, can be understood in terms of that species' set of matched pairs, where each matched pair in that set consists of an innate behavioral capacity and the kind of environmental setting to which the behavioral capacity is ideally suited to manage.[12]

One expects that the organism in its everyday activities will generally find itself in its niche, i.e., in kinds of environmental setting which it is innately

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[11]By "innate" I am willing to include whatever is developmentally determined by relatively nonplastic mechanisms in organisms. So puberty is innate in humans, even though it is not present at birth. To be innate to an organism is to be a genotypic or phenotypic characteristic that is or can or will be operative in all normal individuals belonging to the given species.

[12]Note that this innate capacity need not be sufficient for the organism to be able to adequately manage the segment of its niche it finds itself in. What it is sufficient to do is to provide the organism with a head start in that segment of its niche. Additional learning will much of the time be required in order to refine an organism's innate capacities. What is important about innate capacities is that when uncovered we will have behavioral profiles of species of organism, independently of any further refining that individuals of the species might have undergone through learning.

equipped to manage. However, one can easily imagine that an organism finds itself in a situation which is either merely similar to in some degree or not anything like an environmental setting which it is equipped to manage (e.g., when an organism finds itself in a laboratory setup of some kind). When an organism finds itself in a setting that is nothing like one that it is innately equipped to manage, one would expect that the organism would have no success in learning to manage it. And when an organism finds itself in a setting that is similar to one that it is innately equipped to manage, one would expect that its success in learning to manage it would depend on the setting's degree of similarity to one that the organism is innately equipped to manage.

We now have the beginnings of a framework for explaining behavior that takes into account within- and across-species differences in learning capacities. In other words we have a basis to provide an answer to both how and why learning adeptness varies within species as a function of features of environmental settings and how and why learning adeptness varies across species as a function of some objective feature of species.

The answer to *how* learning adeptness varies within species is that it varies relative to kinds of environmental setting, where a kind of environmental setting just is some set of environmental features. Again, such a set might include any one or more of the following sorts of features: a particular color of leaf, a particular odor of predators, a particular pattern of food distribution, etc. Hence, learning adeptness varies with respect to sets of these latter sorts of features rather than merely with respect to, say, objective environmental complexity.

The answer to *why* learning adeptness varies within species is that each species of organism has evolved distinct innate behavioral capacities to handle only a limited number of distinct kinds of environmental setting. The organism is not well adapted to manage all kinds of environmental setting, just those that make up its niche. Hence how well the organism is able to learn to manage any given environmental setting is going to depend on how similar the given setting is to one of the settings that it has evolved to manage well. Learning adeptness varies within species because some environmental settings that the organism finds itself in are going to be exactly like those that it has evolved to manage well, some environmental settings that the organism finds itself in are going to be merely similar to those that it has evolved to manage well, and some environmental settings that the organism finds itself in are going to be completely unlike any of those that it has evolved to manage well.

Consider the rats who could learn to run back and forth to avoid electric shock but found it very difficult to learn to press a lever to avoid shock. This difference can be explained by the fact that, not surprisingly, the rat's danger avoidance capacities are better adapted to those kinds of settings which require running back and forth behavior in order to escape danger than to those kinds of settings which require lever pressing in order to escape danger.

The answer to *how* learning adeptness for a given environmental setting varies *across* species is somewhat more complicated. To illustrate, let us suppose that there are two different species of organism, $species_a$ and $species_b$. Suppose also that these two species learn to manage environmental setting x with different degrees of adeptness. This difference, if I am right, is not going to be due merely to the fact that one species is uniformly better at learning than the other. Rather, the difference is going to be due to the fact that one species is better than the other at learning to manage the particular setting x — because it is better adapted to x kinds of settings.

Recall that each species will have its own unique set of environmental settings, which it has adapted to manage well. And of these settings, each species will have one setting which most closely resembles setting x (call these $setting_a$ and $setting_b$ corresponding to $species_a$ and $species_b$, respectively). The difference in learning adeptness between these two species in setting x, then, is going to be a function of the difference in how closely $setting_a$ and $setting_b$ resemble setting x.[13] If $setting_a$ is much more like setting x than $setting_b$ is, then $species_a$ is going to be better equipped to learn to manage setting x than $species_b$ is going to be. The answer to how learning adeptness varies across species in a given setting, then, is that it varies according to the differences in how well the species of organism is adapted to that given kind of setting. The answer to *why* learning adeptness varies across species for a given task is that different species are going to be, for the most part, differently equipped to manage any given environmental setting. In other words different species have evolved with different sets of matched pairs.

On the proposed evolutionary account, then, the difference between humans' and chickadees' ability to remember where they put things is explained by the fact that settings in the chickadees' niche are settings which resemble more closely a setting that the chickadee has evolved to manage than any setting that the human has evolved to manage. Perhaps there is more competition for food from other individuals in the chickadee's niche as compared to the human's niche.

The Evolutionary Framework: Explaining and Predicting Behavior

Thus far I have argued that certain experimental results of behavioral studies imply that the structure of behavior for any given species can be under-

[13]Resemblance between settings is indicated by the performance of the organism in the settings. $Setting_a$ more closely resembles setting x than $setting_b$ does if $species_a$ performs over time functionally better in (i.e., is more successful in) setting x than $species_b$ does.

stood from the perspective of matched pairs, where each pair consists of an innate behavioral capacity and a kind of environmental setting. The innate behavioral capacity from each matched pair is especially adapted to manage whatever kind of environmental setting is from the same matched pair. If this is correct, then the task of a psychology would be to elucidate these matched pairs. This elucidation would require that one discover the innate behavioral capacities of the organism, the kinds of environmental setting to which these innate behavioral capacities are matched, and the characteristics of the relationship that express this match. Having elucidated these matched pairs, one would then be in a position to explain and predict the behavior of kinds of organism when located in kinds of environmental setting.

