PART I  A SCIENCE OF ADAPTIVE LEARNING

Chapter 1

Science, Psychology, and Adaptive Learning

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THE HUMAN CONDITION

A recurring message of this text is that learning principles constitute powerful explanations for human behavior and help us understand the way we live and why we, more than any other animal, dominate this planet. Hardin’s classic cartoon is perceptive as well as funny. The human being shares many basic needs and drives with the rest of the animal kingdom and must adapt to its environment in order to survive individually and as a species. Yet we seem more “self-conscious” than even our closest DNA relatives as we ponder the meaning and significance of our existence.
In the not too distant future, it is likely that communication will occur with the remaining few cultures not yet significantly impacted by current technologies. This could cause us to forget that the biological **natural selection** process, which continues albeit slowly, evolved over millions of years in an environment that has been significantly altered by human beings. Remove the clothes from Hardin’s person and place him/her in the Amazonian rain forest (see Figure 1.1) or Australian desert and it becomes startlingly clear how similar our existence becomes to that of other animals. If you or I had been born under such conditions, we would be so different from the way we are and vice versa for the Colombian or Australian young adult.

**Figure 1.1** A Nukak child in the Colombian rain forest.

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**Natural Selection**

A process whereby inherited traits increasing the likelihood of survival and reproduction are more likely to be transmitted to future generations.
I hope that consideration of such a prospect enables you to appreciate the importance of the adaptive learning process in determining who we become as individuals and cultures. Our first topic is the advantages of the scientific method as a strategy for understanding nature, including human nature and the learning process.

EXPLANATION AND EMPIRICISM

From our beginnings on this planet, humans have been attempting to understand nature and explain what they observe. What do we mean by an understanding or explanation of nature and how do we arrive at explanations? Explanation usually means a statement of cause and effect. Initially, we must rely upon our personal interactions with the environment, that is, direct learning, to determine cause and effect. Eventually, we are able to observe or communicate with others, a means of indirect learning.

It has been suggested that the most significant accomplishment of the previous millennium was the transition from relying upon personal experience or authority figures to relying upon empirical testing to understand nature (Powers, 1999). Thus, legend has it that Galileo climbed to the top of the leaning tower of Pisa to drop rocks in pairs to determine the effect of the weight of objects on how quickly they fall. Familiar experiences with very light objects (e.g., paper or feathers) could lead us to believe that heavier objects fall faster than lighter ones. However, simple tests, such as with a dime and quarter, lead to the correct conclusion reached by Galileo that the weight does not matter. It is not coincidental that reliance upon empirical testing has resulted in the tremendous strides in physics, chemistry, and biology that led to many of the technological advances we take for granted in our modern world (e.g., electricity, plastics, and inoculations against diseases). The left side of Figure 1.2 depicts what Manhattan Island looked like in 1609, before it was settled by immigrants from Europe; the right side shows what it looked like in 2009.

**FIGURE 1.2** A computer-generated picture of how the left side of Manhattan Island appeared in 1609 in comparison to how the right side appeared in 2009. (Sanderson & Boyer, 2009)
Within a span of 400 years, the island was transformed from the hilly forest it had been for hundreds of thousands of years to a modern metropolis. These spectacular feats of engineering and construction would never have been possible without the systematic application of the scientific method. Clearly, we must appreciate this powerful methodology if we are to understand our contemporary human condition.

THE SCIENTIFIC METHOD

Not everything that can be counted counts, and not everything that counts can be counted. (Cameron, 1963)

Might a contemporary scientist be interested in determining the number of angels that could fit on the head of a pin? When I ask this question, students frequently chuckle, some seeming uncomfortable. When I ask, might a contemporary scientist be interested in determining the number of influenza viruses that could fit on the head of a pin, students usually respond “yes,” immediately recognizing the difference between the questions. Given the limitations of human senses and currently existing technologies, we are unable to observe the presence of angels and therefore to count them. However, thanks to the existence of electron microscopes, we could theoretically count influenza viruses. The fact that electron microscopes did not exist until 1931 does not mean that influenza viruses did not exist or that they were not important prior to then. The scientific method is limited to questions that can be tested through empirical observation. Only then does the possibility for replication of results exist, a requirement for scientific advancement. If the limitations of being observable, testable, and replicable are met, we know of no more reliable, powerful strategy for determining cause and effect in nature. Next, we review the early history of psychology, considering the implications and challenges of applying the scientific method to the subject matter.

