CHAPTER 5

Ethology and Other Evolutionary Theories

At the beginning of these experiments, I had sat myself down in the grass amongst the ducklings and, in order to make them follow me, had dragged myself, sitting, away from them. . . . The ducklings, in contrast to the greylag goslings, were most demanding and tiring charges, for, imagine a two-hour walk with such children — all the time squatting low and quacking without interruption! In the interests of science I submitted myself literally for hours on end to this ordeal.

— LORENZ, 1952, p. 42

The initial phase, that of protest, may begin immediately or may be delayed; it lasts from a few hours to a week or more. During it the young child appears acutely distressed at having lost his mother and seeks to recapture her by the full exercise of his limited resources. He will often cry loudly, shake his cot, throw himself about, and look eagerly towards any sight or sound which might prove to be his missing mother. . . . During the phase of despair, which succeeds protest, the child's preoccupation with his missing mother is still evident, though his behavior suggests increasing hopelessness. The active physical movements diminish or come to an end, and he may cry monotonously or intermittently. He is withdrawn and inactive, makes no demands on people in the environment, and appears to be in a state of deep mourning.

— BOWLBY, 1969, p. 27

Developmental psychologists have not taken Shakespeare's advice, "Neither a borrower, nor a lender be." Some of the most fruitful ideas about development have been borrowed from other areas of psychology and even other sciences. The evolutionary approach, particularly ethology, sociobiology, and evolutionary psychology, is a good example of this. *Ethology* is the study of the evolutionarily significant behaviors of a species in its natural surroundings. As a subdiscipline of zoology, it looks at the biological and evolutionary blueprints for animal behavior. *Sociobiology*, which developed later, focuses on the evolutionary–genetic basis of human social behavior. The most recently developed theory, *evolutionary psychology*, examines the origins of human psychology, especially cognition, in our ancestors' adaptation to their environment. Related contemporary approaches, such as modern behavioral genetics and biological constraints approaches, also are part of the contemporary biological–evolutionary landscape. The chapter focuses on ethology, because it has provided the main theoretical foundation for the evolutionary perspective on development, particularly through John Bowlby and Mary Ainsworth's studies of infant attachment.

Evolutionary approaches place humans into a broad context, the animal world. It is humbling to contemplate the fact that there are more species of insects in a square kilometer of Brazilian forest than there are species of primates in the world (Wilson, 1975). The English geneticist Haldane, when asked about the nature of God, is said to have remarked that he displays "an inordinate fondness for beetles." The human species is just one small part of the huge, evolving animal kingdom. We are one of an estimated 3 million to 10 million species.

The chapter begins with a history followed by a general orientation. Then comes a section on the main contributions of ethology to human developmental psychology, followed by sections on mechanisms of development, the theory's position on developmental issues, applications, and evaluation.

HISTORY OF THE THEORY

Whoever achieves understanding of the baboon will do more for metaphysics than Locke did, which is to say he will do more for philosophy in general, including the problem of knowledge.

— CHARLES DARWIN

Ethology is linked to the German zoologists of the 1700s and 1800s who studied innate behaviors scientifically. The concept of evolution

grew stronger after Darwin's painstaking observations of fossils and variations in plant and animal life. He, along with Alfred Wallace, concluded that nature ruthlessly selects certain characteristics because they lead to survival: "What a book a devil's chaplain might write on the clumsy, wasteful, blundering, low, and horribly cruel works of nature" (Darwin, quoted in Shapley, Rapput, & Wright, 1965, p. 446). As a result of this selective force, species changed and sometimes differentiated into subspecies. Thus, many animals, including humans, are related through common ancestors. Darwin proposed that intelligence and other behaviors, as well as physical structures, were products of evolution. If they increased the chances of survival, they were retained; if they did not, they disappeared. Darwin's claim of a common ancestry of humans and other primates was not received well in Victorian England: Montagu (1973) related an anecdote about a shocked wife of an English bishop. She said that she certainly hoped that the theory was false, but if it were true, that not many people would find out about it!

Darwin's careful observing and cataloging of plants and animals were imitated by ethologists years later. Just as he carefully described animal and plant life, Darwin also described his own infants' behavior, as in the following excerpt on fears:

> Before the present one was $4\frac{1}{2}$ months old I had been accustomed to make close to him many strange and loud noises, which were all taken as excellent jokes, but at this period I one day made a loud snoring noise which I had never done before; he instantly looked grave and then burst out crying. . . . May we not suspect that the vague but very real fears of children, which are quite independent of experience, are the inherited effects of real dangers and abject superstitions during ancient savage times?
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> (1877, p. 289)

Ethology as a distinct discipline began in the 1930s with the European zoologists Konrad Lorenz and Niko Tinbergen. They developed, often in collaboration, many of the key concepts discussed in the next section. Tinbergen describes this new approach as having "started as a revolt by young zoologists against the dead animal" (Cohen, 1977, p. 316). Ethologists saw animals as active organisms living within a particular ecological niche, not as passive organisms prodded by stimuli, as in the tradition of learning theory. Their studies of species as diverse as ducklings, butterflies, and stickleback fish gave scientific meaning to the sometimes mystical term "instinct." Many of Lorenz's observations were of wild animals that wandered freely in and around his home. Lorenz and Tinbergen's work was honored with the Nobel Prize in medicine or

physiology in 1973, which they shared with another ethologist, Karl von Frisch. For psychologists, Eibl-Eibesfeldt's work (1975, 1989), beginning in the 1950s and continuing in the present, is especially important, for he was one of the first to make a formal connection between psychology and ethology. This link with psychology fueled an interest in ethological accounts of human behavior.

Developmental psychology was receptive to ethology because developmentalists have a tradition of naturalistic observations of children and consideration of the biological basis of development. Many developmentalists continued to observe children even through psychology's behaviorist years. The most important figure to bring ethology to the attention of developmental psychologists was John Bowlby. His turning from a Freudian to an ethological account of infant–caretaker social attachment in the 1950s in England laid the groundwork for subsequent research in this area in both Europe and North America. (His work is described later.) Ethologically oriented psychologists also extended the approach to other areas of infant behavior, for instance, facial expressions and biases toward looking at certain objects, such as faces. With older children, the work focused on peer interaction. It is interesting that one of the founding fathers of ethology, Tinbergen, studied autistic children and interpreted their behavior as an extreme fear response to being looked at by other people (Tinbergen & Tinbergen, 1972). Developmental psychology welcomed ethology as a way to correct the extreme environmentalism of learning theory.

Ethology has continued to influence biologically oriented research on behavior in Europe and North America. Today, however, biologically oriented work on behavior includes many disciplines, for example, comparative psychology, psychobiology, neuropsychology, behavioral genetics, physiological psychology, behavioral ecology, and evolutionary biology. The word "developmental" could be placed in front of each label. In general, this work is more empirical and experimental and less speculative and theoretical than the earlier European "classical" ethological studies. The focus now typically is on the immediate causes of the behavior—for example, scent or temperature—rather than on the evolutionary origins of the behavior. The majority of the approaches favor a reductionist approach and study cells, neural impulses, and hormones rather than the behaviors of the whole organism in its ecological niche. This emphasis on laboratory research on various animal species contrasts with the ethological emphasis on observational research. However, ethology did bring a powerful methodology to biological ap-

aches: "To have made 'inspired observation' respectable again in the avioral sciences is, I believe, a positive achievement of ethology" inbergen, quoted in Cohen, 1977, pp. 323–324).

Ethology was soon joined by sociobiology, defined by its main okesman, E. O. Wilson, as the "study of the biological basis of all social havior" (1975, p. 4). Although ethology and sociobiology overlap a reat deal, the latter focuses on the species level and on social structures, such as customs, rituals, schools, and the legal system, rather than the individual. People can pass on their genes either by reproducing by furthering the survival of the genes of kin through altruistic behavr. Thus, a mother might risk her life for her young, which would not adaptive for her as an individual but might further the survival of ose with similar genes. The field is a hybrid of ethology, ecology (the udy of how organisms are related to their environment), genetics, and pulation biology. Sociobiologists' work on such topics as reproductive tterns, altruism, parenting, and social hierarchies has had some influnce on thinking about the behavior of parents and children. Still, the se of sociobiology has minimally influenced developmentalists.

