1 Introduction to an Evolutionary Perspective

If a being from another universe appeared on earth, what would be its impression of the life forms it would observe? It might note the great similarity between animals such as mammals: food is important; sex is important; caring for young is important; being with others is important. It might also note ways in which humans appear to be different from other **species**. We walk upright and have little hair on our bodies. We don't have natural predators as do other species. We build large cities and create qualitatively different types of technology as compared to other mammals. We use written and spoken language in ways that no other organism does. We produce art, not only to represent our experiences, but also to produce them. We use abstract and symbolic forms such as mathematics to describe the universe. We create theories and consider alternatives. We ask questions of ultimate concerns and display a spirituality not seen in other animals. Although the alien could describe our behaviors well, what the alien could not do is to understand why we do the things we do.

Why we do what we do is a question that can be answered in a number of ways. We may be tired, for example, because our blood sugar is low. We may be tired because we did not get enough sleep. We may feel tired because things are not going our way. Each one of these descriptions could be studied scientifically. Traditionally, many of the topics we study in psychology reflect research on a particular level. We study the physiological level, the individual level, the social level, and the cultural level. In general, each of these levels seeks to describe mechanisms that help us understand human behavior and experience. What is often missing is the larger question of how things came to be the way they are. In this book, I will suggest that the **evolutionary perspective** as seen from a variety of fields, including the neurosciences, not only helps us to understand critical mechanisms involved in behavior and experience, but also gives us valuable perspectives on how these processes came about. Because we are asking these two different types of questions at the same time, we will find ourselves going from very broad perspectives to very specific events. At one moment I will ask you to consider what your life would have been like if you had lived 10,000 or even 50,000 years ago. What would you need to survive and how would you spend your time? At other times, I will ask you to consider a particular person and ask whether you find that person attractive. Sometimes this seems to be strange research. What if you were given t-shirts that a variety of males or females had worn for the last two days? Would you find the smell of some of these shirts more pleasing and others more repulsive? Why? The answer is you would find some t-shirts more pleasing than others and, as you will see later, the reason is related to genetics. Actually, it is the relationship between your genetics and those of the other person that determines your preferences. However, your preference for one smell over another is actually a sophisticated calculus that can result in greater genetic variation and health in your offspring. Overall, you will come to see that as humans, we need to solve a variety of tasks. The evolutionary perspective helps us to determine which of these tasks have been and are currently critical. I will emphasize the evolutionary perspective as we consider human behavior and experience.

The Beginnings of an Evolutionary Neuroscience of Behavior and Experience

If you look at the history of science, it is clear that different questions were asked during different historical periods. With a few exceptions, in ancient Greece, more than 2,000 years ago, the earth and life on it was seen as stable and unchanging. In 1830, with the publication of Sir Charles Lyell's book *Principle of Geology,* scientists began to realize the age of the earth and the manner in which it had changed throughout history. Darwin and some others at the time came to realize that not only the physical earth but organic life on earth was going through an evolutionary process.

If we begin with Darwin's theory of evolution during the late 1800s and examine the history of intellectual thought in psychology until the present, we find a variety of perspectives on understanding life on earth in general and human behavior and experience in particular. As you will see, some have focused solely on the environment as a determining factor, whereas others have focused on the internal processes of the individual or group. In fact, many have conceptualized the history of psychology as an intellectual struggle between those who stress the importance of nurture and its impact on the environment and those who stress nature and its impact on biological determinants. As you will see, given limited exemplars, either side can make a case for its position.

However, the richness of a scientific psychology requires considerations of both in terms of their interaction.

Consistent with Darwin's description of a close and complex relationship between an organism and its environment, current theories have focused more on the interactive nature of the two rather than either separately. Although Darwin presented a theory that united life on earth and its connection with the environment, he did not emphasize psychological processes. This was left for others to develop. However, in terms of many processes important to psychologists, such as the recognition and expression of emotion, Darwin did point the way. I describe the study of emotional expression in Chapter 6.

Psychology during the 20th century can be characterized as beginning a rich laboratory research tradition. Initially, a variety of important questions were studied in this manner. However, near the end of the 20th century and the beginning of the 21st, it became apparent that one of the unintended consequences of this approach was to emphasize short-term changes in behavior. Much of this research examined environmental factors in the laboratory and ignored larger questions concerning human behavior and experience over time. Some of these larger questions relate to how we have interacted with each other and the variety of human processes that facilitate these interactions. Human interactions have developed over our evolutionary history. One critical aspect for humans is that we have always lived in groups. Thus, much of early history related not only to self-preservation and sexuality, but also to how to live in a group and understand other people. From an evolutionary standpoint, it is critical to consider the impact of such a lifestyle and the way in which behavior and experiences can be seen in a larger family and social context. In our 20th-century laboratory studies, questions related to the role of art, music, and spiritual experiences in human life were largely ignored. These experiences have also been a part of human history. Cave art, for example, can be dated to at least 30,000 years ago. Questions about human concerns such as sexuality, feeling accepted or left out of groups, or emotional feelings including love and aggression can be studied in the laboratory. However, taking a broader perspective gives a more complete picture of the process. For example, when studying aggression, a more complete picture is seen when we realize that there appears to have been almost no time in our human history when there was not a war taking place somewhere on earth. Additionally, there is data from around the world to indicate that when a murder is committed, it is 10 times more likely to have been committed by a man than by a woman. It might also come as a surprise to realize that there is less murder today than there was in the Middle Ages. In most of 20th century psychology research, there was little consideration of why humans kill other humans. The larger questions concerning the origins of human nature were often ignored and left in the background by traditional laboratory research.

Pathways Toward an Evolutionary Psychology

Darwin's theory of **natural selection** emphasized physiological adaptations and pointed the way to understanding psychological processes such as memory, perception, thoughts, and emotion. Considering psychology from an evolutionary perspective helps us to understand the tight coupling suggested by Darwin between organisms and their environment. The human visual system, for example, is most sensitive to the frequencies found in natural sunlight. Of course, we do not need to take an evolutionary perspective to determine the frequencies of light that the eye is most sensitive to. We can know this by using the methods of psychophysics and other experimental procedures. The evolutionary perspective adds the question, Why are we most sensitive to the frequencies found in natural sunlight? We could make up many reasons why this might be so. However, a better approach would be to consider all of the human perceptual systems and ask, If they had evolved over our evolutionary history, how might they look? In utilizing such an approach, we might be surprised to discover that the frequencies of light that humans are most sensitive to are also the frequencies that are able to travel through water. Why might this be? One possible answer is that the human eye evolved from basic structures seen in earlier organisms that lived in the water. Throughout the ages, adaptations to environmental conditions have given us the eyes that we have today. A broader evolutionary perspective also helps us to consider not only the adaptations over time, but also how these adaptations may have structured the mechanisms involved. Let's take vision again, as an example. It is initially surprising that, on first glance, the receptor system of the eye appears to be backward. That is, as you observe your retina, you notice that the rods and cones are located behind the neural mechanisms that transfer information from rods and cones to the brain. You also notice that there are no receptors at the place in the eye where information from the eye goes to the brain. This results in a blind spot. It is similar to placing the headlights on your car behind the electrical wiring that connects them to the controls. However, it makes sense once one asks, What if the visual system evolved from much simpler single receptors located directly beneath the skin? This is just one example that helps us understand the evolution of sensory processes. As you will see throughout this book, the evolutionary perspective offers additional insights into many human processes.

In order to fully understand human processes, we must draw from a variety of areas, including physics, chemistry, and biology, as well as psychology. Currently, the neurosciences exemplify the collaboration of a variety of scientific areas that focus on explaining the structure and function of human activity. These approaches should be viewed as supplemental levels of understanding. Each adds a different perspective. Understanding the chemistry of sadness or joy or the locations in the brain where these changes take place does not enable us to explain the experience itself or the environmental factors that might bring about these changes. Thus, one level of understanding cannot simply be reduced to another; rather, additional levels make for more integrated conceptualizations. Likewise, the theoretical perspectives of evolutionary psychology have been drawn from a variety of sources and intellectual traditions. Unfortunately, during the 20th century, these scientific traditions remained somewhat isolated and continued along parallel tracks with little interconnectedness. Because the evidence and perspectives have not been integrated and synthesized to offer a single theoretical perspective, what I must present in this book is the beginning of an evolutionary theory of behavior and experience, rather than a single comprehensive final articulation. The purpose of this current chapter is to consider some of the approaches that have contributed to the study of evolutionary psychology up to the present.