Describe the strengths and limitations of the scientific method in determining cause and effect in nature.

EARLY HISTORY OF PSYCHOLOGY

Wilhelm Wundt is given credit for founding the discipline of psychology at the German University of Leipzig in 1879. It is there and then that the first laboratory exclusively dedicated to psychological phenomena was established. Prior to then, research that would be considered psychological in nature was conducted in physics and neurology laboratories. Examples would include Fechner’s (1860) psychophysics research investigating just noticeable differences on sensory dimensions and Helmholtz’s studies of vision conducted in the 1850s and 1860s (translated into English in 1924).

Wundt (1873, 1896) defined psychology as the scientific study of conscious experience or, as some prefer, the study of the mind. The chemist Dmitri Mendeleev, who formulated the periodic chart of elements, influenced his thinking. Wundt believed
that the goal of psychology should be to determine the fundamental elements of conscious experience, a sort of “mental chemistry.” His research suggested that the basic elements were images, sensations, and affective states (i.e., emotions) and that these had the attributes of quality (i.e. qualitative as opposed to quantitative differences), intensity, and duration. Wundt relied upon introspection (i.e., looking inward) as the exclusive methodology. He believed that with extensive training, individuals could be taught to make objective judgments regarding the attributes of what they were covertly (i.e., privately) experiencing. Thus, a subject might be seated at a desk and asked to describe the intensity and duration of her/his images, sensations, and emotional experiences.

Inevitably, other scientists interested in psychology reacted to different aspects of Wundt’s original approach to the discipline. In 1890, Harvard’s William James published his classic textbook *The Principles of Psychology*, laying out much of the content and organization of introductory psychology textbooks since. Edward Titchener, a student of Wundt’s who established a laboratory at Cornell University, made distinctions between Wundt’s and James’s approaches to psychology, labeling the former as structuralism and the latter as functionalism (Titchener, 1898, 1899). The University of Chicago’s James Angell (1903, 1907) responded with the functionalist perspective on the same distinction. Influenced by Charles Darwin’s (1859) contributions regarding natural selection, Titchener and Angell suggested that Wundt’s original goal of analyzing conscious experience did not adequately emphasize the adaptive role played by the mind in survival. The major functionalists, in addition to James and Angell, included John Dewey and Harvey Carr of the University of Chicago. They argued for broadening the goals of psychology and proposed expanding the methodology beyond introspection to include active experimentation in which the effects of different variables could be investigated.

In 1910, Max Wertheimer, a recent doctorate in psychology, was studying the perceptual experience of apparent movement, later labeled as the phi phenomenon. He had purchased a toy stroboscope that subjectively produced the impression of continuity from appropriately timed presentations of still photos (similar to the projection of filmed still images in a movie theater) and was searching for subjects to investigate the effect. A friend provided laboratory facilities at the Frankfurt Psychological Institute and introduced him to Kurt Koffka and Wolfgang Kohler, two outstanding postdoctoral students to serve as subjects and colleagues (Kendler, 1987). This collaboration resulted in the formation of the distinct psychological perspective called Gestalt psychology (Kohler, 1929). The German word *gestalt* is usually translated as “organized whole” and the catchphrase “the whole is greater than the sum of its parts” succinctly summarizes the major message of this approach. Gestalt psychologists disagreed with structuralists’ goal of analyzing conscious experience. The phi phenomenon was used to exemplify this message. Analyzing the phenomenon into distinct presentations of single photos was inappropriate. They argued that to do so misrepresented and actually destroyed the very essence of what we perceive. The work of describing conscious experience had to be done at the level of complete organized units. For example, to describe a desk in terms of the intensity and duration of visual and/or tactile sensations fails to capture the meaningful pattern that forms the basis of our perceptual experience.

**Introspection**
A methodology in which individuals are asked to describe their conscious experience.

**Structuralism**
Wundt’s initial approach to psychology having the goal of analyzing conscious experience.

**Functionalism**
An early school of psychology interested in how conscious experience enabled individual adaptation to environmental demands.

**Experimentation**
A research method in which an independent variable is manipulated in order to determine an effect on a specific dependent variable.