Evolutionary psychology, which arose after some of the criticisms of ociobiology as deterministic, reductionistic, and socially conservative, romises to have more impact on developmental psychology (Geary & jorklund, 2000). Evolutionary psychologists trace current psychological functioning to adaptations of our ancestors. This relatively new field as made possible "by the simultaneous maturation of evolutionary ology, paleoanthropology, and cognitive psychology" (Cosmides & ooby, 1987, p. 302). Evolutionary psychologists use primatology, rchaeological data, cultural anthropology, and data on contemporary man universals to relate current human cognition and behavior to daptive ancestral behaviors. Most believe that there is little current volutionary selection because of modern medicine, technological adnces, and social services.

Developmental and biological approaches are very important to each ther: "The developmental point of view is basic to an understanding of ow evolutionary and ecological parameters are achieved in individuals nd groups. The gap between molecular biology and natural selection ill be filled by developmental analysis of the nervous system, behavior, d psychology" (Gottlieb, 1979, p. 169). The study of the development behavior is "the backbone of comparative psychology. Shortcomings its study inevitably handicap other lines of investigation, from behavral evolution and psychogenetics to the study of individual and group

behavior" (Schneirla, 1966, p. 283). Currently, developmental psychologists are quite interested in biological influences more generally, particularly in the areas of neuropsychology and domain-specific innate abilities for language, infant cognition, and early social development (see Chapter 8).

GENERAL ORIENTATION TO THE THEORY

Ethology is characterized by four basic concepts: (1) species-specific innate behavior, (2) the evolutionary perspective, (3) learning predispositions, and (4) ethological methodology. The theoretical notions described in this section are based primarily on "classical" ethology, that is, on the contributions of European ethologists, particularly Lorenz, Tinbergen, and Eibl-Eibesfeldt. These contributions have influenced ethological accounts of human development more thus far than have recent related approaches such as sociobiology or evolutionary psychology.

■ *Species-Specific Innate Behavior*

Innate behaviors, like organs of the body, are essentially the same in all members of a species, are inherited, and are adaptive (Lorenz, 1937). Just as physical structures are primarily under genetic control, so are certain behaviors. Although no physical structures or behaviors are completely innate, because they are always expressed in a particular prenatal and postnatal environment, ethology emphasizes the biological contributions to behavior.

Ethologists generally agree that a behavior is innate if it has these four characteristics (Cairns, 1979):

1. It is stereotyped in its form (that is, has an unvarying sequence of actions) across individuals in a species.
2. It is present without relevant previous experience that could have allowed it to be learned.
3. It is universal for the species (that is, found in all members).
4. It is relatively unchanged as a result of experience and learning after it is established.

For example, in certain songbirds, the same song appears in all members of the species at sexual maturity, even if they have never heard the song sung by other members of the species. As this example illustrates,

some innate behaviors are not present at birth but appear later as a result of physical maturation. In contrast to primarily innate behaviors, learned behaviors, such as chimpanzees' use of sticks as "tools," vary in form from individual to individual, require relevant previous experience, usually vary in their occurrence among members of the species, and change as a result of subsequent experience.

Innate behaviors are termed *species-specific*, which means they occur among all members of the species or at least a particular subgroup, such as all the males or all the young. If another species also has the behavior, two inferences are possible. One is that the two species are related, perhaps having split into separate lines at some point in their evolution. That is, they have common ancestors. The other possible inference is that the behavior has evolved independently in the two species, perhaps because they had similar physical environments and needs. For example, in many species the young cling to the mother's fur—a necessity for survival if the infant must travel with its mother as she moves throughout an area in search of food or flees from predators. Ethologists must draw conclusions about similar behaviors in different species very cautiously, not only because the behaviors may have evolved independently but also because they may have different meanings or functions in the two species. An example is tail wagging in dogs and cats.

Two types of innate behaviors, reflexes and fixed action patterns, have particular relevance for humans. *Reflexes*, simple responses to stimuli, have long been familiar to psychologists. Examples from the human infant are grasping a finger placed in the hand, spreading the toes when the bottom of the foot is stroked, and turning toward a nipple when it brushes the cheek. Any long-haired parent would agree with ethologists' interesting observation that infants are particularly likely to grasp hair, especially during feeding. Ethologists speculate that this reflex originally served to facilitate clinging to the mother's fur. Many such reflexes are quite strong. A premature baby can grasp a clothesline and support its own weight, for instance. This ability is later lost. More complex reflexes are coordinated swimming, crawling, and walking movements when the body's weight is supported, in newborns or young infants.

Classical ethology (Lorenz and Tinbergen) emphasized fixed action patterns. A *fixed action pattern* is a complex innate behavior that promotes the survival of the individual, and thus the species. It is a "genetically programmed sequence of coordinated motor actions" (Hess, 1970, p. 7) that arises from specific inherited mechanisms in the central nervous system. For example, squirrels bury nuts, birds per-

form courtship "dances," spiders spin webs, and stickleback fish fight to protect their territory. A hand-fed starling with no experience in hunting prey attacks invisible insects, makes killing movements, and appears to swallow the insects (Lorenz, 1937). Fixed action patterns can become very elaborate, as when the male bowerbird spends hours building a love nest decorated with flowers, fruit, shells, and colorful beetles to attract a mate. He adjusts a twig here, adds a flower there, and seemingly stops to admire his work from time to time. The adaptive value of fixed action patterns lies in the fact that they often end in eating, mating, or protecting the species from harm.

A fixed action pattern is elicted by a *sign stimulus*—a particular stimulus whose presence automatically releases a particular fixed action pattern. Lorenz (1966) likens this process to a key opening a lock. For example, the red belly of a male stickleback fish venturing into another stickleback's territory is a sign stimulus that triggers fighting behavior. A decoy that only vaguely resembles the stickleback in shape but is red on its lower half elicits this fixed action pattern, whereas an accurately shaped decoy without the red area usually does not (Tinbergen, 1951). Thus, the sign stimulus is specific, and sometimes it must be in a particular orientation or position. Tinbergen (1958) discovered this particular sign stimulus when he noticed that his sticklebacks in an aquarium near a window facing a street would become agitated at a certain time of the day. He eventually realized that a red mail truck passed by at that time, a stimulus that approximated the natural sign stimulus. A further example of the specificity of the sign stimulus is that a hen will not rescue a distressed, flailing chick she can see under a glass bell but cannot hear. However, she will rescue the chick immediately if she can hear the distress cries even if she cannot see it (Bruckner, 1933).

When the sign stimulus is an appropriate exaggeration of the normal sign stimulus, it enhances the fixed action pattern. Fishermen take advantage of this fact by using lures that exaggerate the natural prey (the sign stimuli) of larger fish. At the other extreme, under certain conditions animals need very little from the environment to elicit a fixed action pattern, as when a female rat may try to retrieve her young shortly after birth even if no young are present; she will repeatedly grasp her own tail or one of her hind legs and carry it back to the nest (Eibl-Eibesfeldt, 1975). A human example is that infants who do not get enough opportunity to suck during feeding because the hole in the nipple is too large may make sucking movements even when no object is in the mouth (Spitz, 1957).

A fixed action pattern can arise from ambivalent behaviors due to conflict between two need systems. For instance, the male stickleback fish's zigzag courtship dance is a result of a "zig" toward the female that stems from aggression and a "zag" away from her that stems from the desire to lead her to the nest in order to mate. According to Lorenz (1966), this behavior has become ritualized into the innate courtship behavior of the species.

Ethologists have modified the concept of fixed action pattern in several ways (Beer, 1973; Dewsbury, 1978). For instance, research has found that many fixed action patterns are more variable than originally thought. They are now sometimes called "modal action patterns." Furthermore, most ethologists have rejected the classical ethological notion that the buildup and release of drives such as hunger, reproduction, aggression, and flight set the stage for fixed action patterns. They argue that the concept is not a useful one because it is not easily tested, is confusing, and leads to oversimplistic explanations of behavior.

Innate reflexes and fixed action patterns have developmental significance. These behaviors permit young infants' survival, either by allowing them to seek food and hide from predators on their own or by binding them to an adult caretaker through behaviors such as crying, grasping, sucking, or smiling. For example, the infant greylag gosling calls "wi-wi," especially when alone, and elicits a reassuring reply from its mother. Furthermore, with physical maturation come new behaviors such as nest building that allow even further adaptation to the environment. This fit between the organism's needs and the innate behaviors it possesses is not accidental but is the product of the long evolutionary history of its species.