ETHOLOGY

Ethology is the study of animals and what they do. The word is derived from the Greek and means *manner, trait,* or *character*. At the heart of ethology is the naturalistic observation of behavior in an organism's natural environment. For example, an ethologist could describe the interaction of birds as they feed on common food, noting the manner in which feeding birds might react to newly arrived birds. He or she could also note the manner in which human infants will imitate the facial expressions of adults. In this field, it is assumed that behavioral processes have been shaped through evolution to be sensitive to environmental conditions. Thus, behavior can be understood only within the context of a particular environment. Environment, in this context, includes not only the physical characteristics of a particular setting but also the social and cultural milieu in which the organism lives. Given the complexity of behavior within an environment, the field of ethology has largely focused on particular patterns of behavior that have evolutionary significance and the possible mechanisms that produce these behaviors. The question for us, of course, is, Do humans have mechanisms similar to those studied by ethologists?

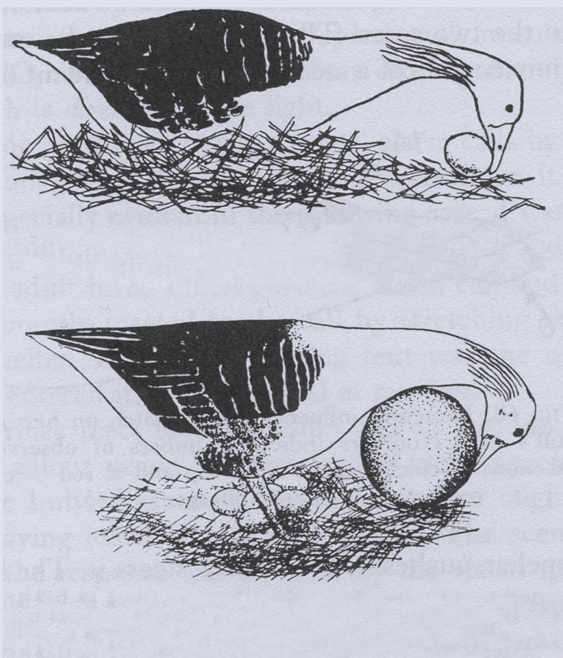
One of the pioneers in the field of ethology was Konrad Lorenz (1903–1989). From his early childhood on the outskirts of Vienna, Lorenz was interested in observing animals. After receiving a medical degree and continuing studies in zoology, Lorenz more formally studied behavioral patterns. He focused on the patterns he considered characteristic of a species. Most psychology students know Lorenz for his imprinting studies. **Imprinting** is a built-in pattern in which birds, such as ducks and geese, follow an object, usually their mother, that moves in front of them during the first 18 to 36 hours after birth. In a series of now-classic studies, Lorenz showed that orphaned baby birds would follow any moving organism, including Lorenz, as if it were their mother. Not only would they follow Lorenz, but they would also ignore members of their own species and, still later in life, attempt to court humans rather than other geese (see Figure 1.1). If the baby birds did not encounter a suitable object during this critical first 18 to 36 hours of their lives, the birds would not imprint and would even show terror.

How did Lorenz understand imprinting? He suggested that imprinting and other similar phenomena worked like a lock and key. The key in this case would be the characteristics of the mother, including the manner in which the mother moved in front of the babies. The lock would be an innate brain pattern or template, in which knowledge concerning the key would be encoded. Further, the lock and key would only work together for a critical period, in this case the first two days of life. More intriguing is the fact that once the imprinting has taken place, it is almost irreversible and cannot be changed. In more technical language, the key is referred to as a **social releaser**. More recent research with imprinting has shown the social releaser to be somewhat specific, in that newly hatched birds prefer to follow females of their own species, as compared to other objects. Studies with newly hatched chickens suggest that characteristics of the object's head serve as the social releaser (Johnson & Horn, 1988). The technical term for the lock is **innate schema** or **innate template**. The limited temporal period during which the lock and key work is referred to as the **critical period** or **sensitive period**.

Figure 1.1 Konrad Lorenz Being Followed by His Geese

One feature of imprinting was that it was learned quickly and did not require a number of occurrences as with various types of skilled learning. This is referred to as *one-trial learning*. In addition to one-trial learning processes such as imprinting, there are also other patterns of species-specific behavior. In 1938, Lorenz, along with Niko Tinbergen, experimented with the egg-rolling movement of the Greylag goose. If the goose sees an egg outside its nest, it will reach past the egg with its bill and roll the egg back with the underside of its bill, balancing it carefully into the nest (see Figure 1.2).

Figure 1.2 Greylag Goose Retrieving an Egg



Lorenz observed that if he removed the egg once the rolling behavior had started, the behavior continued as if the egg were still there. However, the balancing movement was not seen. This suggests that the balancing movement is sensitive to ongoing stimulation and ceases in its absence, whereas the egg-rolling movement, once begun, does not require sensory stimulation to continue. Lorenz referred to the egg-rolling movement as a **fixed action pattern**.

A fixed action pattern has the following characteristics:

1. It is released by a stimulus,
2. It uses the same physiological mechanisms (e.g., muscles) to achieve the same sequence of actions,

3. It requires no learning,
4. It is characteristic of a species, and
5. It cannot be unlearned.

A fixed action pattern, once released, will continue in the absence of the releasing or triggering stimulus.

Tinbergen (1974) was particularly interested in understanding such **instinctual processes** as fixed action patterns in a variety of species. One particular interest of Tinbergen's was the nature of the stimulus that brought forth the response. For example, a newly hatched herring gull chick will beg for food by pecking at the tip of the parent's bill. The bill is yellow with a red spot at the end of the lower mandible. To determine which characteristics of the bill resulted in the pecking behavior, Tinbergen created a series of cardboard dummy birds and varied the color of the spot on the bill. He found that frequency of pecking was highest with the red dot and lowest when there was no dot at all (see Figure 1.3).

Figure 1.3 Models of Herring Gull Heads Used to Study Frequency of Begging Responses in Newborn Chicks

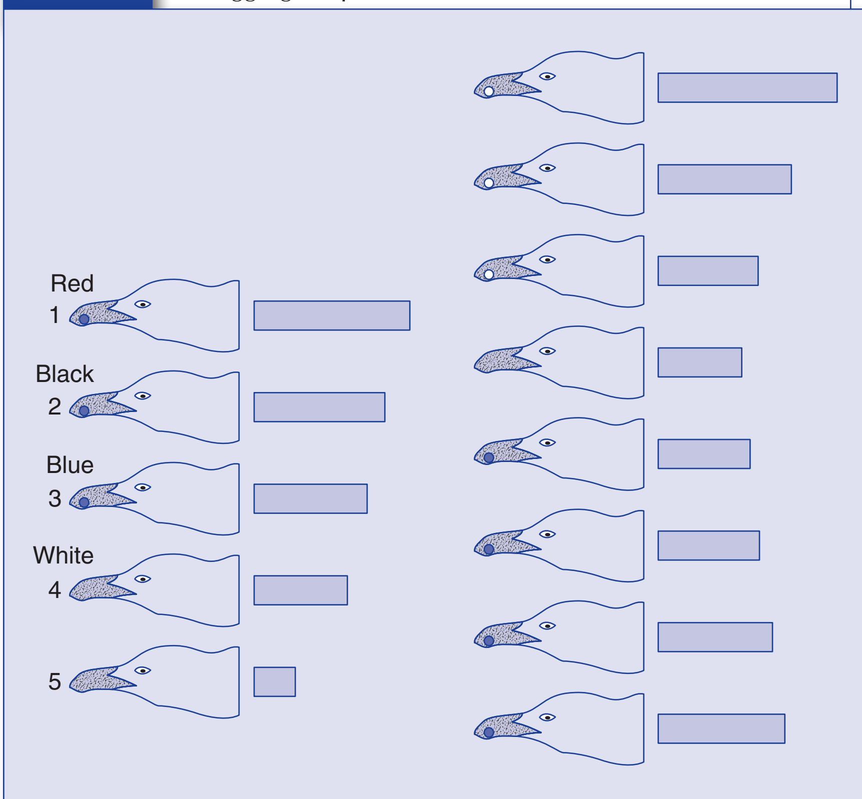
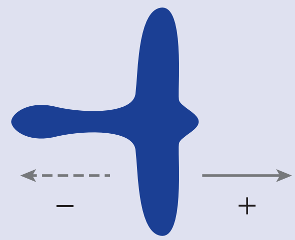


Figure 1.4 Direction of Movement of Stimulus Determines Presence of Alarm Reaction in Ducks and Geese



He also varied the color of the head and found that head color made no difference at all to the frequency of pecking. Another example of instinctual processes in birds was an alarm reaction to a predator flying overhead. The same bird of prey silhouette could produce a different reaction depending on its direction, suggesting some complexity in the reaction (see Figure 1.4).

