The English word learning probably comes from an Indo European root, leis, which meant a track or furrow. Before reaching its present form, it went through many changes: læstan, leornian, lernen. At various times in the evolution of our language it might have been understood as following a track, continuing, coming to know, or perhaps even getting into a rut. The verb last, to endure, came from the same root.

KEY TERMS: Antecedents, Behavior and Consequences (ABC) in a Three-term Contingency; Behavior Analysis; Behaviorism and Mentalism; Behavior Hierarchy; Function and Structure; Response, Response Class, Sponse; Stimulus (plural = Stimuli).
words onto them. In many ways they are as alien to us as extraterrestrials. We have to approach them without assuming that they think like us. To make sense of their behavior we must not assume that they do what they do by first talking to themselves about it. Only after we have seen how nonverbal learning works will we be able to appreciate the new kinds of learning that words make possible. We will also see that nonverbal learning provides the underpinnings of verbal learning: we cannot do anything with words unless they are built on what was there before words existed. Once we get that far, we’ll be ready to talk more clearly about topics especially dear to us, like human language and memory and cognition.

Now let’s get back to learning. Suppose I’m unfamiliar with the word *phenomenon* and then I notice it in a sentence. I may decide from the context that it means something like an event worth noticing. If I look it up I might find it defined as an event that can be observed and probably also as a remarkable or unusual person or thing. The definition might show the word as a singular noun with *phenomena* as its plural, and this form of plural, so different from the usual final *-s*, might suggest that this is a pretty old word with Latin origins. What I learn by checking its definition could be useful the next time I come across the word even if I hardly ever use it myself.

But what about the definition of the subject matter of this book? What is this phenomenon called *learning*? The word doesn’t give us trouble in everyday talk, but a dictionary definition telling us that it means getting to know something or gaining knowledge and skill isn’t very helpful. The word *learning* is more familiar than *phenomenon* and yet is much harder to define. Sure, we can usually say whether we’ve learned something and we can usually agree on what counts as learning. Even so, we run into problems when we try to frame a definition. For example, a textbook might define learning as a relatively permanent change in behavior resulting from experience (e.g., Kimble, 1961 pp. 1–13). But what is meant by *behavior* and by *experience*, and how permanent is *relatively permanent*? Staring at an eclipse of the sun is an experience and if it damages your eyes it will certainly change your behavior. Yet if I told you this damage was an example of learning I hope you’d disagree.

**THE LANGUAGE OF LEARNING AND BEHAVIOR**

From the start we must face the fact that we won’t be able to define learning. There are no satisfactory definitions. But we won’t let that stop us. We can look at how organisms come to behave in new ways. In our study of learning, we’ll ask two very different types of questions: (1) What is the nature of these events we call learning? and (2) What is the best way to talk about them? Our main concern will be to show how learning works. What are the conditions under which organisms learn and what happens as they do so? This will give us plenty to do, so we’ll only occasionally consider theories of learning or explanations of learning in terms of changes in the brain or other physiological events, though those topics are of interest in their own right.

Words like *learning* or *knowledge* seem obviously important, but they function in different ways in different contexts. For example, sometimes we speak of learning *about* something; at other times we speak of learning *how to do* something. I could learn how a car works without knowing how to drive one; conversely, I could learn to drive a car without being able to say how it works. Some kinds of learning involve deeds and others involve words. Should we treat these two kinds together or separately? Philosophers make this kind of distinction when they debate the difference between “knowing how” and “knowing that” (e.g., Ryle, 1949). Psychologists make it by contrasting *procedural* knowledge or memory with *declarative* knowledge or memory. The distinction is so fundamental that, as the table of contents shows, this book includes two major parts, one concerned with learning that doesn’t involve words and the other with learning that does. Learning means different things at different times to different people.
Consider some examples. A pigeon discovers food in its travels and returns to the same place later when hungry. A child becomes able to read a story or to spell simple words. A dog is taught to sit or lie down on command. A patient who once had a bad experience in a dentist’s office feels uneasy in the waiting room. A young cat, after its early hunting expeditions, now avoids skunks and porcupines. A shopper sees an announcement for a sale that hasn’t begun yet and several days later returns to the store to take advantage of bargain prices. An author who encounters an unfamiliar word later uses it in a short story. You read a chapter in a mathematics text and find a way to solve a problem that had baffled you. I need to check a point in a chapter of this book and find a relevant paper through an internet search. What do these examples have in common? They involve dogs and cats, children and adults, and we’d probably agree that they are all instances of learning. But is it reasonable to group a pigeon who learns a route to food with a human who discovers a solution to a mathematical problem? Are these examples as distantly related as chipmunks and spiders and clams are distantly related in the realm of animal life?