**Phi Phenomenon**
The perceptual experience of apparent movement studied by Gestalt psychologists. For example, individual lights going on and off in sequence are perceived as a single light in motion.

**Gestalt Psychology**
An early school of psychology rejecting structuralism’s goal of analyzing conscious experience and arguing that conscious experience consists of organized meaningful units. Its perspective is summarized by the statement “the whole is greater than the sum of its parts.”
It has been quipped that sciences advance when one scientist stands on the shoulders of another and psychology advances when one psychologist stomps on the head of another. The originator of this comment could have had John Watson in mind. Watson was trained as a functionalist at the University of Chicago and upon graduation accepted an excellent position at Johns Hopkins, where he remained for 12 years. Publication of his Psychological Review article “Psychology as the Behaviorist Views It” (Watson, 1913) resulted in no less than a permanent transformation of the discipline. Unlike the functionalists and Gestalt psychologists, Watson considered Wundt’s approach to have been a false start. His manifesto called for a change in the definition, goals, and methods of psychology. Watson reasoned that if psychology were to be considered a natural science, the subject matter had to meet the three criteria of being observable, testable, and replicable. Because conscious experience could not be independently verified by any means, testable questions could not be formulated and results could not be replicated. Limiting the subject matter to observable behavior and defining the discipline as the science of behavior with the goal of prediction and control enabled application of the scientific method to the subject matter. Watson’s behaviorism was particularly critical of introspection as a method of inquiry. Not only was introspection inherently subjective, making independently verifiable replication of results impossible, it was a reactive procedure that unnecessarily limited the discipline’s subject matter. A reactive procedure is one in which the observational procedure affects the results. Watson argued that the act of introspection necessarily altered one’s conscious experience. That is, whatever reliable findings were obtained would apply only under circumstances in which an individual is engaged in introspection, which is not ordinarily the case. Because only reliable verbal human beings could serve as subjects, it was impossible to study abnormal populations, children, or other animals as subjects.

PSYCHOLOGY TODAY

Each of the major early schools contributed significantly to the way psychology is currently practiced. Working backward, behaviorism recognized that our scientific observations are limited to behavior that can be measured (Skinner, 1990). Then, just as in other sciences, psychology’s subject matter expanded with the development of new instruments. Astronomy benefited from the invention of the telescope, biology from the microscope, and psychology from such innovations as the IQ test, personality tests, the reaction timer, galvanic skin response (GSR), electroencephalograph (EEG), magnetic response imaging (MRI), computerized recording of behavior, and so on.

The field of psychology has profited from the wisdom of the Gestalt psychologists as well. Indeed, a hard lesson was learned with the realization that many conclusions about human memory based on the study of nonsense syllables (e.g., GUX) did not apply to meaningful words and sentences. For example, recent evidence has demonstrated that the individual letters in words are processed simultaneously rather than sequentially (Adelman, Marquis, & Sabatos-DeVito, 2010).

The title of this book implies that functionalism continues to exert an influence. Indeed, evolutionary psychology has emerged recently as a significant perspective unifying such distinct content areas as physiological psychology, learning, and social psychology (Confer, Easton, Fleischman, Goetz, Lewis, & Buss, 2010).
By virtue of being first, Wilhelm Wundt was able to define, state the goals, and
develop the methodology of psychology. This advantage had a cost because it provided
others the opportunity to make suggestions and offer criticisms, not always in a col-
legial manner. Still, the most important components of structuralism have been incor-
porated within current practice. The fact that Introduction to Psychology textbooks
universally include chapters on perception, cognition, and motivation (and as we shall
see, learning) demonstrates continued interest in conscious experience. These topics
however must be studied in an inferential manner based upon behavioral observations.
Introspection continues as a methodology for acquiring data in the form of self-report,
with the inherent limitations of such data being recognized and studied in their own right.
Wherever possible, confirmatory measures other than self-report are frequently
obtained. For example, in studies designed to reduce cigarette smoking, subjects are
often required to provide carbon dioxide measures in addition to cigarette per day
self-reports.

Describe Wundt’s initial structuralist definition, goals, and methods for the science
of psychology along with the reactions of the functionalist, Gestalt, and behavioral
schools. Show how our contemporary approach to psychology reflects the contribu-
tions of the early schools.