In order to determine the exact stimulus required, Tinbergen varied the shape of the bird of prey. Using cardboard silhouettes of various birds, he discovered that short-necked silhouettes produced alarm reactions in ducks and geese (see Figure 1.5). Why would this be so? The answer is that short necks are characteristic of predatory birds, such as hawks or falcons, that prey on ducks and geese.

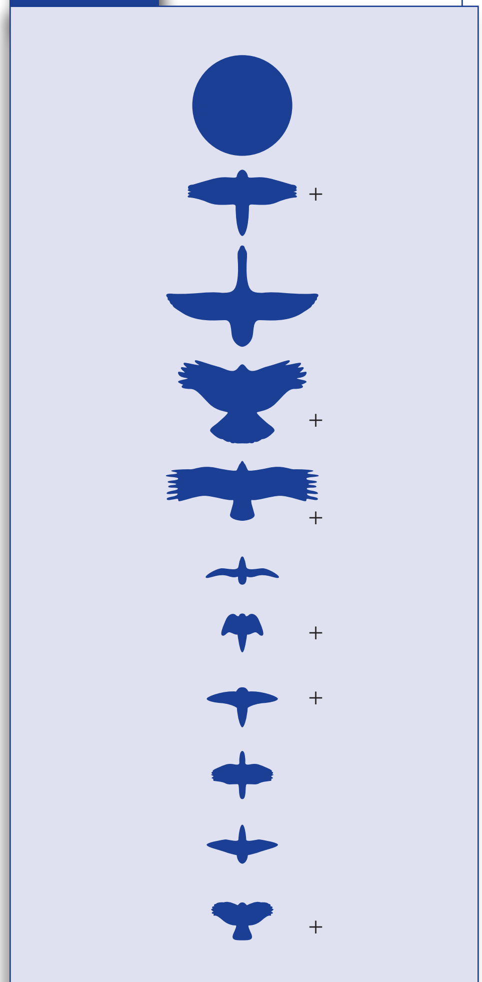
From an ethological perspective, Tinbergen (1963) suggested that there were four "whys" to be considered when studying behavior:

1. causation
2. development
3. evolution
4. function

First, what are the mechanisms that cause the behavior? *Cause,* in this case, refers to physiological mechanisms that are activated by environmental cues. Second, how does the behavior develop in the individual? Third, how has the behavior evolved? And fourth, what is the function or survival value of the behavior?

In the 1960s, Irenäus Eibl-Eibesfeldt extended the ethological perspective to include humans. He summarized this work in his book *Human Ethology,* published in 1989. Like ethological studies with animals, human ethology sought to understand how and why specific behavioral patterns in humans evolved, including the physiological processes involved. The initial criterion for this investigation was **fitness**. This criterion asks how a behavioral pattern contributes to the survival of the offspring. In discussing behavioral patterns, Eibl-Eibesfeldt points out that human ethology is more than just extending animal processes to humans. It also takes into account cultural behavioral patterns, which can include, for example, how we design uniforms or organize sports matches, as well as traditional cultural processes. Further, in the study of humans, speech plays an

Figure 1.5 Bird Models Used by Lorenz and Tinbergen to Determine Alarm Reactions. Those marked with a "+" produced the reaction.



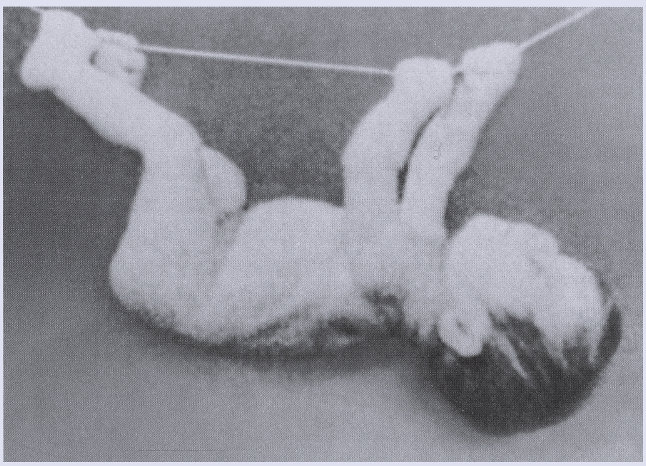
important role. The research methods of such an approach can be broad, ranging from data sampling, to non-participant observation using current technologies, to approaches that examine behavioral patterns across species. There is, however, an emphasis on initial research involving the behavior displayed in its natural context. After this, more experimental studies are possible.

One of the broader questions asked by Eibl-Eibesfeldt is the manner in which life should be considered. Borrowing from Hass (1970), Eibl-Eibesfeldt emphasizes that life should be considered an energetic process. From this perspective, one task of all organisms is to extract energy from their environment in forms such as food, sunlight, and so on, in order to live and perform other functions. Thus, the overall goal is to acquire more energy than one must expend in its acquisition. As we will see throughout this book, the idea of maximizing energy input and limiting energy expenditure will have profound implications for understanding human functioning. Accomplishing this task in ever-changing environments requires **adaptations**.

Adaptations reflect features of the environment relevant to survival, according to Eibl-Eibesfeldt. For example, characteristics of light transmission through water are represented in the construction of a fish's eye. However, the human visual system reflects the transmission of light through air. Some insects literally mimic the environment in which they live (e.g., a leaf). However, the characteristics reflected in the structure and function of an organism are mainly those related to fitness. Lorenz suggested that the thought processes of humans also reflect environmental fitness adaptations. That is to say, our cognitive processes reflect characteristics that maximize fitness. In this manner, our cognitive processes do not depict the external world as would a video recording; we process and store information according to basic instinctual processes. This is easy to demonstrate by asking a variety of people what they read in the morning newspaper. What one discovers in such an exercise is that most individuals remember very little in an organized or rational manner; instead, they retain only that which is directly relevant or interesting to them in some way. Even moving to a higher level of analysis, it is apparent that most of our human creations (e.g., computers) result from situational adaptations to the environment, rather than rational planning.

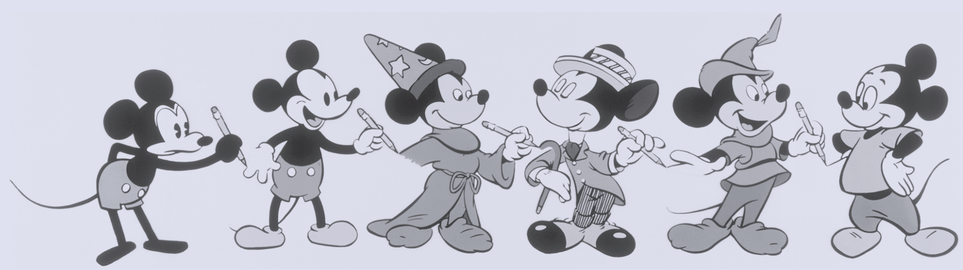
Adaptation over time becomes a key to understanding human behavioral processes. One of the first tasks in human ethology is to identify innate behavioral processes. As we will see throughout this book, and especially in the chapters involving developmental processes, humans display a variety of innate behavioral patterns. Examples of these are clearly seen in newborn babies, such as the grasping movements of the feet and hands when touched, or the rooting reflex when the lips and cheeks are touched. Here we have two very different behaviors in terms of functional significance. Human infants at birth can close their fingers and toes around an object such as a rope tightly enough to enable them to hold their own weight (see Figure 1.6).

Figure 1.6 Grasping Response of Human Newborn



Clearly, this is not a task that human infants are required to do in their environment. However, given that one of the best stimuli for eliciting the response is a clump of hair, it may be that the response is related to the non-human primate infant grasping his mother as she moves through the trees, which does have great survival value. Thus, what has functional significance for non-human primates may have less functional significance for human infants. However, the rooting reflex, in which the infant moves toward a mother's nipple, clearly has significance for both human and non-human primates. Research has also supported the idea that an infant's facial features, including large eyes and forehead, may serve as releasing mechanisms that bring forth positively valenced affectionate responses from adults. Cartoon characters or toys that have similar characteristics are rated as "cute" across a variety of cultures. In fact, Eibl-Eibesfeldt (1989) illustrates the changes in the characteristics of Walt Disney's Mickey Mouse over 50 years (see Figure 1.7). What this suggests is that each new set of artists who drew Mickey Mouse over the years changed his features, emphasizing larger eyes and head, to make him more appealing to humans. This most likely happened without the artists being consciously aware of the slight changes they were making.