Can we resolve our problem by adding that learning has to come about through some change in the brain? We might think so, but do we look at an organism’s brain to decide whether it has learned? Even if we could watch a brain doing something, how would we know that learning was what it was doing? No doubt the brain does a lot, but except with the aid of sophisticated instruments we see only its products. Ordinarily we see only behavior.

This isn’t to say that learning has no physiological basis. Of course it does, and it would be fascinating to find out what neurological changes accompany learning. Yet we’d have trouble figuring out what to look for in the nervous system if we didn’t know much about learning. In fact, we can’t have an adequate neuroscience of learning unless we understand its behavioral properties. Those properties determine what neuroscientists must look for in the nervous system if they want to know what happens during learning. That’s why our main concern will be with the behavioral properties of learning rather than with its physiological basis.

Furthermore, the brain changes as a function of changes in the interaction of an organism with its environment. For example, when a stroke has partially paralyzed someone’s arm, one therapy is to restrain the other arm so that use of the impaired arm will help it to regain full function. This is said to change the brain, but the recovery of the arm and not the change in the brain is the objective of the therapy. Of course the changes in the brain matter, but if the therapy is successful it is important to remember that the behavior, the use of the arm, is what drove those changes. That is why, though we will sometimes consider the nervous system, behavior will always be primary. Behavior will always be our starting point.

So far we’ve hardly worried about the facts of learning; we’ve mostly worried about how we talk about it. Languages are variable; their vocabularies reflect what is currently important to their speakers. One trouble is that the language that has evolved in our everyday interactions with others isn’t necessarily well suited to be a language of learning (that is one reason for the etymologies, or word histories, included at the beginning of each chapter).

We’re usually more interested in what other people know and in what they’re likely to do than in how they came to be that way. For example, a parent might worry about a child who fights with other children and rarely plays cooperatively. If the child begins to play cooperatively, the parent might not care whether this happened because of the natural rewards of cooperative play or because cooperative play was explicitly taught or because fighting was punished. The child’s play might look the same in each of these cases, but it might make a difference how the child got there.

Our language for describing what people do is useful. It is important to know what to expect of others, and that’s probably why we describe people in terms of how they are likely to behave. We speak of each other as outgoing or reserved, easygoing or compulsive, trustworthy or unreliable. Describing
people with words like *artistic*, *athletic*, *social*, *intellectual* or *musical* specifies their preferred activities. Yet this kind of vocabulary isn't suitable for discussing how someone's particular interests or traits arose or changed.

Consider the difference between lying and telling the truth. If one child learns to stay out of trouble by telling lies and another by telling the truth, should we be surprised if the first child grows up to be less truthful than the second? Yet the behavior of each child is shaped by its consequences: Each child behaves so as to keep out of trouble. This shaping of behavior should concern us, whichever way it leads each child, but our everyday vocabulary doesn't equip us well for discussing it.

Similar problems exist in other fields. When physicists look at events in the world, they don't find the everyday vocabulary adequate. Sometimes it even gets in the way. So they coin new terms or take over existing ones. The latter tactic can create trouble. Words like *work*, *force* and *energy*, for example, mean different things to physicists in their technical talk than they do to most people in casual conversation. Fortunately for physicists, much of what they now study is remote enough from our daily experience that we don't confuse their technical language with our everyday talk.