SCIENTIFIC EXPLANATION IN PSYCHOLOGY

As mentioned previously, scientific explanation usually means a statement of
cause and effect. Scientists refer to potential causes as independent variables
and the related effects as dependent variables. Different sciences are defined
by the dependent variables of interest. That is, physics studies the effects of
different independent variables on matter and energy. Biology studies the effects
of different independent variables on life processes. Given what was previously
stated about the current approach to psychology, what does psychology study?

(Answer: The effects of different independent variables on
individual behavior.)

All sciences assume that nature is lawful and that if you study nature
systematically, the underlying laws can become known. This assumption is
referred to as determinism and is not considered controversial today with respect
to physics, chemistry, and biology. We look to these disciplines to provide answers
about how nature works and to benefit from technological advances resulting from
scientific understanding. Those who believe we possess freedom of the will, how-
ever, consider the assumption of determinism with regard to human behavior very
controversial. The concept of freedom within a deterministic science of psychology
is addressed in the final chapter. For now, the controversy can be reduced or elimi-
nated by pointing out that the logical opposite of determinism is not freedom of
the will, but nondeterminism. That is, the logical opposite of the assumption that
nature is lawful is that nature is not lawful. Everyone, including those believing
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strongly in freedom of the will, acts as though behavior is lawful. We (usually) stop at red lights and proceed when they turn green. We (usually) take turns listening and speaking. We (usually) show up for class on time, and so on. None of this would be true if we did not expect others to act in a similarly predictable manner. Predictability, implying lawfulness, can be true only within a deterministic system.

Let us now ask what would be considered a lawful psychological explanation of human behavior. We start with a couple of scenarios. Imagine that you are in a classroom and a person of your age enters, walks over to a wall, and starts banging his/her head against it. Then, this person takes a seat and starts talking out loud, apparently to no one. Someone from the university counseling center enters the room and states “he/she is doing that because he/she is schizophrenic.” Another person of your age enters the classroom, clearly congested and coughing. Someone from the university health services enters and states “she/he is congested because she/he has influenza.”

These two scenarios appear very similar. An individual’s behaviors or physical symptoms are explained by reference to an underlying condition or illness. However, the first example constitutes an example of a pseudo-explanation (e.g., a false one), whereas the second example could fulfill the requirements of an adequate explanation. Why is that? Both explanations involve terms that are difficult to pronounce and spell. What makes influenza a “better” explanation than schizophrenia?

Remember, by explanation we mean a statement of cause and effect. This requires a separate observable potential cause (independent variable) and effect (dependent variable). In the case of influenza, a specific bacteria or virus can be detected through the appropriate tests. The term influenza does not simply stand for a syndrome of symptoms. It stands for the relationship between a specific “germ” and a specific syndrome. It is possible to test and replicate the relationship between this specific germ and specific symptoms. This is not the case with the term schizophrenia, which is defined exclusively on the effect (dependent variable) side (DSM 4R, 2000). It is circular to explain a phenomenon with the name for the phenomenon. Why does the person behave that way? Because he/she is schizophrenic. How do you know he/she is schizophrenic? Because he/she behaves that way.

Pseudo-explanations can be extremely problematic in psychology. For example, it is known that the frequency of students’ getting out of their seats can be increased through the attention of their teacher (Allen & Harris, 1966). If you were informed your child gets out of her/his seat frequently because she/he is hyperactive, you might not search for an alternate explanation. Even worse is the potential for the development of a self-fulfilling prophecy. That is, by virtue of being labeled hyperactive, she/he might be treated differently by others, resulting in the problem behaviors increasing in frequency. One of the most valuable lessons you can learn is when you understand a phenomenon (in psychology or otherwise) and when you do not. Be vigilant for pseudo-explanations. Always look for testable relationships between observable independent and dependent variables.

- Describe what is meant by a pseudo-explanation in psychology and give an example. What are the dangers of believing pseudo-explanations?
WHERE DOES PSYCHOLOGY LOOK FOR EXPLANATIONS?