The emphasis on innate behavior should not leave the impression that ethologists think learning is unimportant. Rather, most ethologists simply argue that it is necessary to describe and understand innate behavior before studying how it is modified by the environment. Most behavior is viewed as an interweaving of innate and learned components. A raven innately knows how to build a nest, but through trial and error learns that broken glass and pieces of ice are less suitable than twigs for this purpose (Eibl-Eibesfeldt, 1975). An innate skill can easily be adapted to new situations, as when English titmice quickly learned how to use innate gnawing behaviors to open milk bottles. The survival value of this interweaving of innate and learned behaviors is clear.

Waddington (1957) proposed a now-classic model of how biological regulating mechanisms constrain the course of development while

allowing for the modification of development by the environment. He presented development as a ball rolling down an "epigenetic landscape." As the ball descends, this landscape becomes increasingly furrowed by valleys that greatly restrict the sideways movement of the ball. Slight perturbations from the developmental pathway can be corrected later through a "self-righting tendency," and the ball returns to its earlier groove. Thus, the general course of development is set, but some variation is possible because of particular environmental events. For a more complex description of contemporary systems models, see Gottlieb, Wahlsten, and Lickliter (1998).

Even a primarily learned behavior can contribute to survival. An example comes from Lorenz's description of how a learned act, "shaking hands," becomes an appeasement gesture:

> Who does not know the dog who has done some mischief and now approaches his master on its belly, sits up in front of him, ears back, and with a most convincing "don't-hit-me" face attempts to shake hands? I once saw a poodle perform this movement before another dog of whom he was afraid.
>
> (1950, p. 178)

■ *Evolutionary Perspective*

A chicken is just the egg's way of making another egg.

—ANONYMOUS

Evolution involves *phylogenetic* change, or change in a species over generations, in contrast to *ontogenetic* change, or developmental change in a single lifetime. From an evolutionary perspective, humans are an experiment in nature. A person is viewed "as though seen through the front end of a telescope, at a greater than usual distance and temporarily diminished in size, in order to view him simultaneously with an array of other social experiments" (Wilson, 1978, p. 17). Each species, including humans, is a solution to a problem posed by the environment. The problems include how to avoid predators, how to obtain food, and how to reproduce.

The course of development within an individual follows a pattern that was acquired by the species because it facilitated survival. The young must adapt to their environment in order to reach the age at which they can reproduce and transmit their genes into the next generation. Just as certain physical characteristics, such as the upright stance and the hand with opposable fingers and thumb, facilitated making and using tools, so did certain behaviors—reflexes and fixed action patterns—facilitate survival through mating, food gathering, caretaking, and so forth. Social behaviors, such as interindividual communication and cooperation, encouraged group cohesion and thereby increased the chances of survival. New behaviors arose through natural genetic variations or mutations and, if they allowed the organism to survive long enough to reproduce, were genetically transmitted to the next generation. These successful behaviors gradually became more common in the whole population over many generations.

Evolutionary theory has changed somewhat over the years, particularly in light of modern molecular genetics. Modern evolutionary theory combines Darwinian natural selection theory with population genetics. The latter views evolution as a "numbers game" (Surbey, 1998, p. 373) involving changes over generations in the relative frequencies of various genes. One current notion, for example, is that sudden changes during evolution may have been more common than Darwin thought.

Inferring the course of evolution is not as simple as it seems, however. It is not always obvious what the survival value of an innate behavior is. For example, a behavior may lead to the death of individuals but increase the survival of relatives or other members of the species. When an individual bird spots a predator, it gives a warning call to the flock, thus attracting the predator's attention and endangering its own life. The flock, however, survives. A further complication is that many existing behaviors, such as many of the reflexes in the human infant, are no longer necessary for survival; they appear to be relics. Many of the early arguments about evolution illustrate the dangers of armchair speculation about function. It was once claimed that flamingos are pink because that makes it difficult for predators to see them against the sunset (Thayer, 1909).

■ *Learning Predispositions*

Ethologists see the biological control of behavior not only in innate behaviors acquired during evolution but also in predispositions toward certain kinds of learning. Biology both enables and constrains learning. To a great extent, the brain is "like an exposed negative, waiting to be dipped into developer fluid" (Wilson, 1975, p. 156). Species differ in which aspects of their behavior are modifiable, in what kinds of learning

occur most easily, and in the mechanisms of learning. Learning predispositions include sensitive periods and general or specific learning abilities. *Sensitive*, or *critical, periods* are specific periods in which the animal is biologically ready to acquire a new behavior. During those times, the animal is especially responsive to particular stimuli and has certain behaviors that are particularly susceptible to modification.

The most popular ethological example of a sensitive period comes from Lorenz. Shortly after birth, usually in the first day or two, certain birds (for example, geese) are most able to learn the distinctive characteristics of their mother and therefore their species. During this sensitive period, the young learn to follow a stimulus and come to prefer that stimulus—a phenomenon called *imprinting*. Imprinting increases the survival of the young because it ensures that they stay close to the parent and, therefore, near food and shelter and far from predators and other dangerous situations. The stimulus to be followed must meet certain criteria; for example, it makes a particular call note or type of movement. The criteria vary from species to species, but the mother always meets these criteria. In the wild, a row of ducklings scurrying after their mother is a common sight. However, as Lorenz discovered, certain "unnatural" objects also meet the criteria. Young birds have become imprinted on flashing lights, electric trains, moving milk bottles, and a squatting, quacking Konrad Lorenz (see the excerpt at the beginning of this chapter). Horses and sheep have also become imprinted on humans. Lorenz considered imprinting critical because he thought it was irreversible; a duckling imprinted on a flashing light does not become imprinted on its real mother if she appears for the first time after the end of the sensitive period. More recently, however, ethologists have questioned this irreversibility. Still, ethologists agree that how experience affects the organism depends on the stage of development at which the experience occurs.

In many species, imprinting has a long-term effect on sexual behavior. Lorenz (1931) discovered that jackdaws raised by humans will join a flock of jackdaws but return to their first love, a human, during the reproductive season. They try to attract the human with their species' courting patterns.

Ethologists have also identified sensitive periods for behaviors such as learning bird songs, learning to distinguish males and females of the species, acquiring language, and forming a bond between the newborn and the mother. In the last case, for example, mother goats form a bond with their young in the first 5 minutes after birth. If the young are removed right after birth for 2 hours, the mother attacks them upon their return. Waiting 5 minutes after birth before removal, however, leads to their acceptance later (Klopfer, 1971).

Sensitive periods involve learning predispositions. In the case of imprinting, a young bird is biologically pretuned to notice certain types of objects, sounds, or movements, yet it links up a response to this stimulus as a result of experience, that is, of seeing the object and then following it. Thus, biology prepares the bird to learn from experience. The learning involved in imprinting or other behavior acquired during sensitive periods should not be confused with operant conditioning (discussed in the chapter on learning). Imprinting is acquired with no reinforcement; it even increases when punishment in the form of an electric shock occurs, and it resists extinction.

Developmental psychologists have drawn heavily on the concept of a sensitive period, and many have argued that early experience is particularly important for adult behavior, as suggested by Freud and others. Furthermore, all stage theories claim that at each stage the child is particularly sensitive to certain experiences, such as motor exploration in the sensorimotor period (Piaget), the meeting of one's needs by other people in the stage of trust versus mistrust (Erikson), and the satisfaction or deprivation of anal drives during the anal stage (Freud). Most nonstage theories also use the concept of readiness—the idea that the child is most likely to learn from an experience if it comes at the optimal time. The child may not profit from being shown how to put objects to be remembered into categories when she is 3 years old but may have increased recall as a result of this experience at age 6. Finally, it should be noted that sensitive periods are a central notion in embryological development. A particular drug taken by a pregnant woman will have no effect or a devastating effect on the fetus, depending on its stage of development.

In addition to sensitive periods, a second way in which biology indirectly controls behavior is found in *general and specific learning skills*. Particularly in humans, the genetic endowment includes a tremendous general ability to learn from experience. As Lorenz (1959) noted, humans are "specialists in nonspecialization." We have evolved a central nervous system that is capable of flexible thinking: humans can construct novel solutions to problems in various types of environments. Humans also have hands that can perform many different actions and

language system that permits symbolic thought and verbal communication. The advantage of this flexibility is that the organism can adjust to a changing environment. Humans rely less on fixed action patterns for survival, especially during adulthood. Another way in which a general learning ability is tied to innate factors is the ability to learn via reinforcement and punishment. The ability to be affected by the consequences of one's behavior must be built into the nervous system.