This isn't so for behavior. We are all inescapably involved with it. We speak of how people grow and change and we speculate about why they do things. If we want to talk about these events in new ways, we must take care not to confuse our new ways of talking with the old ways. We've all spent most of our lives talking about what we do, but those familiar ways may interfere with our new ways of talking, so we must beware of language traps. Some parts of this book will introduce a language of behavior. That language will not be a paraphrase of everyday usages. It will be fundamentally different. It will demand new ways of looking at familiar phenomena.

Behavioral and Cognitive Languages

Sometimes we talk about what people do and sometimes we talk about what they know. On the one hand, what someone does is all we have to go by. We have nothing else to study but behavior. Someone in a learning experiment may describe thoughts or feelings, but these descriptions are still only behavior; verbal behavior may be special, but it is behavior nonetheless. Thoughts and feelings are supposed to be inside of us, but if nobody else can detect them how can anyone teach us how to talk about them? Our words and our theories must ultimately be derived from behavior, from what organisms do. This is another sense in which behavior must come first.

On the other hand, there is more to an organism than shows in its behavior. Two students may sit silently through my class. They aren't behaving differently right now and yet based on their past coursework I may know that one can answer certain questions and solve certain problems while the other cannot. The difference is in what each potentially can do; I might simply say that one student knows more than the other. When we study this knowledge, it is tempting to say that we study the mind.

The debate between those who call themselves behaviorists and those who call themselves cognitivists or mentalists has been long-standing. To a large extent it has been about how we talk. The behaviorist argues that, because behavior is all that is available to measure, the language of mental events can be misleading, especially when a mentalistic account is accepted as explanatory and therefore discourages further inquiry.

For example, we sometimes casually say that an idea, a feeling or a hunch led someone to do something. The behaviorist doesn't dispute the existence of ideas, feelings and hunches, but rather criticizes appeals to them as causes of behavior. It is too easy to be satisfied with an explanation in these terms. For a behaviorist, it isn't enough to say that someone did something because of an idea, a feeling or a hunch. Ideas, feelings and hunches are about the world, and therefore must have their origins in our experiences with the world. We must look further, to these past experiences or, in other words, to past behavior, to account for what we do. If we are successful, we may also have some-
thing useful to say about the origins of our ideas, feelings and hunches.

The cognitivist maintains that such a view is unnecessarily narrow. Things must occur in our dealings with the world that aren’t observable in our behavior. When we try to recall a word that is “on the tip of our tongue” or try to solve a problem by “sleeping on it,” things are happening that don’t show directly in our behavior and we may not even be able to report them. If we can find out something about such events, it is bound to be relevant to our study of learning.

This dispute stems as much from different ways of talking about behavior as from differences in research findings. Some difficulties arise because behaviorists and cognitivists are often interested in very different types of questions. Behaviorists tend to deal with questions of function and cognitivists with questions of structure.

Suppose I’d like to teach a child to read. Where do I start? On the one hand, I could worry about how to involve the child in reading. What will keep the child alert, what will help the child to attend to the words presented, and what will help the child remember what the various words are? Will I be more successful rewarding the child’s right answers or penalizing the child’s wrong ones? When I arrange different consequences for the child’s different answers, I determine the functions of these answers or, more technically, the functional relations between behavior and its consequences.

On the other hand, no amount of worry about the effects of reward and punishment on the child’s mastery of reading will tell me the most efficient way to present reading materials to the child. What is the best way to order them? Should I start with single letters, with syllables, or with whole words? When I present these materials in different orders, I’m structuring the subject matter. Are words best taught as units or as structures built up from simpler parts such as letters or syllables? Problems of structure are concerned with the organization of behavior and of the world within which it takes place.

Educators concerned mainly with function might try to improve a school system by changing what happens in the classroom, without worrying much about how the curriculum is structured. Those concerned mainly with structure might try to improve the school system by changing the curriculum, without worrying much about what happens in the classroom. But obviously both are important. Any attempt to improve how children learn to read that ignores either is likely to prove deficient. Any that ignores both, as in concentrating mainly on instilling a vaguely defined trait such as self-esteem, has no hope at all.