Many psychologists and psychiatrists are searching for the cause(s) of schizophrenia. Where do they look? Based on the influenza example, one possibility is a germ. If this were to be the case, schizophrenia would be considered a medical (psychiatric) condition. Psychologists look to nature (heredity) and nurture (the environment) for causes. Their assumption is that our genes determine our total potential for development that is then realized through exposure to appropriate environmental events. A high school valedictorian provided a metaphor by thanking his parents, friends, and teachers for helping him prepare for life. He thanked his parents for providing water, his friends for their sunshine, and his teachers for producing so much fertilizer!

You are no doubt familiar with so-called nature-nurture controversies. Some suggest that with respect to intelligence, heredity is more important than the environment or vice versa. Technical journals reference heritability ratios as indications of the extent to which intelligence or some other behavior results from hereditary influences. This is another controversy that is best reframed, as we did with questions regarding freedom of the will. Let us combine some of the elements of the novels *Jurassic Park* (Crichton, 1990) and *Tarzan of the Apes* (Burroughs, 1914) to show how.

Someone is exploring the site where Marie Curie or Albert Einstein died and discovers a mosquito frozen in amber. Sure enough, it is determined that this mosquito stung the scientist while alive and it is possible to extract the DNA and clone it. A healthy, lively infant results and is given to a loving pair of gorillas to raise. Obviously, the known genetic potential will never be realized in this impoverished environment (by current technologically advanced standards). The reverse is also true. We could provide a wonderful, loving pair of human parents with a chimpanzee to raise (chimpanzees share 98% of their DNA with humans). This, in fact, was done with the famous chimp Washoe, the hero of a wonderful book *Next of Kin* (Fouts, 1997). This book will make you laugh and make you cry, and you will never think of chimpanzees in the same way. Still, by human standards, Washoe does not attain many of the complex abilities that the great majority of us do as adults.

It appears misleading to argue that heredity or environment is more important with respect to the development of complex human behavior. The genetic potential must be present or the complex behavior cannot occur. Even if the potential is there, without exposure to the appropriate environmental circumstances, it will not be realized. Psychology then is accurately described as the study of how genetic and environmental variables interact to influence internal processes (thoughts and feelings) as well as overt behavior in individual animals. Psychological explanations consist of descriptions of the relationships between hereditary and experiential independent variables and behavior.

- Describe how it is often misleading to ask whether nature (heredity) or nurture (experience) is more important to understanding complex human behavior.
- Describe what constitutes an adequate psychological explanation.
Human Genetic Potential

A convenient way of considering our genetic potential is to examine the so-called human homunculus (little person). This is a representation of the amount of “brain space” in the cortex allotted to different parts of our body (Figure 1.3). A disproportionate amount of the motor cortex is allocated to our face, lips, tongue, larynx (voice box), and hands (particularly the thumb). The ability to manipulate our facial muscles, tongue, and larynx enables us to emit an enormous variety of vocalizations. Initial attempts to teach chimps to speak (Hayes & Hayes, 1952) were unsuccessful, primarily because of limitations in the use of these body parts. Our ability to manipulate our fingers and thumbs to form the precision grip enables us to grasp and hold objects of different sizes and shapes. Millions of years of evolution resulted in an animal with the genetic potential to speak and create tools (Pollard, 2009). As described in Chapter 11, this potential took a very long time to emerge. However, once realized, this combination of abilities resulted in an animal that dominated and changed our planet. Evolutionary biologist Jared Diamond wrote a wonderful Pulitzer Prize–winning book tracing the history of the human being leading up to and after the last ice age, approximately 13,000 years ago. He describes how features of the climate and environment impacted the course of development of humans on the different continents and why some cultures eventually dominated others. The revealing title of his book is Guns, Germs, and Steel (Diamond, 2005). Thus, an alternative title of this textbook could be Thumbs, Tongues, and Cortex. Theodosius Dobzhansky (1960), the noted Russian genetic biologist, stated

Mutation, sexual recombination and natural selection led to the emergence of Homo sapiens. The creatures that preceded him had already developed the rudiments of tool-using, tool making and cultural transmission. But the next evolutionary step was so great as to constitute a difference in kind from those

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**Human Homunculus**

(little person) A visual representation of the amount of “brain space” allotted to different parts of the body.

**Precision Grip**

The ability to move our fingers and opposable thumbs in order to grasp and manipulate objects of different sizes and shapes. This ability enabled humans to create and use tools.