As a result of humans' biologically based general ability to learn, we have developed cultures to help us adapt. The culture is passed on to the next generation by imitation, instruction, and other forms of learning. Thus, even cultural adaptation has its biological origins.

General learning abilities are complemented by specific learning skills, each applied to a particular domain such as the representation of spatial locations. Specific learning skills reflect the fact that an organism does not learn everything equally easily. Each species has its own bias toward certain kinds of learning. The digger wasp, during its morning inspection of up to 15 nests, decides how much food is needed by each nest. He retains this information for the entire day. A well-known example of an amazing specific memory skill is the ability of salmon to return to their spawning ground by remembering the odor of the water in which they were born. Rats, which normally live in burrows, will learn to make their way through a psychologist's maze faster than herons and frogs (Eibl-Eibesfeldt, 1975). Wild rats quickly learn, after an unfortunate experience, to avoid poisonous bait (Barnett, 1963). When new bait is presented, rats will eat very small quantities and, if they fall ill, will subsequently avoid the bait.

Humans also have specialized learning skills. Chomsky (1965) and others have claimed that human infants are pretuned to process and acquire language. The rapid acquisition of language early in life, the culturally universal forms of early utterances, and the occurrence of babbling in infants born deaf all point to this conclusion. All infants are born with the ability to discriminate all human language sounds, but the particular subset of these phonemes that they still can discriminate by late infancy depends on the language or languages to which they were exposed during early infancy.

An interesting footnote to animal learning comes from Lorenz (1963), who suggests that once a behavior is learned, deviating from it often causes great fear. He offers the following anecdote to illustrate this point: A greylag goose that lived in Lorenz's room had developed a routine for entering the house every evening. At first she had always walked past the staircase to a window before climbing the stairs to her room. This detour was shortened until she merely turned toward the window at the foot of the stairs instead of going over to it. One evening Lorenz forgot to let the goose into the house. When he finally remembered as darkness approached, the goose ran in and immediately ascended the stairs:

> Upon this something shattering happened: Arrived at the fifth step, she suddenly stopped, made a long neck, in geese a sign of fear, and spread her wings as for flight. Then she uttered a warning cry and very nearly took off. Now she hesitated a moment, turned around, ran hurriedly down the five steps and set forth resolutely, like someone on a very important mission, on her original path to the window and back. This time she mounted the steps according to her former custom from the left side. On the fifth step she stopped again, looked around, shook herself, and performed a greeting display behavior regularly seen in greylags when anxious tension has given place to relief. I hardly believed my eyes. To me there is no doubt about the interpretation of this occurrence: The habit had become a custom which the goose could not break without being stricken by fear.
>
> (Lorenz, 1963, p. 112)

Methodology

Ethologists rely on two general methods for studying behavior: naturalistic observation and laboratory experimentation. Both are necessary to the theory. The insistence on observing organisms in their natural environments most clearly differentiates ethology from related disciplines such as evolutionary psychology and sociobiology. Ethologists' particular version of naturalistic observation ranks as one of their main contributions to psychology.

Naturalistic Observation ■ Although theories lead to particular methods, methods also influence theories. Rather than observe animal learning in the wild, learning theorists observed bar pressing in rats and table tennis in pigeons in the lab. These could hardly be considered typical species-specific behaviors. It is unlikely that interesting natural behaviors, such as defending a territory or building a nest, would occur often in barren laboratory cages. In contrast, ethologists emphasize naturalistic observation.

Naturalistic observation is closely tied to the three characteristics of the theory mentioned earlier. If one wants to describe species-specific

innate behaviors or learning predispositions that evolved because they led to survival in a species' natural habitat, there is no substitute for observing animals in their typical environments. In particular, one can understand the function of a behavior only by seeing how it fits into the species' natural environment in order to satisfy the animals' needs. Giraffes' long necks make sense when we see them eating leaves from tall trees; we understand young gulls' innate "freezing" rather than fleeing in the face of danger by noting that their nests are built on narrow ledges or steep cliffs (Eibl-Eibesfeldt, 1975).

Observations of animals in captivity are inadequate because their behavior may be abnormal due to their atypical environment. One cause of abnormal behavior in this setting is the absence of sign stimuli that would release fixed action patterns. Thus, behavior is often redirected. Animals may restlessly pace back and forth, constantly rock, and kill their young. A simple change in the environment can often eliminate these abnormal behaviors. For example, an armadillo in the Amsterdam zoo made various abnormal, stereotyped movements until a layer of dirt was placed on the floor of its bare cage. The animal could then bury itself at night when it slept (Eibl-Eibesfeldt, 1975). Ironically, giving too much care to the captive animal may cause problems. Titmice in a zoo threw their young out of the nest soon after birth. The problem was that food was too readily available. The young quickly became full, stopped gaping, and consequently were taken for dead by the parents. Young titmice in the wild never stop gaping unless they are sick or dead, because the parents must hunt for food and the infants are never full (Koenig, 1951). In humans, abnormal behavior—for example, rocking—has been observed in children in unnatural environments such as orphanages and hospitals.

Ideally, ethologists follow a particular sequence of steps when studying an organism.

1 They develop an *ethogram,* an extensive, detailed description of the behavior of a species in its natural environment. An ethogram is like an inventory or a catalog. It includes the animal's behaviors, the characteristics of the environment, and the events immediately preceding and following each behavior. Of interest are not only the types of behaviors—for example, nesting and food gathering—but also their frequency, stimulus context, function, and ontogenetic development. Psychologists have been particularly oblivious to the frequency of a behavior in natural settings. The problem of not having scientific data about frequency was noted long ago by Thorndike: "Dogs get lost hundreds of times and no one notices it or sends a scientific account of it to a magazine. But let one find its way from Brooklyn to Yonkers and the fact immediately becomes a circulating anecdote" (1898, p. 4).

It is as important to describe the environment as it is to describe the organism's behavior. In fact, a complete description of the setting essentially defines the animal that inhabits it: "If we specify in detail the niche of a fish (its medium, its predators and prey, its nest, etc.), we have in a way described the fish" (Michaels & Carello, 1981, p. 14).

The descriptive labels must be refined until two or more observers can agree, in nearly every case, regarding what behavior occurred and when it began and ended. Did a child smile or grimace, and for how long? When describing a behavior, ethologists examine the structure of that behavior: what elicits it, what the components are, in what order these components appear, and what ends the behavior. Note that these "raw data" in the ethogram focus on certain types of behaviors, namely, those that have evolved as an aid to survival. Furthermore, ethologists historically have been particularly interested in observing fixed action patterns that involve social behavior. Ethologists sometimes study human behavior by examining contemporary hunters and gatherers in order to understand the environment in which current human behaviors evolved.

2 Ethologists classify behaviors according to their function, that is, how they encourage survival. The categories—such as caretaking, mating, and defending territory—serve as working hypotheses that they modify after more observations. Ethologists often can identify function after determining which species do or do not exhibit the behavior and then finding out what differentiates these species. For example, they may find mother–child bonding only in species in which the young are helpless.

3 Ethologists compare how a given behavior, such as a fixed action pattern, functions in various species and how different behaviors meet the same need in different species. They are especially interested in similar fixed action patterns in closely related species. If several closely related species of birds have a similar courtship dance, they may have a common ancestor. Such species comparisons, along with changes in behavior inferred from fossils (for example, an increase in brain size), provide evidence about the evolutionary course of a behavior.

4 As described in the next section, ethologists use laboratory experiments to determine the immediate causes of the behavior described in the first three steps. From the viewpoint of ethologists, psychology has worked backward historically by performing laboratory research before obtaining a sufficient database of naturalistic observations.

Ethologists increase the power of the observational method by filming or videotaping their observations. They thus can return to an earlier observation to check a hypothesis formed after observations of many individuals. After observing many human babies, an investigator may notice that they seem to be less fearful of strangers when strangers kneel down than when they stand. By viewing all of the observations again, she can check this hypothesis.