Figure 1.7 Changes in the Depiction of Mickey Mouse Over 50 years, Emphasizing Larger Eyes and Head



Many of the insights of the ethologists will be described throughout this book as they relate to specific topic areas. In studying the behavioral processes of animals and our own species, the ethologists have helped us develop a more sophisticated way of moving beyond the simple nature/nurture dichotomy. For example, a process such as imprinting shows us that innate components are important. However, there are other conditions that play a role. Imprinting is also a question of timing and what is taking place in the environment during this critical period. In later chapters of this book, we will see that human processes such as language development and mother-infant attachment can be understood as also reflecting a rich interaction between environmental and innate factors. In considering these processes, we will see that both innate and environmental factors place constraints on human behavior and experience that are not easy to describe in simplistic ways. You will also see that many of the approaches used in human ethology have also been important in psychology, as illustrated by Paul Ekman's study of human facial expressions in Chapter 6.

GENETIC TRADITIONS

R. A. Fisher

In the 1930s, statistician R. A. Fisher (1930/1999) published *The Genetical Theory of Natural Selection.* Fisher was interested in putting natural selection on a more scientific footing by developing an underlying mathematical formulation. This book is often described as the first major work to provide a synthesis of Darwin's theory of natural selection with Gregor Mendel's genetic research. As you will see in Chapter 3, Mendel worked with the pea plant and was able to show how traits such as flower color or height were passed on from generation to generation. Darwin described the process of evolution but lacked knowledge of the mechanisms by which it could take place. Darwin could not explain the specific causes of variation that drove evolutionary theory. What Fisher, along with others, began to do was to articulate the concept of variation as developed in genetics and integrate this with evolutionary theory using statistical concepts. In accomplishing this task, Fisher worked with Darwin's son, Leonard Darwin, to gain perspective. One of Fisher's important mathematical demonstrations was the understanding that natural selection progresses by the accumulation of many small changes in genes, rather than a few large changes. As you have learned in your statistics courses, many characteristics of organisms, such as height or bone or tooth size or wing length, fall on a normal distribution or bell-shaped curve.

How are we to understand the meaning of these distributions? Fisher related these to *fitness.* He suggested that there must be an optimal value that relates to the physical characteristics of the organism as well as the environment. Take, for example, the length of a bird's wing. If it is too short, it will not be able to lift the bird off the ground. If it is too long, the bird's muscles may not be strong enough to move the wings appropriately. Thus, there is an optimal length. For Fisher, the optimal measurement was the same as the mean, or average value, exhibited by the species. He also concluded that a small advantageous change in gene structure can occur only a small number of times before it changes the entire population. Let's look at a specific example of this. Assume that a variation in gene structure caused some individuals to become more intelligent than the rest of the population. If this higher intelligence were an advantage, then slowly over time, higher intelligence would become a characteristic of the entire population. Then, of course, what was previously high intelligence would now be average intelligence because it would be a characteristic of the entire population. Fisher's work helped to set the stage for an integration of the study of genetics with the study of evolution through natural selection.

INTEGRATION OF GENETICS AND EVOLUTION

Theodosius Dobzhansky

A step toward the modern synthesis of evolution and genetics took place in 1937 with the publication of *Genetics and the Origin of Species* by Theodosius Dobzhansky. Dobzhansky had been interested in studying insects in the wild since his early years as a child. After coming to America from Russia, he began studying fruit flies with Thomas Hunt Morgan at Columbia University and later at the California Institute of Technology. Morgan and his group had shown spontaneous variation in genes in the laboratory fly. Dobzhansky was able to integrate this work on genetic variation with the work of those who studied species in the wild. One of his original questions had to do with the genetic variability that determines the differences in populations of a species. While studying organisms both in the lab and in the wild, it became clear that members of the same species can have different genetic variations. It was not the case, as some thought at the time, that each member of a species had an identical set of genes. What, then, helped to define a *species?* Dobzhansky suggested it was sex. That is, a species is a group of animals or plants that mate among themselves. His book, *Genetics and the Origin of Species,* pointed to some ways in which species could come into existence. He began with the idea that genetic mutation leads to variation. However, this in itself would not lead to the changes necessary to produce a new species. What was necessary was for conditions to change in some manner that could lead to what Dobzhansky called **isolating mechanisms**. A variety of factors could help to produce these isolating mechanisms, ranging from changes in geography to changes in physiology. As a result of these changes, a part of a species could become isolated and begin to breed with each other, as would be expected. In the process, these organisms would become genetically different from the larger population. As additional variations developed in the isolated population, the mechanisms of natural selection would come into play, such that these traits would become part of the isolated population and thus they would be more dissimilar from the original population of animals. As shown in lab work, these isolated populations could carry genes that would interact negatively with those of the original population, such that no offspring would be produced or they would die prematurely. It is in this manner that species can develop and live side by side. Although beyond the scope of our present discussion, others such as Ernst Mayr, George Gaylord Simpson, Bernhard Rensch, and G. Ledyard Stebbins helped to complete the modern synthesis of genetics and evolution, which highlighted the similarity of understanding in such apparently unrelated fields as genetics, zoology, botany, and paleontology (Price, 1996; Zimmer, 2001).

The modern synthesis combining the study of evolution with the study of genetics was begun over 70 years ago. Presently, there is a call for a new synthesis that takes into account the complex ways in which organisms change over time (see Pennisi, 2008). As you will see in Chapter 3, since that original synthesis, a variety of important discoveries have been made. These include the discovery of the structure of DNA, the sequence of the human genome, and the additional ways, such as epigenetic mechanisms, for information to be transmitted from one generation to the next. Another important theme that you will be reading about throughout this book is the critical importance of the environment and its ability to turn genes on and off. Further, as you will read throughout this book, psychological factors play a crucial role in our understanding.

KIN SELECTION AND ALTRUISM

William Hamilton

William Hamilton (1936–2000) published two papers in 1964 that were to become a major part of what has been called the "second Darwinian revolution." Darwin's description of natural selection led scientists to ask how particular characteristics or behaviors would favor the survival and reproduction of the individual. Hamilton enlarged Darwin's view of reproductive success. As scientists after Darwin examined social systems, particularly those found in animal populations, a number of questions arose. What Darwin had not addressed was the question of social relations in general and **altruism** in particular. For example, why would individuals engage in behaviors that did not benefit them in terms of survival or passing on their genes? We know, for example, there are a number of social behaviors among insects that appear not to benefit the individual. Take the honeybee hive, with a queen, some males, and 20,000 to 40,000 females. These sterile females not only put effort into gathering food for others, but they will also defend the hive against attackers and die in the process. Before we understand why this happens, we need to know something about their genetics. Most vertebrates, including humans, have two copies of each chromosome in their cells; one comes from the mother and the other from the father. Bees, ants, and wasps may or may not have two copies, depending on their sex. Honeybee eggs, which are laid by the queen, do not have to be fertilized for the insect to hatch. Unfertilized eggs result in a male honeybee. Thus, males will have only one copy of each chromosome from the queen because they began as unfertilized eggs. Female worker bees come from fertilized eggs and will have two copies of the chromosomes. However, because all the sperm produced by the males is genetically identical, worker females have more genetic material in common with each other than is usually the case. In fact, sister bees are genetically more similar to one another than they are to their mother. That is, sister bees share approximately 75% of their genes. It is this relationship that helped Hamilton to explain altruism. By acting altruistically, Hamilton suggests, the organism ensures that genetic material more similar to its own is passed on. That is to say, if a behavior helps to ensure the passing on of genes similar to one's own, then this behavior would be favored.