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**Figure 1.3** The human homunculus for the motor cortex.
before it. There now appeared an organism whose mastery of technology and of symbolic communication enabled it to create a supraorganic culture. Other organisms adapt to their environments by changing their genes in accordance with the demands of the surroundings. Man and man alone can also adapt by changing his environments to fit his genes. His genes enable him to invent new tools, to alter his opinions, his aims and his conduct, to acquire new knowledge and new wisdom.

The Importance of Learning

One powerful experiential explanation for much of our behavior is learning. Before defining learning, we need to emphasize how important the process is in realizing our genetic potential. It is not an overstatement to suggest that all our knowledge, skills, and attitudes are learned. In fact, one would be hard pressed to come up with an example of any complex (i.e., not a simple reflex) human adult behavior that is not learned.

Also, parenting, teaching, and all psychological (as distinct from psychiatric) treatments depend upon the learning process. Procedures as diverse as psychodynamic, humanistic-existential, and cognitive-behavioral approaches to psychotherapy all involve providing a specific experience with the goal of attaining a specific behavioral change. The experiences may be as diverse as speaking about early family relationships or manipulating rewards and punishments. The therapeutic goals could be modifying interpretations of inkblots or increasing initiation of conversations with one’s spouse. Much of the controversy concerning different types of psychotherapy could be diffused if they are understood as simply representing different learning experiences having different objectives.

Describe the importance of learning as an explanation for human behavior.

DEFINITIONS OF LEARNING

Operational

The theme of this text involves combining and slightly modifying a couple of existing definitions of learning. The traditional definition is presented along with another that has not attained the same degree of popularity but complements it in a constructive way. Practically all textbooks provide an operational definition of learning. Operational definitions describe the procedures used to measure the particular term. For example, “intelligence” is often measured by the score on a paper-and-pencil test. The operational definition of learning describes how one objectively determines whether or not a behavioral observation is an example of the process. All sciences rely upon operational definitions in order to establish a degree of consistency in the use of terminology.

The most common operational definitions are variations on the one provided in Kimble’s revision of Hilgard and Marquis’s Conditioning and Learning (1961, p. 6).
According to Kimble, “Learning is a relatively permanent change in behavior potentiality which occurs as a result of practice.” Let us parse this definition. First, it should be noted that learning is inferred, not directly observed. Only when we see a change in behavior resulting from appropriate experience do we conclude that learning has taken place. Other possible causes of behavior change include maturation, which is nonexperiential, and fatigue or drugs that do not produce relatively permanent changes. Kimble includes the word potentiality to emphasize that even if learning has occurred, a corresponding behavior change is not guaranteed. Evidence for this conclusion is provided in Tolman and Honzik’s (1930) classic demonstration of latent learning (i.e., learning not necessarily reflected in behavior).

The research cited in this textbook is almost all experimental. Tolman and Honzik studied three groups of rats placed in a 14-unit T-maze (Figure 1.4). Figure 1.5 is the first of many graphs portraying experimental research results. Carefully studying each graph may help you understand the research. As indicated in the operational definition of learning, experience will be manipulated and behavior observed. The graph’s legend describes the experiences provided the three groups (i.e., the independent variable). One group of rats was placed in the start box and removed from the maze after reaching the end. The second group received a food reward at the end and was permitted to eat prior to being removed. The third group did not receive food at the end of the maze until the 11th day. The dependent variable (number of errors) was recorded on the y-axis for 17 days.

Before considering the third group, let us see how the results for the first two enable us to conclude that learning has occurred in the second group. These two groups

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**FIGURE 1.4** Sketch of the maze used in Tolman and Honzik (1930).
might be described as a control group and an experimental group. The groups are treated the same with one exception, the experimental group receives food at the end. Therefore, if the results differ, we are able to conclude that it must be this experience that made the difference. Examination of the results for the No Food Reward group reveals that the dependent variable, average errors (i.e., wrong turns in the maze), changed only slightly over the course of the experiment. However, the Regularly Rewarded group demonstrated a consistent decline in the number of errors, exactly what one would expect if learning were taking place. It would not be possible to conclude that the experience made a difference in this group without the control condition. One could argue that something else was responsible for the decline (e.g., a change in the weather, maturation).