Another advantage of videotaped observations is that the action can be sped up or slowed down. When this is done, previously unnoticed patterns of behavior sometimes emerge. For example, a flirting look often involves raising the eyebrows for only one-sixth of a second—a movement that becomes a noticeable invariant part of the flirting sequence only when the film is slowed down (Eibl-Eibesfeldt, 1975). By speeding up videotapes, investigators have noted that people who eat alone look up and around after every few bites, as if scanning the horizon for enemies, as baboons and chimps do (Eibl-Eibesfeldt, 1975). This is much less obvious at a normal camera speed.

Filming humans poses special problems because their awareness that they are being filmed is likely to change their behavior. The one-way mirror, which makes unobtrusive filming possible in the laboratory, is obviously of little use in field settings. Eibl-Eibesfeldt has made use of one clever solution to this problem. A mirror prism inserted in his camera allows camera operators to point the camera at a right angle to the target. Subjects know the camera is present but do not think they are being filmed.

Laboratory Studies ▪ For an ethologist, a behavior has both a phylogenetic cause and an immediate cause. A spider spins a web "because" that innate food-gathering behavior has allowed the species to survive. In addition to this phylogenetic cause, various types of immediate causes can be identified. Spinning a web may be caused by specific physiological events, particular inborn neurological pathways, the presence of a sign stimulus, certain aspects of motor experience, and so on. Ethologists clarify these various causes of behavior suggested by the observational studies with controlled experiments.

The classical ethological experiment is the *deprivation study*, which determines whether a behavior is innate or learned. In this method, ethologists deprive the animal of specific experiences that could be relevant to the behavior of interest. Obviously, they do not deprive the organism of broad aspects of experience—a procedure that would cause widespread disruption of behavior or even physical deterioration. As an illustration of the deprivation study, an ethologist interested in the origin of nut-burying behavior raised squirrels in isolation in a cage with a bare floor and provided a diet of only liquid food. The squirrels had no exposure to other squirrels (who could serve as models), nuts, or earth (which could provide digging practice). Under these conditions, squirrels demonstrated a stereotyped sequence of nut-burying behaviors at the same age as do squirrels in the wild. When presented with a nut at this time, they ate until satiated, then dug an imaginary hole in the concrete floor, pushed the nut into the "hole" with their snouts, covered it with invisible soil, and carefully patted down the "soil" to finish the job (Eibl-Eibesfeldt, 1975). Thus, since they had no opportunity to learn this behavior, it must be an innate fixed action pattern of the species.

Other ethological laboratory experiments do not differ in method from those of comparative psychology or physiological psychology. They clarify which variables influence behavior and what the underlying physiological mechanisms are. For example, by systematically varying stimuli, researchers can determine which attributes of a stimulus are critical for eliciting the response. The experiments examine a variety of responses, ranging from pupil dilation (which indicates interest or attraction) to the amount of time spent near the stimulus. Although the laboratory experimental method is shared with the mainstream of experimental psychology, ethology maintains its distinctiveness by the content it chooses to study: behaviors tailored to the survival of the species.

CONTRIBUTIONS TO HUMAN DEVELOPMENTAL PSYCHOLOGY

Ethologists are interested in the same categories of adaptive behaviors in humans as in other animals, for example, feeding, communication, parent–child interaction, and reproduction. However, there is no unified ethological view of development. Instead, ethologically oriented

psychologists have selected particular topics. The study of children has focused primarily on infant attachment but also has examined topics such as the organization of peer interaction and problem solving. Recent evolutionary accounts of development have focused on cognitive evolutionary psychology; cultural transmission, social cognition, and theory of mind; and the advantages of immaturity. A look at representative research in each of these areas will show ethology's imprint on both the content and the methodology of developmental research (see also Bjorklund & Pellegrini, 2000; MacDonald, 1998).

■ *Infant–Caretaker Attachment*

Bowlby's Theory ▪ John Bowlby, a London psychoanalyst, is credited with bringing ethology to the attention of developmental psychologists. Because World War II had left many children as orphans, there were concerns about the effects of maternal deprivation. Bowlby's observations of infants separated for a long time from their mothers led him to conclude that an early social "attachment" between infant and caretaker is crucial for normal development. A disrupted relationship between mother and infant often leads to the infant's protest; then despair, characterized by grief and mourning; then detachment; and finally, in some cases, psychopathology (see the excerpt at the beginning of this chapter). Evidence for the attachment bond in normal situations includes protest when the parent leaves and greeting behaviors, such as smiling and babbling, when the parent returns. Children also seek their attachment figure when under stress.

Drawing on observations of mother–infant bonding in nonhuman primates, Bowlby [1969(1982)] proposed that attachment to a caretaker has evolved because it promotes the survival of helpless infants by protecting them from predators or exposure to the elements. Separation of the infant from its mother can be a fatal error in many animals. At birth and throughout early development, infants have a biological predisposition to maintain proximity to adults of the species. In animals other than humans, the young often use the mother's odor or the warmth of the nest to keep in contact with her (Moltz & Leon, 1983; Rosenblatt, 1976). Many of the human newborn's reflexes served this function during human evolution. One of these reflexes is grasping an object such as a finger or the hair when it contacts the infant's palm, just as many mammalian infants stay with the mother by clinging to her hair. Another reflex is an embracing movement in response to a sudden loud sound or a loss of support. This reflex may have prevented many ancestral infants from falling when the mother suddenly ran upon seeing a predator.

Of course, these reflexes have little value for attachment in human infants, who need not physically attach themselves to the parent in order to survive. Of more importance to human babies are signaling mechanisms such as crying, babbling, and smiling. These behaviors communicate infants' needs and encourage adults to come to infants, since young babies cannot go to adults. Just as following the imprinted object in ducklings maintains proximity, so do signaling behaviors serve this purpose in humans. The result is the same: the infant is protected and nurtured. These signaling behaviors are more complex than the simple reflexes and are considered by some to be fixed action patterns. Another ability found in young infants that may facilitate their relationship with their parents is imitation of facial gestures (Meltzoff & Moore, 1989). As the infant matures, other behaviors, such as crawling, walking, and talking, facilitate contact between parent and child.

Research supports Bowlby's notion that signaling behaviors are innate. Even infants born blind or blind and deaf acquire a social smile at approximately 6 weeks, as do normal infants. In fact, children blind and deaf since birth reveal a wide range of normal behaviors, including laughing, crying, babbling, and pouting, and typical facial expressions of fear, anger, and sadness (Eibl-Eibesfeldt, 1975, 1989). For example, they throw back their heads when laughing and stomp their feet when angry. Thus, these naturally occurring "deprivation experiments" show that visual and auditory experiences that would allow imitative learning are not necessary for these signaling or expressive behaviors to develop. Further evidence for the universality of the human smile and other expressions comes from observations of these behaviors in infants in many cultures (Eibl-Eibesfeldt, 1975). Darwin long ago observed smiling in infants of every culture with which he had contact.

It is highly unlikely that adults teach these expressive behaviors to normal infants or blind and deaf children. Smiling and laughing involve a complex sequence of coordinated movements or sounds. Eibl-Eibesfeldt (1975) describes a deaf and blind 12-year-old with severe brain damage who was unable to learn simple actions such as bringing a spoon to her mouth, in spite of an intense training program. Yet she was able to smile, laugh, and cry. Even the possibility that blind and deaf children might learn facial expressions by touching the mother's face and imitating her facial movements was ruled out by a child deaf and

blind since birth who was born with no arms. Despite these handicaps, he showed normal facial expressions.

Bowlby proposed that these early reflexes and signaling behaviors, along with a bias toward looking at faces, leads to an attachment to adults in general and then, usually around 6 to 9 months of age, to one or a few specific adults. This specific attachment can be seen in the infant's protest when separated from a particular adult, as opposed to all adults. This separation is an innate "cue to danger" that elicits signaling behavior intended to restore proximity.

The infant and adult behaviors eventually become synchronized into an "attachment behavioral system," according to Bowlby. The appearance and behavior of each member serve as sign stimuli for the fixed action pattern in the other. Each member of the system comes to expect that the other will respond to its own behavior in certain ways. Children's expectations are part of their "internal working models" discussed in Chapter 2—mental representations of the attachment figures, the self, and the relationship. These models help children interpret and evaluate new situations and then choose a behavior such as playing or seeking the attachment figure for comfort. Between the ages of about 9 and 18 months, an infant's various individual behaviors, especially sucking, clinging, crying, smiling, and following, become incorporated into more complex, self-correcting "control systems."