Hamilton's answer to the question of altruism came to be called **kin selection** or **inclusive fitness**. Inclusive fitness as a property can be measured by considering the reproductive success of the individual plus the effects of an individual's actions on the reproductive success of its relatives. Given that we share different amounts of genetic material with our relatives, the relationship must be corrected by the degree of relatedness. For example, parents and their children or siblings share more genetic material than do first cousins: 50% vs. 12.5%, to be exact. One implication of this perspective is that we could test the idea that altruistic behavior will be greatest among those individuals who share the most similar genetic material. For example, a number of species produce vocalizations to raise an alarm if there is danger. We could test the kin selection hypothesis by seeing whether a particular species (e.g., ground squirrels) would give more alarm calls when those facing the danger are related to them than when they are not. Indeed, this is the case for female ground squirrels. They produce more alarm reactions to danger when their sisters are nearby than when unrelated squirrels are nearby. Other research suggests that in those insect colonies in which there is a single father, such as bees or ants, the workers take better care of the female larvae than the male larvae, which results in a 3-to-1 female-to-male ratio. In those colonies in which there are multiple fathers, the female-to-male ratio dropped to 1-to-1. The implication is that in single-father colonies, the genetic material of the female larvae is more similar to that of the female workers, whereas in the multiple-father colonies, the genetic material would be similar for both females and males. Although a number of studies have demonstrated kin recognition mechanisms in animals, current research shows that humans have also evolved mechanisms for assessing genetic relatedness (see Lieberman, Tooby, & Cosmides, 2007).

Hamilton's suggestion is often presented in the form of a mathematical relationship or rule, which states that a behavior will evolve if the cost to the individual is outweighed by the gain to another multiplied by the degree of genetic relationship. Mathematically, this is stated as "cost to the individual is less than the degree of relationship times the benefit" or ($C < R \times B$).

If you think about the implications of this rule, you realize that Hamilton has turned the question of evolution upside down. It is not the individual or even the group who is benefiting, but the gene. Hamilton suggested this in a 1963 paper in which he wrote that the ultimate criterion that determines whether a particular gene will spread is not whether the behavior will benefit the individual, but whether it will benefit the gene. This led to the concept of the "selfish gene," which was articulated in a book of the same name by Richard Dawkins in 1976. According to this view, even though the behavior of an individual may be altruistic, it is really performed in the service of the gene.

George Williams

Two years after Hamilton's introduction of the concept of inclusive fitness, George Williams (1966) published *Adaptation and Natural Selection.* This book helped to shift thinking in the field of evolutionary biology by clarifying a number of concepts. Williams begins his book by saying that its purpose is to purge biology of "unnecessary distractions that impede the progress of evolutionary theory and the development of a disciplined science for analyzing adaptation" (p. 4). Adaptation, according to Williams, is a concept that is often used in a loose manner and thus lacks any scientific power. Williams suggested that the concept of adaptation should be used only when it is really necessary. Consider one of Williams' examples: A fox heading to a hen house after a snowfall makes a path with its feet. It then uses this path on other trips to the hen house. We would not, however, want to say that the fox's paws evolved to make paths in the snow, although doing so would save considerable time and food energy for the fox, which, in turn, would be crucial for survival. Thus, there may be benefits of snow packing, but this should not be explained in terms of adaptation. However, it would be appropriate to view the legs and feet of the fox as designed for running and walking. In clarifying the logic of adaptation, Williams not only made an important contribution to biology, he also helped set the stage for evolutionary psychology. In his clearly written descriptions, Williams articulates Hamilton's formal description of inclusive fitness. He emphasized that natural selection should be understood in terms of the individual and the manner in which the genes of the individual are passed on. This was in contrast to some alternative views of his day that emphasized group selection and suggested that natural selection benefited the group. The group selection approach suggested that organisms displayed altruism as a means of benefiting the group. Within less than a decade following the publication of the books and articles of Hamilton and Williams, the group selection view had all but disappeared.

Robert Trivers

Robert Trivers originally went to Harvard to study mathematics, but after changing directions a number of times and never actually receiving his undergraduate degree, he did graduate work with the well-known biologist Ernst Mayr. He received his PhD in the early 1970s and stayed to become part of the Harvard faculty until 1978. During this period, Trivers wrote three important papers. The first paper (1971) described his theory of reciprocal altruism, or altruism among non-kin. The basic idea of reciprocal altruism is that our own fitness, in an evolutionary sense, can be increased if we can expect others to help us some time in the future. Trivers saw this tendency growing out of an evolutionary past in which humans lived in small groups. In a small group, it is possible to note who helped whom or who did not help. Those who helped were helped in return and thus had a greater chance of surviving and passing on the genes related to these processes. The second paper (1972) was directed at the question of parental investment. Actually, the idea of parental investment brought together questions related to investment of parents in their children, sexual selection, and mating behaviors. The basic idea is that the sex that invests the most in its offspring will have evolved to be the most discriminating in selecting its mating partner. *Investments*, in this case, are factors such as time, energy, and effort that increase the offspring's chances of survival. It should also be noted that when an organism is investing in an offspring, this in turn reduces its ability to produce additional offspring. Thus, there is a tradeoff between investment in offspring and mating success. The concept of parental investment further suggests that the sex that invests the least will be less discriminating in mate choices. Trivers' third paper (1974) addressed the question of parent and offspring conflict. At its heart, this paper considers the situation in which a parent and its offspring, who shares 50% of its genes, are both seeking to optimize their resources. One clear example is weaning, in which the mother may wish to wean the child before the child wants to be weaned. The mother may wish to use her resources for her other children. These three papers have brought forth important research in a large variety of areas.

SOCIOBIOLOGY

Edward O. Wilson

Edward O. Wilson is a biologist who throughout his career has brought together a number of disciplines. His early work took place at the interface between evolution and ecology, with an emphasis on ant colonies. In studying ants, he focused on a variety of problems, including the manner in which ants invade new territories as well as respond to different environments and limitations. Wilson's domain was insect societies and the pressures that influence them. The large-scale question Wilson next asked concerned the nature of all animal societies, ranging from termites to chimpanzees to humans. The answer he gave was contained in a 700-page book, *Sociobiology: The New Synthesis,* published in 1975. The synthesis was a grand one, ranging from cellular biology through physiology to psychology and ecology. The book even begins with quotations from the Hindu god Krishna and the French philosopher Camus. Wilson's basic theme focuses on social behavior and recapitulates Hamilton's idea of inclusive fitness and kin selection, with an emphasis on genetic reproduction as the ultimate goal. He states this as follows:

> In the process of natural selection, then, any device that can insert a higher proportion of certain genes into subsequent generations will come to characterize the species. One class of such devices promotes prolonged individual survival. Another promotes superior mating performance and care of the resulting offspring. As more complex social behavior by the organism is added to the genes' techniques for replicating themselves, altruism becomes increasingly prevalent and eventually appears in exaggerated forms. (Wilson, 2005, p. 3)

It is somewhat of a paradox that one of the shortest chapters in Wilson's book has caused the most controversy. This was the last chapter, which focused on humans. The idea of the chapter was to point out the evolutionary origins of humans on this planet. Wilson begins by describing how ecologically unique we are. There is basically only one species of humans, which is found throughout the planet but forms high-density communities. Humans are also different from other animals in terms of our erect posture and bipedal locomotion. Compared to other primates, humans have no hair but more sweat glands (2 to 5 million). Humans also have continuous sexual activity, as opposed to periods of "heat." Further, language and culture are extremely predominant aspects of human life. Although what Wilson said about humans was not new information and had been acknowledged by a variety of scientific disciplines, he became a straw man for those on the nurture side of the nature/nurture argument. In terms of psychological theory, the 1970s was a period in the social sciences in which many of the theories assumed that humans came into the world as a blank slate and that experience determined almost all of the psychological and societal characteristics they displayed.

Wilson himself saw his critics' objections as composed of two large issues. The first was biological determinism. Although Wilson emphasized synthesis and holism as well as reduction to basic principles, his critics saw his work as trying to reduce everything to the level of biology. However, it did not help that Wilson suggested that sociobiology would replace a number of disciplines, including psychology. The second objection to sociobiology, according to Wilson, was that of genetic determinism. This is the idea that all aspects of human behavior can be explained by the presence of genes. As you will see, both of these ideas result from a misunderstanding of science and the manner in which genes influence behavior.

In a new introduction to the 25th-anniversary edition of *Sociobiology*, Wilson (2000) states the task as follows:

> Where cognitive neuroscience aims to explain *how* the brains of animals and humans work, and genetics how heredity works, evolutionary biology aims to explain *why* brains work, or more precisely, in light of natural selection theory, what adaptations if any led to the assembly of their respective parts and processes. (p. vii)

Overall, Wilson approached humans from the viewpoint of zoology, with an emphasis on description and behavior. One important aspect of sociobiology was to help psychologists consider new questions to ask. What it did not do was to articulate a psychological perspective for understanding behavior and experience in light of evolutionary theory. Current evolutionary psychologists consider psychological mechanisms to be an important level of analysis that cannot be reduced to biological levels (e.g., Hass et al., 2000). The current evolutionary perspective emphasizes the manner in which biology and experience play intertwined roles in the development and operation of psychological mechanisms, which manifest in behavior and experience. What happened next in the development of evolutionary psychology was that psychologists considered humans from the standpoint of mind.