Historically, some controversies about learning arose because those interested in functional problems tended to speak a behavioral language whereas those interested in structural problems tended to speak a cognitive or mental language. The problems in which behaviorists and cognitivists were most interested interacted with how they each talked about them. If I’m concerned with function, I study the consequences of particular relations between environmental events and actions; I can conveniently express these in the behavioral language of stimuli and responses. If I’m concerned with structure, I study the properties of particular capacities or abilities; I can conveniently express these in the cognitive language of knowledge and mind. This issue is not unique to psychology. A parallel distinction between structure and function, the separation of anatomy and physiology, was significant in the history of biology (e.g., Russell, 1916).

Let’s not be sidetracked by this controversy. We’ll consider both function and structure in learning and we’ll therefore examine both types of research. In either case, it will often be useful to describe situations in terms of antecedents, or the circumstances that set the occasion for behavior, the behavior that occurs in those circumstances, and the consequences of the behavior (these three terms are conveniently abbreviated as ABC). We can consider either function, the relations among the terms (given certain antecedents, what consequences are produced by responses?) or structure, the properties of behavior (how are environments and responses organized?).

Though I will usually emphasize the behavioral approach, this book deals with both function and
structure and therefore encompasses both behavioral and cognitive concepts. These two approaches differ in their languages and in what they study, but they have in common the reliance on experimental method, the anchoring of concepts to experimental observations, and the assumption that our subject matter, however complex, is orderly and not capricious.

The World and the Laboratory

How then do we find out about behavior? Our language is not the only problem. We live in a complex world. The events that influence our behavior don’t occur in isolation. Thus, to understand a situation we must strip away the unessentials. We must analyze it. To analyze something is simply to break it down into its component parts. To do this we start in the laboratory, studying organisms simpler than ourselves, in simple environments, in a science called behavior analysis. We must face the objection, of course, that a laboratory experiment is artificial and so may be inappropriate for establishing generalizations about learning outside of the laboratory. But starting with simple events helps us to develop techniques and vocabularies applicable to complex ones. Biologists could not have mapped the human genome if they hadn’t started with the genetics of simpler creatures, such as the fruit fly *Drosophila melanogaster* or, simpler still (but nevertheless complex), the bacterium *E. coli*.

In the laboratory environment we look at one thing at a time. We arrange circumstances so that we know what goes into a situation; if we’re careful enough, we’ll exclude distractions that might otherwise obscure what we wish to study. The simplicity of our laboratory environment may also help us to see things more clearly. We must be able to identify events before we can study their properties. Yet even after we’ve studied behavior inside the laboratory, we can’t expect to successfully interpret every instance of behavior outside. There are limits to what we can know. It is tempting to ask why someone did this or that, what led to a certain incident, how someone came to have certain interests, fears or attachments. But usually we have so little information that giving a plausible interpretation is the best we can do.

In this respect, behavior analysis is not much different from other sciences. If I see a leaf blow across cars on a busy street and land at the foot of someone sitting on a sidewalk bench, I couldn’t say how or why it got there. But a failure to account for every twist and turn in the path of that falling leaf doesn’t invalidate the principles of aerodynamics. We can’t possibly measure the details of air currents, leaf surface, and so on in enough detail. Similarly, the principles of behavior aren’t invalidated when we can’t account for what someone did on some occasion. Again, we simply can’t measure personal history and other factors in enough detail. In our study of learning, we must recognize what remains out of our reach. In what follows, we’ll find that the most profitable course is one that stays close to the data. We’ll worry less about theory than about properly describing our findings. It will usually be more useful to describe what an organism has learned or remembered than to try to explain its learning or its remembering.

ANTecedents, BEHAVIOR, CONsequences

Behavior is no easier to define than learning. We may say glibly that behavior is anything we do, but this definition is too global. Should we count respiration or metabolism along with muscle movements and glandular secretions? We describe behavior with verbs; people walk, talk, think, do things. But we also distinguish between active and passive actions. We may say that someone breathes, but are we likely to say that someone heartbeats? People bleed when cut but do we want to call their bleeding behavior? Let’s not try to resolve this problem. The phenomena of behavior are varied, and though they sometimes share common names we’ll probably do better by considering examples than by attempting definitions. We can deal with specific examples without much risk of misunderstanding.
Stimuli and Responses

When we observe an organism, we see properties of its environment, *stimuli*, and properties of its behavior, *responses*. In the singular, we speak of a *stimulus* and a *response*. Neither is of interest by itself. An experimental analysis determines what kinds of relations exist between stimuli and responses and how they can be changed. It must also consider the situations or broader contexts within which these stimuli and responses are embedded.