Bowlby used control-systems theory from engineering as a model of how attachment forms an organizational system. Control systems are goal-directed and use feedback to regulate the system in order to achieve the goal. A simple control system is a thermostat, which maintains a particular room temperature (the goal) by comparing the actual temperature (the feedback) with the desired temperature. With respect to behavioral systems, Bowlby proposed that genetic action causes the behavioral system to develop but that the developed system is flexible enough to adjust to changes in the environment, within prescribed limits. Just as the human respiratory system works within a particular range of oxygen, a behavioral system operates efficiently within a certain range of variation in relevant features of the environment. The particular acceptable range of social and physical stimuli relevant for attachment varies from species to species. In human attachment, infants have a goal: an acceptable degree of proximity to the adult. When infants detect that the adult is too far away (feedback), they correct this state by crying or crawling, which reestablishes contact and reachieves equilibrium in the system. The limits of acceptable distance vary,

depending on internal factors, such as hunger or illness, and external factors, such as the presence of an adult stranger or other cues of danger. The development of a secure attachment expands the distance acceptable by establishing the caretaker as a secure base from which the child can explore.

Bowlby's theory of attachment includes many of the characteristics of the general theory of ethology. Species-specific reflexes and fixed action patterns, which are the products of evolution, ensure the proximity of the mother to the child. Sensitive periods and general and specific learning abilities biologically predispose infants and caretakers to develop a system of synchronized interactions. In keeping with ethological theory, Bowlby relies heavily on observations of children. However, much of the more recent research on attachment stimulated by his theory was conducted in laboratory settings. Mary Ainsworth (Ainsworth, Blehar, Waters, & Wall, 1978) developed methods for assessing attachment and provided much of the empirical evidence for attachment theory in her research.

The ethological account of attachment, with its focus on innate behaviors, obviously contrasts with learning theory's focus on the reinforcement value of food (or, in later versions, other stimuli, such as warmth and physical contact), which establishes the mother as a secondary reinforcer. Although it seems likely that pleasant interactions have a positive effect on the bond between child and adult, ethologists point out that attachment occurs even when the attachment object physically abuses the infant. Ethological accounts also differ from Freudian theory's focus on the oral drive. Finally, ethology differs from both traditional learning and Freudian theory in stressing the infant's effect on the parent as much as the parent's effect on the child.

Bowlby later (1980) incorporated into his theory some of the notions of information-processing theory. He explained unsatisfactory early social relationships, abnormally strong repression, and thinking disorders in part by general principles of selective attention and selective forgetting. For example, if young children's attachment behavior is continually aroused but not responded to, they eventually exclude from awareness the sights, thoughts, or feelings that normally would activate attachment behavior.

Bowlby continually applied his ideas about attachment to his clinical work. Interestingly, his final book (1991), a biography of Darwin, traces Darwin's chronically poor health back to his failure to fully mourn his mother's death when he was 8 years old.

Adults' Responsiveness to Infants ■ One important contribution of the ethological account of attachment is that adults, as well as infants, are biologically predisposed to develop attachment. Species in which infants depend on parents for survival should retain, over the course of evolution, innate caretaking responses in adults. Babies elicit adult attachment behavior by signaling behaviors or by their babyish appearance. Many infants emit calls to which the mother responds. For example, ultrasonic sounds from a young mouse elicit nest-building behavior in the adult female mouse (Noirot, 1974). Human signaling behaviors, such as smiling, visually fixating the face, and babbling, elicit the parent's attention and interest.

The infant's babyish appearance may elicit caretaking. Lorenz (1943) noted that the infants of many species, especially mammals, share certain physical characteristics, which are depicted in Figure 5.1. These characteristics include a head that is large in relation to the body, a forehead that is large in relation to the rest of the face, limbs that are relatively short and heavy, large eyes at or below the midline of the head, and round, prominent cheeks. This description is simply an objective description of what is better known as cuteness. This babyishness is exaggerated in baby dolls for children and in young animals in the Disney cartoon films. Interestingly, Gould (1980) observed that as Mickey Mouse became more lovable and well behaved over the years, his physical appearance became more babyish—a larger head with softer, more rounded features and larger eyes.

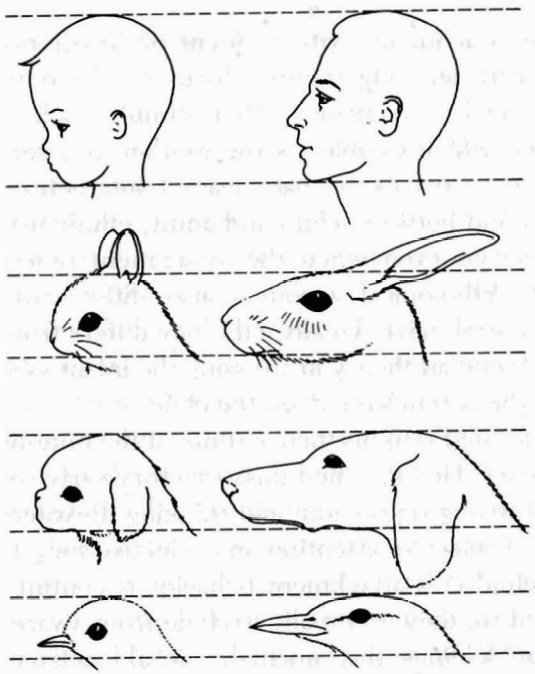

Figure 5.1
Characteristics of babyishness or cuteness common to several species.
SOURCE: From "Die angeborenen Formen möglicher Erfahrung," by Konrad Lorenz, in *Zeitschrift für Tierpsychologie*, 1943, 5, 235–409. Reproduced by permission of Verlag Paul Parey.

Infants' smiles also may be powerful elicitors of adults' attention. It has been suggested that the adaptive significance of an infant's smile is to make the tired, busy mother of the young infant feel that those difficult first months are worthwhile (Robson, 1967). Studies of adults' and children's responses to pictures of infants or to live infants have included physiological measures (pupil enlargement or changes in heart rate), behavioral measures (amount of interaction with the infant), or self-reports (rating the attractiveness of faces). This research shows that people respond positively to infant faces but that various factors affect the degree of their response. For example, 12- and 13-year-old girls who had begun menstruation rated pictures of infants more positively than did boys of the same age or girls of the same age who had not begun menstruation (Goldberg, Blumberg, & Kriger, 1982). However, responsiveness to infants is not always greatest among females or during the childbearing years. The pattern of results depends on the type of response measure used, the physical and social nature of the testing situation, the person's experience with young children, and the person's cultural background (Berman, 1980). Thus, social factors, such as cultural expectations, appear to play at least some role in responsiveness to infants. Interpretation is also clouded by the fact that even infants prefer looking at babies to looking at children or adults (McCall & Kennedy, 1980).

The caretaker typically forms an emotional bond to the child in the first few hours or days of life. This *bonding* encourages caretaking and thus enhances survival. One of the most exciting discoveries from attachment research is a possible sensitive period for bonding during the first few hours after birth. It is tempting to draw an analogy with the sensitive period for imprinting in birds. Klaus and Kennell (1976) compared two groups of mothers and newborns. The control group followed usual hospital procedures, that is, a look at their babies at birth, brief contact at 6 to 8 hours, and 20 to 30 minutes of contact every 4 hours when they fed their infants. The "extra-contact group"

received their nude babies for 1 hour of contact in the first 2 hours after birth and for 5 extra hours, compared with the control group, on each of the following 3 days. At the babies' examination 1 month later, the mothers from the extra-contact group held and soothed the infants more, showed more eye contact and fondling when they fed the infants, and reported they were less likely to leave the infants with another caretaker, in comparison to the control group. The differences were still present at 1 year. By 5 years of age, children in the extra-contact group had higher IQ and language-test scores. Although there is disagreement about the replicability of this research, its methodological adequacy, and its proper interpretation (Myers, 1984), the research does point to the importance of events that occur shortly after birth.