Bringing Evolution to Psychology

If you were entering college in the 1950s, there would be no computers in the classroom, no cell phones, few televisions in the country, and foreign travel would take considerable time. Going back another 50 years to the beginning of the 1900s, you would find radios or airplanes were yet to be invented, electric lights and telephones were few, and the mode of transportation was largely by horse and buggy, trains, or ships. Farming occupied far more people at that time than it does today. One way of thinking about these changes in the last 100 years is that they have given us a greater variety of environments in which to live. Sometimes, a seemingly simple invention such as the elevator can change our environments drastically. Before the elevator, buildings were usually no more than six floors high. After the elevator came skyscrapers. Another way to consider the changes of the last 100 years is to realize that humans live in culture as well as nature, and changes in culture and nature may move at different rates. That is to say, through learning, imitation, and other forms of adaptation, humans are able to copy each other and to make changes. Using language and other forms of communication, we can transmit new ideas quickly. This is especially true in the realm of technology. For example, in only about 10 years, computers and cell phones transformed how we communicate with one another. However, 10 years or even 100 years is just a flash in time when we consider the 100,000 years of evolutionary history during which humans developed their social, emotional, cognitive, and sexual patterns of behavior and experience. Even 100,000 years is just a flash if we consider the even broader history that led to the evolution of the human body and its physiology. Bowlby (1969), the British psychiatrist who studied the relationship between infants and their mothers, reminds us how different the environments that we live in today are from those of our ancestors. Unlike other species, humans today live in environments that are different in many respects from those that shaped our early evolutionary history. In fact, when considering more instinctual processes, Bowlby and others suggest that we need to look back a few million years and also consider these processes in primates other than humans. Bowlby referred to the historical environment in which humans experienced difficulties, found food, mated and raised children, and formed and lived with others in social groups as the **environment of evolutionary adaptedness** (EEA). We use the EEA to inform our considerations of our present-day behaviors and experiences, especially in terms of survival value.

Although Bowlby used the EEA as a way of understanding relationship patterns between mothers and their infants, his ideas of attachment were often studied in the 20th century without direct reference to an evolutionary perspective. One exception was an introductory psychology textbook based largely on evolutionary themes. It was written by Harry Harlow, James McGaugh, and Richard Thompson in 1971 and included Harry Harlow's work on attachment in primates and other evolutionary perspectives. However, it was not until the 1980s that the term *evolutionary psychology* began to appear in psychological discussions. This perspective for psychology was discussed by Leda Cosmides and John Tooby at the Center for Evolutionary Psychology at the University of California, Santa Barbara. They describe their views in a number of papers (e.g., Cosmides & Tooby, 1992) as well as on the Center's website (http://www.psych.ucsb.edu/research/cep/primer.html). They begin with a discussion of their goals for an evolutionary psychology that emphasizes research and the human mind.

> The goal of research in evolutionary psychology is to discover and understand the design of the human mind. Evolutionary psychology is an *approach* to psychology, in which knowledge and principles from evolutionary biology are put to use in research on the structure of the human mind. It is not an area of study, like vision, reasoning, or social behavior. It is a *way of thinking* about psychology that can be applied to any topic within it.

Cosmides and Tooby (1997) view their work within the historical context of Charles Darwin and William James. At the end of the 19th century, William James (1890) suggested that humans had more instincts than other animals and that our brain gave us the ability to manipulate these instincts. Cosmides and Tooby (1997) reconceptualize instincts in terms of an information processing paradigm, to reflect specialized neural circuits developed through evolution for specific processes. These neural circuits, for Cosmides and Tooby, define human nature. In fact, they state, "In this view, the mind is a set of information-processing machines that were designed by natural selection to solve adaptive problems faced by our hunter-gatherer ancestors." In more recent work, they discuss these processes as computational (Tooby & Cosmides, 2005). *Computational* refers to the manner in which such processes as cognitive, emotional, and motor functions are regulated by neural networks in response to internal and external behavioral processes. The basic idea is that neural processes have evolved in response to the types of problems that humans needed to solve: How do you recognize another's face? How do you decode emotional experiences? How should you respond when you see a snake? Thus, one would expect to find the human brain to be packed with programs for solving a variety of domain-specific problems.

This view of human nature as an evolved set of predispositions based on the types of problems our ancestors needed to solve is contrasted with what Cosmides and Tooby (1997) call the **Standard Social Science Model** (SSSM). As noted previously, the metaphor for this model is the mind as a blank slate. That is to say, it is assumed that experience plays the major role in determining our behavior, and experience thus reflects the nurture side of the nature/nurture debate. Cosmides and Tooby describe the SSSM as follows:

> Over the years, the technological metaphor used to describe the structure of the human mind has been consistently updated, from blank slate to switchboard to general purpose computer, but the central tenet of these Empiricist views has remained the same. Indeed, it has become the reigning orthodoxy in mainstream anthropology, sociology, and most areas of psychology. According to this orthodoxy, all of the specific content of the human mind originally derives from the "outside"—from the environment and the social world—and the evolved architecture of the mind consists solely or predominantly of a small number of general purpose mechanisms that are content-independent, and which sail under names such as "learning," "induction," "intelligence," "imitation," "rationality," "the capacity for culture," or simply "culture."

According to this view, the same mechanisms are thought to govern how one acquires a language, how one learns to recognize emotional expressions, how one thinks about incest, or how one acquires ideas and attitudes about friends and reciprocity—everything but perception. This is because the mechanisms that govern reasoning, learning, and memory are assumed to operate uniformly, according to unchanging principles, regardless of the content they are operating on or the larger category or domain involved. (For this reason, they are described as content-independent or domain-general.) Such mechanisms, by definition, have no pre-existing content built in to their procedures, they are not designed to construct certain contents more readily than others, and they have no features specialized for processing particular kinds of content (Tooby & Cosmides, 1992).

The evolutionary psychology that Cosmides and Tooby (1997) offer as an alternative to the blank slate view has five guiding principles:

> Principle 1. The brain is a physical system. It functions as a computer. Its circuits are designed to generate behavior that is appropriate to your environmental circumstances.
>
> Principle 2. Our neural circuits were designed by natural selection to solve problems that our ancestors faced during our species' evolutionary history.
>
> Principle 3. Consciousness is just the tip of the iceberg; most of what goes on in your mind is hidden from you. As a result, your conscious experience can mislead you into thinking that our circuitry is simpler that it really is. Most problems that you experience as easy to solve are very difficult to solve—they require very complicated neural circuitry.
>
> Principle 4. Different neural circuits are specialized for solving different adaptive problems.
>
> Principle 5. Our modern skulls house a Stone Age mind.

You need to consider these principles from a broader perspective. The broader perspective is not only our history throughout time as an organism but also what functions we are designed to perform in the world. This can best be seen by comparing humans with other organisms. Cosmides and Tooby (1997) give what seems like a simplistic example, that of a human and a dung fly. A female dung fly seeks out piles of dung as a place to lay her eggs. Humans, of course, avoid dung at all costs. The smell is repulsive. However, each organism was solving different problems. The dung fly was making sure her young would be taken care of. Humans, of course, did not evolve in a way that uses dung as food. As you think about this comparison, a number of specific questions may come to mind. We can also think of broader questions, such as, What are humans designed to do in their environment? One answer Cosmides and Tooby gives is that the design of the human brain and body allows it to solve adaptive problems.

Adaptive problems have two characteristics, according to Cosmides and Tooby (1997). First, adaptive problems are the problems that have been with us throughout our history as a species. Second, adaptive problems are the problems whose solution affects the reproduction of individual organisms. "What to do when one sees a bear" is not only a longstanding problem but also one that, if not solved, will prevent one from having children. Most adaptive problems have to do with the basics of life: how to provide food and shelter, how to communicate with others, how to have pair relationships and produce children, how to take care of children. From this perspective, knowing how to surf the waves off the Hawaiian coast is directly related to solving the problem of how to walk upright on two legs without losing one's balance. You can thank a complicated mechanism in your inner ear for that, by the way. Likewise, the majority of the use of modern technology can be seen as an extension of how we solve the problem of communicating with others. Of course, you can always use the brain circuitry designed for one solution for other purposes, as we do when we go on rides at amusement parks. However, you must solve the basic problems first. The overriding assumption is that those individuals who were not able to solve these problems are no longer with us. Although Cosmides and Tooby use the term *adaptive problems,* technically natural selection results in the passing on of adaptive solutions.