Imagine a pigeon in an experimental chamber. On one wall is an opening to a feeder that can dispense food. Above the feeder opening is a recessed translucent disk or key that can be lit from behind. The pigeon has learned to earn food by pecking the key whenever it is lit. Now suppose the pigeon hasn’t eaten for a while, the key is lit, and a peck on the key immediately makes some food available. We need to know the context before we can guess what the pigeon will do. It is one thing if the alternative, not pecking, is never followed by food; it is another if not pecking is followed by a somewhat delayed but much larger amount of food. In each case a response, the key peck, is followed by a stimulus, food. But the contexts are very different. We would expect the pigeon to peck the key in the first case, but what about the second? If the pigeon doesn’t peck, we might want to say that it shows self-control, forgoing the small amount of immediate food in favor of the larger but delayed amount. We could catalogue what she does and we might discover that some movements usually occur in particular sequences. But if we only watch, we can’t say much more than that she does different things more or less often and more or less in certain orders.

We needn’t be restricted to watching. We might touch or rock her, move objects in or out of her view, make sounds, or offer a pacifier. We’d expect her to respond to each event in a characteristic way. If we touched her palm, for example, she would most likely clench that fist, grasping whatever touched it. The vocabulary for these events is already familiar: we call the touch to the palm a *stimulus*, and the grasping a *response*. We may notice that this stimulus and this response are correlated (Skinner, 1931); they tend to occur together in sequence.

Besides the grasping produced by a touch to the palm, we could catalogue other examples of stimulus-response correlations: crying caused by a sudden loud noise; sucking produced by a nipple in the mouth; blinking triggered by a flash of light. We see the environment act on this infant when stimuli produce responses, but things may go in the other direction. She can act on the environment. Her crying, for example, often brings her mother’s attention. Crying, then, is a response that often produces a consequence: mother’s presence. This case involves stimuli and responses, but here the responses come first, not the stimuli; here behavior has consequences.

The relations can get more complicated. If the infant’s eyes move while the lights are on, those eye movements change what she sees. Eye move-
PART I: INTRODUCTION

ments can't have this effect with the lights off. Thus, she may come to look around in the light but not in the dark. In the presence of one stimulus, the light, moving the eyes produces other stimuli, some new things seen. Eye movements can't have this consequence in the dark. The relation involves three terms: an antecedent stimulus, the light; a response, eye movement, in its presence; and a consequence, what is newly seen given this response in its presence. This three-term relation, stimulus-response-consequence, is sometimes called a three-term contingency. It is important because an organism's behavior depends on both antecedents and consequences.

An antecedent is simply something that comes before. A consequence is simply what is caused by or what happens as a result of some event. Thus, everyday usage corresponds pretty well to the senses of these terms when we use them technically. It is important to note that consequences should not be identified with stimuli. Responses can have many types of consequences. They sometimes produce stimuli that would otherwise have been absent, but they can also prevent things from happening or change the consequences of other responses. For example, food produced by a response is both a stimulus and a consequence, but food presented independently of behavior is a stimulus only; shock prevented by a response is a stimulus, but the consequence of the response is the absence of shock, which isn't a stimulus. Sometimes the consequence of one response is a change in the consequences of some other response, as when a light switch stops working and changing the light bulb restores the usual consequences of operating the switch.

For stimulus and response, the relations between technical and everyday usages are not so simple. Stimuli are events in the world and responses are instances of behavior. The term stimulus is often restricted to specific physical events such as lights or sounds or touches. But organisms respond to varied features of the environment, including relations (e.g., to the left of, on top of), complex behavior (e.g., facial expressions, tones of voice), functional properties (e.g., edible, comfortable), and so on (cf. Gibson, 1979). We'll often speak of such environmental features as stimuli even when we cannot specify their physical dimensions.