As mentioned above, not only does the evolutionary framework for understanding behavior explain our within- and across-species differences, it manages to avoid the traditional problems with behaviorism that we outlined above. Recall the three problems:

(1) The problem of determining, for cases of ordinary behavior, what slices of the environment are associated with what slices of behavior;
(2) The pragmatic problem of compiling stimulus–response histories for individuals; and
(3) The problem of explaining and predicting novel behavior.

There are two implications of the evolutionary framework which work together to avoid these problems. First, the evolutionary framework implies that the target of investigation is the innate structure underlying the behavior of a species of organism, not precise stimulus–behavior pairs of individual members of a species. Hence, the evolutionary approach avoids the second problem because it avoids the need to uncover the reinforcement history of each individual organism before being able to provide explanation and prediction of behavior.

Secondly, the evolutionary framework implies an ecological approach to investigating this innate structure. If the evolutionary framework is correct, then there are environmental settings which the organism's behavioral capacities are naturally adapted to. And these environmental settings are those that the organism ordinarily finds itself in. This means that in order to understand the behavioral capacities which are matched to these environmental settings, one merely needs to study the organism in those settings in which the organism ordinarily finds itself. As opposed to implying a behaviorist method, then, the evolutionary framework implies an ecological method for studying ordinary everyday behavior.

One might object at this point because it is not at all obvious how studying the organism in its natural environment avoids problem 1, viz., of how to determine what slices of behavior are associated with what slices of the environment. On the evolutionary account, however, since the target of investigation is the innate structure underlying behavior, one does not need to determine precisely what particular instances of behavior are lawfully associated with what particular segments of the environment. One merely needs to discover what kinds of behavior a species of organism is inclined to engage in when encountering a kind of environmental setting, but does not need to discover, or to be able to explain or predict, at a moment in time, the organism's precise behavioral response under a precise set of circumstances. In other words one merely needs to discover and provide a description of the salient regular patterns of interaction between the organism and segments of its natural environment.[14] Once these regular patterns are discovered for a particular species of organism for all of the kinds of environmental setting which make up its niche, one has achieved something for that organism that the behaviorist is incapable of achieving, viz. a characterization of the structure of the organism's behavior which can serve as a viable basis for explaining and predicting its behavior. In other words, on this externalist account, as opposed the behaviorist one, one can determine what slices of the organism's behavior are associated with what slices of the organism's environment.

Clearly, however, the evolutionary approach would initially be in the business of compiling species profiles of behavior rather than, like the behaviorist, compiling behavioral profiles for individuals. The sort of law-like relation that the ecological psychologist provides is the following:

(LR) If organism O is in K kind of environmental situation, ceteris paribus, then it is highly likely that O will exhibit P pattern of behavior.

While the behaviorist attempts, but in principle fails, to explain and predict the precise ordinary behavior of individual creatures, the evolutionist attempts, and in principle and in practice (Cheney and Seyfarth, 1990) can explain and predict patterns of behavior inherent to species. Any given individual from a given species will be highly likely to exhibit whatever pattern of behavior, for its species, is matched to whatever environmental situation it is in. And this means that the ecological evolutionary approach to studying behavior can be empirically confirmed. What's more, once we have a viable evolutionary theory of learning, we should be able to begin to provide more individualistic behavioral profiles than what is given by the above law-like generalization.

Finally, the evolutionary framework for explaining and predicting behavior does not, as does the behaviorist framework, have difficulty explaining novel behavior. The evolutionary ecological psychologist claims to be able to explain

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[14]For examples of such descriptions, see Barker, 1978; Cheney and Seyfarth, 1990; Kendon, 1973.

and predict only patterns of behavior. Since there are many distinct sequences of behavior which can produce the same pattern of behavior (under a suitably general description of that pattern), there is nothing in the evolutionist account which implies that the particular behavior of the organism cannot be novel.

For example, suppose that humans, when in bad weather, engage in the pattern of behavior described by the phrase "sheltering one's self." The evolutionary ecological psychologist predicts that if a woman is in bad weather, then it is highly likely that she will engage in sheltering behavior. This prediction does not preclude the existence of novel behavior. For, there are many particular ways that one can engage in sheltering behavior. One can enter a cave, build a grass hut, construct an umbrella, wrap oneself in a plastic garbage bag, etc. All of these kinds of behavior exemplify the pattern of behavior described as sheltering oneself, and therefore any one of them might occur without violating the evolutionary ecologist's prediction in our hypothetical case. Hence, there is room for novel behavior according to the proposed externalist approach to understanding behavior.

An ecological approach to behavioral science conducted within an evolutionary framework does provide a viable externalist theory for understanding behavior. It promises to improve upon behaviorism by avoiding its most stubborn problems. It avoids the looming problems with circularity and intentional laws inherent in the standard internalist approach to explaining behavior. The externalist approach to understanding behavior also holds promise for helping resolve the frame problem by explaining how entire settings can contribute to behavior (See Footnote 6).

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