We have seen how it is possible to conclude that the Regularly Rewarded group learned the maze based upon a comparison of its results with the No Food Reward group. A related, seemingly logical conclusion would be that the No Food Reward group failed to learn the maze. Tolman and Honzik’s third group was like the No Food Reward group for the first 10 days and like the Regularly Rewarded group for the remaining days. This third group enabled us to test whether or not the absence of food resulted in the absence of learning. It is important to understand the rationale for this condition. If this group had not learned anything about the maze on the first 10 days, the number of errors would be expected to gradually decline from day 12 on. However, if it had been learning the maze, a more dramatic decline in errors would be expected. This is indeed what occurred, leading to the conclusion that the rats in the third group had learned the maze despite the fact that it was not evident in their behavior (latent learning). Learning is but one of several factors affecting how an individual behaves. Tolman and Honzik’s results imply that incentive motivation (food, in this instance) was necessary in order for the animals to display what they had learned. Thus, we see the need to include the word potentiality in the operational definition of learning. During the first 10 trials, the rats clearly acquired the potential to negotiate the maze.

**Control Group**
An experimental condition either not exposed to or exposed to a different level of an independent variable than the experimental group.

**Experimental Group**
A research condition exposed to an independent variable.
Tolman and Honzik (1930) is the first of several studies to be described in depth. One of the objectives of this text is to encourage the development of a scientific schema. All sciences use similar formats in research articles. They generally consist of introductions placing the study within the context of prior research; method sections providing sufficient detail to replicate the procedures; reporting of results and statistical analyses; and discussion of the conclusions, implications, and limitations of the research. In order to assess whether you understand Tolman and Honzik (or any other research study), ask yourself the following: What was the question being addressed by the investigator(s)? How did the procedures enable the question to be addressed? What were the results and conclusions regarding the question?

### Scientific Schema

A format for research articles consisting of an introduction placing the study within the context of prior research; a methods sections providing sufficient detail to replicate the procedures used in the study; reporting of results and statistical analyses; and discussion of the conclusions, implications, and limitations of the research.

### Structural/Functional Definition of Learning

Defining learning as involving the acquisition of stimulus and response expectancies resulting in adaptive responding. The definition is structural in the sense that expectancies are considered the elements of conscious experience forming the basis of learning. It is functional in that it describes the purpose of learning as adaptive responding.

### Stimulus Expectancies

Anticipating events based upon patterns of stimuli in the environment (i.e., event-event learning). For example, “If this happens, then that happens.”

### Structural/Functional

In contrast to the traditional operational definition of learning, Tarpy (1982) introduced what might be described as a structural/functional definition. It is structural in the sense that expectancies are considered the elements of conscious experience forming the basis of learning. It is functional in that it describes the purpose of learning as adaptive responding. According to Tarpy, “learning is the acquisition of expectancies, based upon patterns of stimulus inputs and response feedback, which allow an animal to behave in an adaptive fashion” (p. 10). Tarpy distinguishes between two types of expectancies: stimulus expectancies based upon patterns of stimuli in the environment and response expectancies based upon the effects of an individual’s behavior on the environment (i.e., consequences of behavior). Stimulus expectancies may be described as event-event learning (i.e., if this happens then that happens). Response expectancies are examples of response-event learning (i.e., if this behavior occurs then that happens). Tarpy (1982) states,

In short, the fundamental task for any organism, in terms of learning is to be able to predict changes in its environment, to anticipate the future....

To deny that learning involves the acquisition of expectancies would be to fail to grasp the fundamental truth about the learning process: that it has evolved to help animals deal with uncertainties, to allow them to perform more adaptively in a changing world, to permit them to exert some order over a complex and changeable environment. (pp. 8, 11)
Although Tarpy’s definition has not resulted in wide-scale modification or supplementation of the traditional operational definition, it has much to recommend it. It connects the study of learning to the traditional goals of the science of psychology: to analyze and determine the adaptive nature of conscious experience.

Tarpy’s structural/functional definition has an additional significant benefit. Students reading a textbook on learning or the learning chapter of an Introduction to Psychology text often notice that the term learning, which they associate with human beings, is hardly discussed. Most of the content is dedicated to classical and instrumental conditioning based on research with other animals. Tarpy’s definition suggests why this is the case. The type of learning being considered is adaptive learning, a fundamental process characteristic of much of the animal kingdom. Classical conditioning is a research paradigm enabling the study of event-event learning whereby response-event learning is not possible. For example, as a result of stimulus patterns, Pavlov’s dogs could eventually anticipate that the tone would be followed by meat powder. However, they were not able to affect the occurrence of either the tone or the meat powder. In comparison, Skinner’s rats, based upon the feedback of receiving food after pressing a bar, were able to undergo response-event learning and affect food availability.