The third and fourth principles relate evolutionary psychology to our current knowledge of brain structure. I will discuss the cognitive and affective neurosciences in great detail throughout this book. We know that we are not always aware of the information we use for making a decision. In fact, we may even make up information to keep our stories consistent. We also know that different areas of the brain, or neural networks, are involved in different processes. We know, for example, that different brain processes answer the questions "What is the object?" and "Where is the object?" We also know that the brain answers questions related to emotional or social processing differently than it answers strict logic propositions, even though both questions may use the same underlying logic. As we think about social and economic issues, we will see we are generally not logical at all, at least in the traditional Aristotelian sense. We also know that when engineers try to design robots to perform what appears to be a simple human perceptual process, they often run into great difficulty, suggesting that what appears to be a simple human activity may not be that simple after all.

The final principle states that our modern skull houses a Stone Age mind. Current estimates suggest that the species *Homo sapiens* can be dated to about 170,000 years ago in Africa. It is suggested that most of this time was spent as hunters and gatherers. Only about 10,000 years ago does agriculture first appear. As noted, agriculture requires a different lifestyle. With agriculture, individuals must remain in one place while seeds are planted, taken care of, and harvested. By about 5,000 years ago, about half of all humans were engaged in agriculture. It was also 5,000 years ago that written documents began to appear. If you do the math, you realize that humans lived as hunter-gatherers at least 1,000 times longer than as anything else. If you jump to the present day, you realize many of the things you consider part of your everyday life, such as electric lights and high speed transportation, are a little more than 100 years old. Computers and the Internet have existed for less than one human lifetime. Given the manner in which natural selection works, it becomes clear that the adaptive problems our brains evolved to solve were those of hunters and gatherers. Of course, we use this circuitry to live in a very modern world, but its original design came from a time long ago.

According to Cosmides and Tooby (1997),

> The Five Principles are tools for thinking about psychology, which can be applied to any topic: sex and sexuality, how and why people cooperate, whether people are rational, how babies see the world, conformity, aggression, hearing, vision, sleeping, eating, hypnosis, schizophrenia and on and on.

Let's now turn to one example of evolutionary psychology research related to reasoning. In this research (Cosmides, 1989; Cosmides & Tooby, 1989), a logic problem known as the *Wason selection task* is presented. The task is as follows:

> Part of your new job for the City of Cambridge is to study the demographics of transportation. You read a report on the habits of Cambridge residents that says, **"If a person goes into Boston, then that person takes the subway."**
>
> The cards below have information about four Cambridge residents. Each card represents one person. One side of a card tells where a person went, and the other side of the card tells how that person got there. Indicate only those card(s) you definitely need to turn over **to see whether any of these people violated the subway rule.**

Boston	Arlington	subway	cab

From a logical point of view, the rule has been violated whenever someone goes to Boston without taking the subway. Hence the logically correct answer is to turn over the *Boston* card (to see whether this person took the subway) and the *cab* card (to see whether the person taking the cab went to Boston). More generally, for a rule of the form *If P then Q*, one should turn over the cards that represent the values *P* and *not Q*.

What did you answer? If you are like most of the college students who took this logic test, three out of four of you gave the wrong answer. Other research has shown that even training in formal logic does not help to improve one's ability to solve Wason problems. However, if the problem is stated not as a logical problem but one of social exchange, then the number of people who correctly solve the problem increases drastically: from 25% to as high as 80%. The social exchange problem would be presented as follows:

If you are to eat those cookies, then you must first fix your bed.

Each card below represents one person. One side of the card tells whether the person ate the cookies, and the other side of the card tells whether that person fixed his bed. Indicate only those card(s) you definitely need to turn over **to see whether any of these people violated the cookie rule.**

Ate Cookies	No Cookies	Fixed Bed	Didn't Fix Bed

Why would the number getting the social exchange problem correct be three times higher than the number getting the logic problem correct? The answer is that our brains were not designed to generalize every problem into a single logical system. Rather, our cognitive processes have evolved in relation to *domains* of problems to solve. As a social group living together over the past 150,000 years, humans needed to be more sensitive to problems relating to social relations, in this case cheating. These domains are living questions that our organism monitors. For example, we are quick to notice how we are treated by our friends and especially whether there is some change in our relationships. We are likewise sensitive when we are in a new group of people. We will return to these types of living questions later in this book. Overall, one important aspect of evolutionary psychology is an identification of specific domains and the manner in which humans process those domains.

ADAPTATION

In 1992, a book was published which sought to bring evolutionary psychology to a broader audience by asking a variety of scientists to discuss their area of expertise from the standpoint of evolutionary psychology. This book was *The Adapted Mind* edited by Jerome Barkow, Leda Cosmides, and John Tooby. To many, the book is a milestone in the emergence of evolutionary psychology. The authors of this book sought to articulate the manner in which evolutionary principles could be used to understand the development of cognitive processes such as the development of language, spatial abilities, and aesthetics, as well as characteristics of mate selection, sexuality, and the nature of caregiving. The central theme of the book suggests that there is a universal human nature. That is to say, there is a tendency of individuals to display similar predispositions in similar environmental situations throughout the world. The assumptions associated with this theme were (1) universal human nature results from evolved psychological mechanisms; (2) these evolved psychological mechanisms are adaptations, constructed by natural selection over evolutionary times; and (3) the structure of the human mind is adapted to the way of life of Pleistocene hunter-gatherers and not necessarily to that of the current era. This third point refers to what John Bowlby (1982) called the EEA. As you remember, the basic idea of EEA is that many of the processes of interest to psychologists, such as language, tool use, and culture, arose during the period that our human ancestors spent as hunter-gatherers on the African savanna prior to the development of agriculture some 10,000 years ago. A current challenge in terms of adaptation is to distinguish the behaviors that have resulted from an evolved adaptive process from those that have not.

Considering the evolutionary perspective has helped psychologists answer questions not easily answered from other perspectives. For example, it has even been suggested that evolutionary psychology is the only coherent theory that helps to explain such aspects of human existence as kinship, morality, cooperation, beauty, motherhood, sexuality, and violence (Pinker, 2002). Clearly, as we shall see in other chapters of this book, questions of human motivation in terms of sexuality, commitment, and family relationships have benefited greatly from the evolutionary perspective. As Darwin pointed out, organisms are in a dynamic and close connection with their environment. For humans, part of that environment is culture. We live in culture much more than we live in nature, although there is, of course, a dynamic interaction between these processes. What is important is that you not see culture and evolution as opposing explanations. As I have begun to point out, evolutionary perspectives ask a "why" question related to time. Culture offers a different level of analysis.

At this time in the study of evolutionary psychology, there is a rich discussion taking place concerning the theoretical underpinning of the field. For example, Bjorklund (Bjorklund, 2003; Bjorklund & Blasi, 2005; Bjorklund & Pellegrini, 2002; Geary & Bjorklund, 2000) has emphasized the importance of incorporating the developmental system perspective into evolutionary considerations, and I will discuss these ideas in Chapter 5. As you will see in Chapter 4, important insights from the neurosciences are informing the field. At this point, many scientists are searching for the appropriate ways to discuss the richness and complexity of human behavior and experience. For example, the manner in which an evolutionary understanding can inform the study of cognition, emotion, economics, art, and religion is beginning to be seen in major scientific journals. In the 20th century, we learned that as important as learning theory is, it presented a limited view of how humans acquire the understanding that we have of ourselves and the world. It is now totally clear that humans do not come into the world as blank slates. The emerging view is that we come into the world ready to ask certain types of questions at established times. Further, humans have a variety of behavioral decision rules. For example, we treat others who are related to us differently than those who are not. Evolutionary psychologists have been developing the scientific protocols with which to articulate these and other such processes, although the complexity of human behavior and experience leave this endeavor as a work in progress (as is all of science). The acquisition of language is one prime example. It is clear that we come into the world ready and wanting to express and acquire a language. This is so prevalent across humans that some researchers have referred to this as the "language instinct" (Pinker, 1994).