Contemporary Perspectives on Attachment ▪ Contemporary attachment research has focused on predispositions toward attachment in very young infants and on patterns of attachment identified by Mary Ainsworth. Young infants are biased toward attending to people. Newborns prefer to look at human faces rather than inanimate objects. Interestingly, infants prefer female faces that have been rated as attractive, rather than unattractive, by adults, even infants who are too young to have been taught this preference (Langlois et al., 1987). Even young infants gurgle and make various "pleasure sounds" in response to the sound of the human voice.

Infants also appear to be predisposed to learn to discriminate their mother's odor from that of others. Two-week-old breast-fed infants turned toward a pad that had been worn in their mother's underarm area rather than a pad worn by another lactating female (Cernoch & Porter, 1985). Just as infants can recognize their mother's odor, so do mothers quickly recognize their infant's distinctive smell. Six hours after giving birth, and after only a single exposure to their babies, blindfolded mothers could pick out, by smell alone, their own baby from a set of three babies (Russell, Mendelson, & Peeke, 1983).

One of Bowlby's colleagues, Mary Ainsworth, focused on the role of the attached parent as a "secure base" for exploration. The parent is a secure home base from which children venture to explore the next room or the next block and to which they return from time to time for "emotional refueling" (Mahler, 1968). If, however, the responses to children's signaling behaviors are inappropriate (unpredictable, slow, abusive, or not matched to the child's needs), children feel insecure and are less likely to use the mother as a base for exploring a strange environment (Ainsworth et al., 1978). Because the appropriateness of the adult's responses is more important than the total amount of interaction, infants become attached to fathers who respond appropriately to the child's signals, even if the total amount of time spent with the father is small.

Ainsworth (e.g., Ainsworth et al.,1978) devised the "Strange Situation" procedure, which lasts about 22 minutes, to assess babies' patterns of attachment to their mothers. The child, a parent, and a stranger in a laboratory setting proceed through a sequence of episodes, gradually moving from low stress (child with parent) to high stress (child with stranger in parent's absence). On the basis of their reactions to these events, children are classified as *securely attached* (approximately 65 percent of typical middle-class samples), *insecure–avoidant* (20 percent), or *insecure–resistant* (15 percent). However, it appears that some children do not fit easily into any of these categories and may form a fourth category—*disorganized or disoriented* (Main & Solomon, 1990). They have no consistent way of dealing with stress; they show contradictory behaviors such as calmness and anger. This disorganization is not surprising because they sometimes have parents who abuse them. The dyad's type of attachment depends on many factors, including parents' sensitivity to the child's needs, stresses on the family, parental psychopathology, and child characteristics such as Down syndrome or temperament (e.g., Thompson, 1998). Secure attachment predicts later child behaviors, particularly effective social functioning during childhood and adolescence (for reviews, see Cassidy & Shaver, 1999; Thompson, 1998).

A recent interpretation of these findings is that this variability in types of human attachment prepares the young of the species to adapt to their parents' pattern of investment in offspring, a notion from evolutionary approaches (Chisholm, 1996). Infants increase their chances of survival if they can adapt to their particular caregiving condition. If parents are heavily invested in their children and thus are sensitive and responsive, then environmental risk decreases and children can explore more freely from their safe base. If, because of environmental pressures such as scarce food, parents are unable or unwilling to invest heavily in caring for their children, then resistant or avoidant attachment may be more adaptive. In resistant attachment, clinging to the caregiver could elicit whatever meager resources are available. In avoidant attachment, a more independent infant can try to obtain resources from other adults. As Thompson concludes, "Attachment patterns that are adaptive for certain rearing conditions may be maladaptive for others, and

patterns that are initially adaptive may not remain so if conditions change appreciably" (1998, p. 43).

Contemporary issues about attachment include the following, some of which challenge the original Bowlby–Ainsworth attachment theory (Cassidy & Shaver, 1999; Thompson, 1998): How stable over time is an infant's attachment classification? How broad is the effect of early attachment on later social relationships and cognitive abilities? Are aspects of the parent–child relationship other than attachment of equal importance? How are specific aspects of the attachment relationship related to specific later relationships? What is the child's active contribution (for example, temperament) to the attachment relationship? How, if at all, do child-care arrangements affect attachment and development? What accounts for the variability in a child's attachment behavior across situations? What effect does parental physical abuse of the infant have on the attachment bond?

One particularly interesting area of research concerns the possible link between insecure attachment and various sorts of later psychopathology. The early attachment pattern has an indirect effect in that it plays an ongoing role during development in the child's selection of environments, degree and type of engagement in activities in the environment, and interpretation of her experiences (Sroufe, Carlson, Levy, & Egeland, 1999). Also, work on young children at developmental risk, such as children with Down syndrome, cerebral palsy, or autism, promises to broaden our understanding of the variety of social attachments and the complex interweaving of genetic and environmental forces (Vondra & Barnett, 1999).

Today, researchers have added several perspectives to ethology to address broader questions about early social relations (Thompson, 1998). One is young children's theory of mind, such as their inferences of parents' feelings and intentions. This knowledge both affects and is affected by interaction with parents. Children's representation of events and their autobiographical memory also are important. Another perspective is cultural studies of attachment that clarify what cultural–ecological factors influence the security or insecurity of attachment. In general, Ainsworth's attachment patterns have emerged in studies in various countries, but the percentage in each category shows some variability from country to country and even within a country. For example, in one study (Van Ijzendoorn & Sagi, 1999), U.S. and Western European groups showed more avoidant infants than did groups from other regions. Still another perspective is related to the internal working models perspective described in Chapter 2. Young children's representations of the self and another person and their relationship could underlie the formation of later social relationships. As mentioned in Chapter 2, adults' memories of their own attachment as young children to their mothers fall into these same three categories and are related to how they treat their own infants. The initial attachment pattern sets in motion particular styles of thinking, feeling, and interacting that continue to influence the way children negotiate their environments throughout development. Attachment now is viewed as a lifelong process of forming affectionate bonds with various people (Ainsworth, 1989; Parkes, Stevenson-Hinde, & Marris, 1991).

Peer Interaction

Ethologists argue that children are innately predisposed toward interacting with other people in adaptive ways (Eibl-Eibesfeldt, 1989). Children's social interactions involve not only the family, especially the parents, but also the peer group. Ethological studies of animals' dominance hierarchies, aggression, play, altruistic behavior, and nonverbal communication led naturally to observations of these behaviors in groups of children in natural settings (Blurton-Jones, 1972; McGrew, 1972).

A basic feature of the organization of nonhuman primate groups is the *dominance hierarchy,* a pattern of social relationships related to the resolution of social conflict. It involves the distribution of power, especially access to resources such as food or mates, among group members by setting implicit "rules" as to who can control whom (Hinde, 1974). These dominance hierarchies also construct the social environment into which an infant is born. For example, in rhesus monkeys, which form large and complex social groups (troops), the matrilineal (mother's) dominance hierarchies affect the rank of the infant. All members of the highest-ranking matriline, even infants, outrank lower matrilines. Thus, a newborn "inherits" the status of the mother and outranks even adults of lower-ranking matrilines. Dominance hierarchies even affect how mothers treat their infants. High-ranking mothers are more "laissez-faire" in their supervision of their young than are low-ranking mothers. The latter are more limited in the social situations from which they can rescue their infants, so they are reluctant to let them explore much. Also, within each matriline, there is a clear hierarchy among females. Younger sisters outrank older sisters, even though the latter are much

larger and stronger. Thus, mothers and the rest of the matriline give preference during sibling conflicts to younger sisters. This sibling hierarchy usually continues even after the sisters are fully grown. (See Sameroff & Suomi, 1996, for a review of this research.)

To illustrate ethologically oriented research on children's dominance hierarchies (see also Archer, 1992), we turn to a study by Strayer and Strayer (1976). They videotaped the free play of a group of preschool children toward the end of the school year, when the group had stabilized. The dominance relations could be inferred from the outcomes of three categories of naturally occurring social conflict between two children. These conflicts included physical attacks, threat gestures, and object or position struggles (physical or nonphysical struggles over a toy, standing at the front of the line, and the like). In response to these conflicts, a child could submit, seek help, counterattack, give up the object or position, or make no response. The child who wins in these encounters is considered to be the more dominant. These categories of initiated conflict and response to the conflict are quite similar to those used to study dominance in nonhuman primate groups. The analysis of the videotapes revealed a relatively rigid and stable dominance hierarchy in the group. Although boys initiated more conflict than did girls, boys were not higher in the hierarchy than girls overall. The fact that there were few counterattacks suggests that the stable dominance hierarchy minimizes group aggression, just as in nonhuman primate groups. Other research, in agreement with this argument, shows that conflicts are high among humans when groups first form, but then they drop drastically (Savin-Williams, 1976). Finally, research has suggested that boys' rough-and-tumble play may permit them to assess each other's relative strengths—one basis for dominance hierarchies—and to gain experience in dominant and subordinate roles (Biben, 1998; Pellegrini & Smith, 1998).