**Adaptive**

One might question why classical and instrumental conditioning are the only two processes generally considered. This brings us to the definition of learning used for the remainder of this book: *Learning is an adaptive process whereby individuals acquire the ability to predict and control the environment.* Adaptation consists of predicting and controlling events. **Classical conditioning** procedures investigate learning how to predict when control is not possible. **Instrumental conditioning** procedures investigate learning when control is possible (i.e., from the rat’s perspective, it is controlling the delivery of food). The advantage to describing learning in terms of predicting and controlling is that these are the two components of adaptation. This makes clear why only classical and instrumental conditioning processes are discussed. To add an updated version of the operational definition to the one proposed here, Domjan (2005b, p. 7) has offered “Learning is a relatively enduring change in the potential to engage in a particular behavior resulting from experience with environmental events specifically related to that behavior.”

**DIRECT AND INDIRECT LEARNING**

Many chapters and books on learning include a discussion of observational learning as though it were another type of learning in addition to classical and instrumental conditioning. Observational learning will be treated differently here by using the previously
mentioned distinction between direct and indirect learning. The conditioning processes involve an individual’s direct interaction with environmental events. In contrast, observational learning is indirect in the sense that someone (or something) else is interacting with the environment. An example of indirect classical conditioning might involve one chimpanzee (the observer) witnessing another (the model) being shocked after a tone. After a few trials, the model screams upon presentation of the tone. When the observer is placed in the same situation and hears the tone, it is likely that it too will scream despite never having experienced the shock. An example of indirect instrumental conditioning might involve one chimpanzee witnessing another in a Skinner box press a bar and receive food. If placed in the box, it is likely that the observer chimp will immediately press the bar.

Another indirect form of learning that is critical to human adaptation is the symbolic use of language. **Language** is a consensually agreed-upon collection of arbitrary symbols representing objects, movements, properties, relationships, and so on. Through language, humans can provide the same information as through observational means, thereby resulting in similar behaviors. For example, I can tell you that lightning predicts thunder, or that pressing any key will turn off the screen saver. Olsson and Phelps (2004) provide an excellent study examining the neuroscience underlying the direct, observational, and linguistic learning of a fear of faces. Human subjects were either exposed to a shock (direct learning) in the presence of a picture of a face, observed another person’s emotional reaction to the face (indirect observational) or were told that the picture of the face would be followed by shock (indirect symbolic). The three groups subsequently demonstrated similar fear reactions (as assessed through skin conductance response) to the picture of the face. It may therefore be concluded that the three types of experiences represent three paths to the same adaptive learning (see also Kirsch, Lynn, Vigorito, & Miller, 2004). In later chapters, we will examine the research literature addressing the methods, theoretical issues, and applications of adaptive learning principles. We will observe how these principles enable us to understand and transform the human condition. In preparation, in the next chapter, we consider the challenges posed by the scientific study of the learning process.

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**Summary**

Some human beings are still living Stone Age existences on our planet. What we mean by the human condition can change dramatically from place to place and from time to time. Within the past 400 years, humans have transformed the planet earth from its natural state, and many of us are now adapting to a human-constructed environment. The transition from relying upon personal experience and authority figures to the use of the scientific method to understand nature is responsible for this transformation. Science requires that its subject matter be observable and measurable. Although psychology was originally defined as the study of conscious experience (a.k.a. the study of the mind), eventually it became apparent that advancement as a science required behavioral observation. Explanation within a science usually consists of cause-and-effect relationships. Psychology studies the effect of genetic (nature) and environmental (nurture) variables on the behavior of individuals.
Learning, defined as experientially caused changes in behavior, is a powerful explanation for why we behave as we do and how we have transformed the human condition. It is appropriate and helpful to describe learning as an adaptive process through which individuals acquire the ability to predict and control their environment.

Learning can occur directly, through personal experience, or indirectly, through observation of others or symbolic means (language).

References