As for the term response, everyday usage often implies that it is to something (typically a stimulus). The term won't function that way here, however, because an account of what causes responses typically includes other factors along with or instead of the stimuli that precede them. We'll be especially interested in responses that are not elicited by stimuli but are caused in other ways. Such responses are said to be emitted. Unfortunately response, a useful word for such cases, is not a well-established term (but see Provine, 1976).

A stimulus is an environmental event, but such events vary in complexity. When the infant's crying produced the mother's attention, we regarded the mother as a stimulus. An infant's environment is certainly different when the mother is present than when she is absent. Yet what sort of stimulus is the mother? We don't know which aspects of her looks, her voice or her touch are important to the infant early in life. We might guess that the infant wouldn't react to her as usual if she approached wearing a surgical mask, but we couldn't be sure unless we did the experiment. Despite our ignorance with respect to these questions, we don't doubt that the mother is an important part of the infant's environment. It is useful to speak of the effects she has as she comes and goes in the infant's world.

This example again illustrates structure and function. When we try to analyze which of mother's visual, auditory and tactile features are important to the infant, we deal with the structure of this complex stimulus, mother. We might ask how the infant learns to respond to a particular individual as mother despite changes in her dress or hair style, her facial expression or posture. If we concentrate instead on how mother interacts with the infant's responses, we're concerned with the functional significance of mother in the infant's environment. For example, if an infant cries we may not care whether the infant recognizes mother by her face, her hair or her voice, as long as her presence
makes a difference; it would be enough to see that when mother goes to the infant the crying stops. Later we’ll often be interested in simpler stimuli: lights, sounds, food in the mouth. But even with simpler stimuli we’ll have to distinguish between structural problems, as in analyzing stimulus properties, and functional problems, as in analyzing the interactions between stimuli and responses.

And what about responses? In describing responses, we encounter at least two difficulties. The first is that behavior isn’t repeated exactly from one instance to the next. If the infant grasps an object on two different occasions, the grasping won’t be the same each time. The difference may be small, in the force of the grasp, for example, or in the exact placement of the fingers. But if there is any difference at all, we must worry whether the two grasps should be regarded as two instances of the same response or as two different responses. We must speak not of individual responses but of classes of responses having common properties.

The second difficulty is that responses are sometimes adequately described in terms of movements, but at other times the description must include the environment in which the responses occur. For example, suppose we want to compare the infant’s grasping of an object with clenching a fist. If we look just at muscles, grasping an object with the right hand and clenching that fist have more in common than grasping an object with the right hand and grasping an object with the left hand. Yet sometimes it is more important to speak of the act of grasping an object, no matter which hand is used, than to speak of the movement of closing a particular hand.

An account of behavior must distinguish between movements, responses defined by their form or the musculature used, and actions, responses defined by their relations to the environment. We’ll find that actions are more important for our purposes. Consider how often we speak of doing things, going places or manipulating objects, without regard to the details of how we do them.

Even in the absence of movement we sometimes conclude that behavior has occurred. We do many things that involve no obvious movement. For example, while listening to a song I may shift my attention back and forth between the vocalist and the accompaniment. Those shifts of attention are behavior even though we can’t record them as movements. Many aspects of thinking and imagining involve no movement, but as things we do they count as varieties of behavior. Thus, not all instances of behavior need be movements. In fact, we will later find that a useful criterion for whether something counts as behavior is not its form but whether it varies depending on how it affects the environment.

Whether behavior involves movement or not, it typically has consequences, and one of the most significant consequences of behavior is that it provides opportunities for other behavior. For instance, if a child is given a cookie, the cookie affords the child an opportunity to eat. The significance of the cookie is based on the child’s eating, its behavior with respect to that stimulus. As we will see again and again, we cannot characterize stimuli independently of an organism’s behavior, nor can we characterize responses independently of an organism’s environment. Behavior is the interaction between an organism and its environment.