Some evolutionary psychologists have replaced the word "instinct" with "modules in the brain." In particular, they see the brain as composed of a number of modules or microcomputers. The metaphor is that of a Swiss army knife that contains a variety of independent tools. Each of these tools, or modules, evolved to solve a specific problem related to human functioning, such as survival or reproduction. One characteristic of such a module is that it is able to function somewhat independently of other brain processes. However, just because it is useful to view a process as self-contained does not, in turn, mean that there is a particular area of the brain that only does that process. Although a module is a useful metaphor, as we will see in Chapter 4, the actual structure of the brain is more complicated than that. In particular, some areas of the brain do function as if they were modules for solving particular problems. However, other cortical areas, such as those associated with higher forms of processing, appear more as a general purpose device able to solve a variety of problems. We will also see that over the course of evolutionary time, areas of the brain that begin to solve one type of problem become involved in a variety of other living questions we seek to answer. As evolutionary psychologists, we can speak of specific problems, but we also need to be aware that the developing brain shows an amazing degree of plasticity. Even on a short-term basis, learning a skill well will modify cortical areas involved in the task. How these changes relate to individual differences will be an important question for the next generation of evolutionary psychologists to understand. As important as the idea of localization of function in the brain is, we also know of extensive networks that enable us to live life successfully. Thus, a crucial question for future research is what modularity might mean, beginning at the level of the gene, especially in terms of its mapping to actual cortical processes (see Callebaut & Rasskin-Gutman, 2005, for an overview).

In summary, it may be useful to think about traditional instincts such as self-preservation, sexuality, and social processes as important domains that could be considered somewhat modular across species. Overall, in terms of brain processes, although it is true that certain processes can be localized, it is also important to understand the intensive dynamic networks that comprise our neural circuitry. In this light, some of the views of brain structure that have become popular in the field of evolutionary psychology should be seen in more metaphoric ways, rather than as descriptions of the actual neural network. The crucial question is the extent to which humans organize their functioning as a finite set of domains, and what these are.

Traditionally, the field of evolutionary psychology has emphasized human universals. For example, Tooby and Cosmides (1992), in their emphasis on universals, suggested that individual differences were really "noise" without adaptive significance. However, I will suggest in this book that some individual differences, such as the development of personality, may function in many ways like the development of language. As such, the development of specific personalities fits consistently with an evolutionary perspective and can be described in terms of genetic and human/environment interactions. As with any field, new discoveries inform and modify current speculation. This is a very challenging task because these new discoveries can come from a variety of sources, including genetics, ethology, ecology, paleontology, and the biological sciences as well as psychology itself.

Fictions About the Evolutionary Approach to Psychology

There are many misconceptions concerning evolutionary psychology. Some of these have recently been discussed by Dennis Krebs (2003). He describes six misconceptions concerning the focus and nature of evolutionary psychology.

1. Evolutionary approaches adopt a theoretically reductionistic "gene-centered" level of analysis.
2. Evolutionary theorists attempt to explain ontogenetic processes or outcomes by appealing to the creative or designing role of natural selection.
3. Evolutionary theorists believe genes are the sole source of transgenerational inheritance.
4. Evolutionary theorists believe that genes are self-contained and impervious to extragenetic influences.
5. Evolutionary approaches are genetically deterministic.
6. Evolutionary theorists pay lip service to environment.

In general, these misconceptions stem from a misunderstanding of genetics. As will be described in Chapter 3, genes turn on and off in relation to environmental conditions. For example, there is a butterfly that will be brightly colored if born in the rainy season but gray if born in the dry season. Except for blood type in humans, there are few traits that are not influenced by environmental interactions. Further, there are other ways that information is transmitted from one generation to another in humans. One of these is epigenetic transmission, in which the gene itself is not changed but the way in which it is turned on and off is. In this way, what a mouse, for example, eats can influence the hair color of her grandchildren. Additional means of generational transmission in humans include imitation, learning, and culture. Each of these means of information transmission requires a large environmental component.

SUMMARY

Building on a variety of perspectives, the field of evolutionary psychology has emerged as an important theoretical perspective. It has begun to reshape the questions asked in psychology as well as to offer answers to "how" and "why" questions concerning human behavior and experience. This chapter examined some of the major perspectives that shaped this view. The first was ethology, which is the study of organisms and their relationship to their natural environment, as seen in the research of Lorenz, Tinbergen, and Eibl-Eibesfeldt. One emphasis of ethology was the study of innate mechanisms and the environmental factors that evoked their expression. A second perspective examined was genetics and statistics and the work of Fisher. Fisher offered a statistical way to understand fitness over evolutionary time. A third perspective was that of Dobzhansky, who brought forth the synthesis of evolution and genetics, which is referred to as the modern synthesis. A fourth perspective drew from theoretical biology. Hamilton described a way to understand kin selection and altruism based on the degree of genetic relationship that one organism has with another. Williams helped to clarify the concept of inclusive fitness. Trivers better clarified altruism and the concept of parental investment. Finally, Wilson helped to establish the field of sociobiology, which emphasized "why" questions as applied to humans in terms of evolutionary theory. These perspectives offered a backdrop to considering psychological processes in the context of evolution. Bowlby focused on the relationship between mothers and their infants and the role of this relationship to anxiety. Cosmides and Tooby began to articulate a foundation for evolutionary psychology. As the 20th century ended, evolutionary psychology emphasized human processes that were universal to all individuals throughout the world. These universals, such as mate selection or emotional expression, were seen to reflect ways in which humans adapted to their environmental conditions during the broad historical period humans have inhabited the earth.

STUDY RESOURCES

Review Questions

1. What is the focus of the science of ethology, and how is it normally studied?
2. Define the following concepts discovered by Lorenz: imprinting, lock and key, social releaser, innate schema or template, critical period or sensitive period, fixed action pattern. How are they related?
3. What are the four "whys" that Tinbergen suggested should be considered in studying behavior?
4. Eibl-Eibesfeldt extended the ethological perspective to humans. What were the primary concepts he developed in thinking about the interaction between humans and their environment?
5. How did Fisher's work help to set the stage for an integration of the study of genetics with the study of evolution through natural selection?
6. What were two of Dobzhansky's important contributions to the modern synthesis of evolution and genetics?
7. Why would individuals engage in behaviors that did not benefit them in terms of survival or passing on their genes? What were the contributions of Hamilton, Williams, and Trivers that were significant enough to become a major part of what has been called "the second Darwinian revolution"?

8. Define Bowlby's concept of environment of evolutionary adaptedness (EEA). What does it mean for us today in studying evolutionary psychology?
9. What do Cosmides and Tooby mean by the "Standard Social Science Model" (SSSM)? What are the five principles of the evolutionary psychology perspective they offer to counter that model?
10. The central theme of *The Adapted Mind,* published in 1992, was that there is a universal human nature. What are the assumptions behind this model? Do you agree with their premise that all individual differences are really "noise" without adaptive significance? Can you think of any counterexamples?

For Further Reading

Dawkins, R. (1989). *The selfish gene.* New York: Oxford University Press.
Eibl-Eibesfeldt, I. (1989). *Human ethology.* New York: Aldine de Gruyter.
Lorenz, K. (1981). *The foundations of ethology*. New York: Springer-Verlag.
Pinker, S. (2002). *The blank slate.* New York: Viking.
Tinbergen, N. (1974). *The study of instinct.* New York: Oxford University Press.
Wilson, E. O. (2000). *Sociobiology: The new synthesis, twenty-fifth anniversary edition.* Cambridge, MA: Harvard University Press.

Key Terms and Concepts

- Introduction to an evolutionary perspective
- The beginnings of an evolutionary neuroscience of behavior and experience
- Pathways toward an evolutionary psychology
    - Ethology
    - Genetic traditions
        - R. A. Fisher
    - Integration of genetics and evolution
        - Theodosius Dobzhansky
    - Kin selection and altruism
        - William Hamilton
        - George Williams
        - Robert Trivers
    - Sociobiology
        - Edward O. Wilson
- Bringing evolution to psychology
    - Adaptation

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Glossary Terms

- Adaptation
- Adaptations
- Adaptive problems
- Altruism
- Critical period
- Environment of evolutionary adaptedness (EEA)
- Ethology
- Evolutionary perspective
- Fitness
- Fixed action pattern
- Imprinting
- Inclusive fitness
- Innate schema
- Innate template
- Instinctual processes
- Isolating mechanisms
- Kin selection
- Natural selection
- Sensitive period
- Social releaser
- Species
- Standard Social Science Model (SSSM)