Behavior Hierarchies

One way to classify an organism’s behavior is to rank its responses according to the relative frequencies with which the organism engages in them. Such a ranking has been called a behavior hierarchy (Hull, 1943). Let’s construct an environment for a rat that gives it access to different stimuli in different compartments. Figure 1-1 shows some possibilities: compartments containing a food hopper, a drinking tube, an activity wheel, or nesting material; a small dark compartment and a large bright one; compartments in which the rat’s entry turns on quiet music, a changing display of dim lights, loud noises, a cold shower or a blast of hot air; and, finally, a compartment with an electrified grid floor.

If the rat lives here for a while, it will learn what is in each compartment. From time to time
it will enter the food compartment and eat, or the water compartment and drink, or the activity wheel compartment and run. After a few days it might always sleep in the compartment with nesting material, or it might prefer the small dark compartment and carry some nesting material there. It might spend some time looking or listening in the light show and music compartments, but would seldom stay long in the large bright compartment. And after only a few entries it would rarely enter the compartments with loud noise, a cold shower, hot air, or the electrified grid.

If we wondered about responses relatively low on the hierarchy, such as looking at the light show or listening to music, we could rank just those two by restricting the rat’s access to all of the other compartments. If we were interested in the behavior occasioned by the compartments the rat rarely enters, such as those with noise or showers or hot air or shock, we could place the rat in these compartments and rank them based on how quickly the rat leaves, or we could set things up so it has to be in one or the other and see which one it stays with.

Figure 1-1  A hypothetical behavior space for a rat. The order and frequency of the rat’s visits to each compartment and the rapidity of its departure if it is placed in one can be described in terms of a behavior hierarchy. Eating and drinking and running in the wheel are likely to be high on this hierarchy, though either might outrank the other at any particular time; looking at lights or listening to music might occur at an intermediate level; and spending time with loud noises or in a cold shower or on an electrified grid will probably be low in the hierarchy.
Our description of the rat's hierarchies will of course depend on what we make available to it. The compartments in Figure 1-1 will tell us nothing about the rat's social or sexual behavior. If we wanted to know where interaction with other rats stood in the hierarchy, we'd have to add more compartments, with a male rat, a female rat, and different sized groups of rats of one or both sexes.

Now let's look at hierarchies with a child instead of a rat as our example. If we gave a child an opportunity to eat, to play with toys or to take a bath, we might find that the child plays a lot, eats occasionally, and hardly ever volunteers for a bath. Playing, as the most likely or most probable behavior, comes first in this ranking, followed by eating and then by taking a bath. An equivalent way of describing the ranking is in the language of preference: we could say that the child prefers playing to eating and prefers either of these to taking a bath.

Behavior hierarchies are changeable. For example, if we wait until the child's usual mealtime and provide a choice between eating and playing, we might find that eating has become more probable than playing. While eating, the child is neither playing nor taking a bath, but we could find out about the relative rankings of those responses by giving the child a choice between the toys and the bathtub. We might discover that this child almost always prefers the toys. We therefore conclude that right now playing with toys ranks above taking a bath in this child's hierarchy. We might even find that this child always leaves the bathtub area even when there isn't much to do elsewhere. Maybe the child recently had a bad experience there. For any kind of behavior, we must consider when it stops as well as when it starts.

It is often convenient to speak of stimuli rather than of opportunities for responding. Thus, for this child we might describe food as an appetitive stimulus or event and taking a bath as an aversive one, with events that are neither appetitive nor aversive categorized as neutral. Unfortunately, even though we may be able to use such terms in specific situations, stimuli in general cannot be sorted out so neatly. Context makes too much of a difference. We cannot just divide the environment into three simple classes of events called appetitive, neutral and aversive. Instead, we must evaluate each stimulus relative to the others available.

With changes in the behavior hierarchy come changes in the significance of stimuli. For example, consider how food may change from appetitive to aversive over the course of an unusually large holiday dinner. In the bathtub example, if the parents handle things carefully this child may begin to tolerate baths and eventually even come to prefer toys in the tub to toys in other places. We've now surveyed some general properties of stimuli and responses as they enter into the relations among antecedents, behavior and consequences. With these preliminaries behind us, we are ready to move on to some classic experiments and findings in the study of learning.