The Strayer and Strayer study reflects the ethological approach in its content (dominance hierarchies observed in animals), method (observation of behavior in its natural context and subsequent categorization of this behavior), and theory (emphasis on behaviors adaptive for the species). Ethologists have also studied peer interaction in play (Smith & Connolly, 1972) and children's appeasement behaviors, such as slumping the shoulders and bowing the head, which cause aggression to cease (Ginsburg, Pollman, & Wauson, 1977). The ethological approach clearly contrasts with social learning theory's focus on how a behavior (for example, aggression) in individual children is affected by

reinforcement, punishment, and imitation. And, unlike Freud, ethologists focus on interpersonal processes more than individual psychological processes.

It may seem strange that researchers have shown more interest in negative, aggressive, power-oriented social relationships than positive, cohesive ones. Indeed, Strayer (1980), during a period of observation at a nursery school, saw fewer than 200 competitive or aggressive episodes in contrast to more than 1000 affiliative episodes. Sociobiologists have been interested in developing genetic models to outline a biological basis of altruistic behavior, in particular to show how self-sacrifice can be adaptive to the species. Moreover, some ethologists have argued that prosocial behaviors actually can be a form of competition for resources. In particular, when children enter grade school, they start rejecting dominant aggressive peers; most children learn that they must express dominance in more subtle ways in order to obtain resources—what Hawley (1999) calls "competing with finesse." Prosocial strategies such as persuasion, cooperation, and helping enable children to access resources such as toys or friends in ways that foster acceptance and maintain group harmony (see Hawley, 1999, for a review of developmental changes in strategies for obtaining resources). We now turn to recent evidence for this position.

At any phase in the life span it is adaptive to obtain resources from the environment. As Charlesworth expresses it:

> Whether it is an infant crying for attention, a preschooler struggling with a sibling over a toy, an adolescent trying to impress a peer, a graduate seeking a job, a scientist writing a grant proposal, or an octogenarian looking for someone to shovel snow, the possibility is always present of failing to acquire what one needs because of the competing needs of someone else. While all needs obviously do not have to be satisfied, a certain proportion of them must be if the individual is to carry out normal life functions.
>
> (1988, p. 24)

The task of obtaining resources changes developmentally. In most families infants need only signal their needs through crying or fussing in order to obtain resources. Later, during socialization, children acquire a variety of skills for obtaining resources—aggressing, lying, threatening, frightening, flattering, helping, sharing, and working together. Through experience, children learn which strategy is most effective in various situations. The types of resources that are most important also change developmentally. Charlesworth suggests that Erikson's eight

developmental crises, or tasks, can be seen as changes in which resources are needed most critically—such as access to food and attention in infancy, materials and tools during grade school, and a mate during late adolescence.

Charlesworth (1988, 1996) studied the roles of cooperation and competition in establishing dominance and thereby obtaining resources in children age 4 to 8. He devised a situation in which four children attempted to obtain a resource—viewing a cartoon movie. One child could view the cartoon only if a second child turned on the movie light and a third turned a crank to start the movie. Thus, cooperation was necessary for anyone to see the cartoon. A fourth child had to simply be a bystander. From an analysis of the videotapes of the children's interaction, Charlesworth developed an observational scheme that categorized various types of resources, resource-acquisition behaviors, reactions to such behaviors, and outcomes of the interaction. Resource-acquisition behaviors included several types of verbal behaviors, such as requests, appeals to take turns, and threats, and several types of physical behaviors, such as touches, blocks, and attacks.

Using this ethological methodology, Charlesworth found that cooperative behavior led to inequitable outcomes for the children in the groups. By the end of 30 minutes, a few children saw some of the cartoons, but most did not. Some children were more skilled at obtaining resources than others. Successful children produced a mixture of assertive, selfish, deceptive, and cooperative behaviors. They somehow managed to get into the viewing position and then get others to turn on the light and crank the switch. That is, by engineering cooperation, they competed more successfully. For example, child A got child B to crank the switch but then looked at the cartoon longer. Child A also sometimes cleverly entertained the others, who could not see the cartoons, by narrating or acting out the cartoon events! The losers either did not detect the deception or inequity or were unwilling or unable to rectify it. Charlesworth has observed this pattern in all cultures studied thus far—American, Indian, Malaysian, and black South African—and thus argues for universality.

Dominance rank in the classroom, gender, age, and friendship predicted which children were most effective at obtaining resources. For example, high rank in the peer group enhanced a child's ability to get others to cooperate in ways that benefited the self. In addition, boys obtained more resources than did girls; boys used more physical behaviors than did girls, who used more verbal behaviors.

Ethology offers the intriguing notion that resources include not only terials and objects but also other people (MacDonald, 1998). From evolutionary perspective, a child evaluates the resources to be gained m a peer—friendship, a play partner, cognitive stimulation. Popular ildren provide resources such as social status and the characteristics sociated with it, such as friendliness, generosity, cheating, and helpness. As all the above programs of research show, ethology provides a werful framework for understanding peer relations.

A final aspect of peer interaction is the maintenance of a preferred stance between the self and another person, just as birds on a wire eep a certain distance from one another. The desire to prevent another erson from coming too close has been observed in many cultures, but e preferred distance may vary from culture to culture. One experient (Barash, 1973) examined the response to violation of one's territry. A person sat down close to another person in a library with many mpty seats. The latter person frequently turned away and sometimes uilt a barrier of books or other objects between the intruder and himelf. The preferred distance may be related to the establishment of roup territories. These territories are common in many animal species nd serve to spread out the population to avoid starvation and overcrowding.

Problem Solving

gather firewood
s if I had been at it
or a million years

—CHARLESWORTH, ONE YEAR OF HAIKU, *1978*

ntelligence increases adaptation to the environment and therefore surival. As a result of evolution, the human brain is prepared for what is alled an "evolutionarily expected environment." A species' cognitive ystem is designed to deal with a certain general type of environment, he type in which the species has evolved. What kinds of problems do hildren encounter in their daily lives and how do they solve them? In ne ethologically oriented study, Charlesworth (1983) observed toddlers' responses to barriers (or "blocks") encountered in their everyday ves at home. Examples of these problems include being unable to each a glass of juice (a physical block), being told by their mother to top an activity (a social block), and being asked by someone to identify omething (an informational block). In each case, the problem involves

a relationship between the children and their environment. A block can come from outside of individuals or from individuals themselves—their need or desire for something unavailable. Charlesworth recorded all blocks to children's behavior and their response to each block, for example, compliance, ignoring, or hitting. The $3\frac{1}{2}$- to $4\frac{1}{2}$-year-olds, for example, encountered approximately 18 problems per hour and solved the problems 33 percent of the time. Many of the problem-solving episodes lasted several minutes. Social blocks occurred much more frequently than physical or informational blocks in these situations. It is therefore striking that solving social problems is not assessed to any extent on standard intelligence tests or on Piagetian cognitive tasks.

Charlesworth (1988) also has examined problem solving in a girl with Down syndrome and among preschoolers at nursery school in free play or instructional settings. In addition, he has documented the greater frequency of blocks, particularly informational and physical ones, among children with physical disabilities. These children interacted with the teachers more than did other children, who were involved in significantly more peer interaction. Finally, his ethological analysis included undergraduate honor students who faced blocks such as deciding what to wear in cold weather, running out of eggs for breakfast, having difficulty in finding library materials, being asked for advice by a friend, and forgetting how to make garlic bread.

The Charlesworth research illustrates the kind of information about cognition that we do not have from other current approaches to studying this topic. The intelligence-testing approach views intelligence as a trait or disposition that is revealed by certain tests administered by an adult, usually in a setting unfamiliar to the child. Laboratory studies of problem solving examine thinking out of context, usually about physical, nonsocial events. In contrast, Charlesworth's ethological research studies the function and ecological significance of the children's spontaneous use of their intelligence. This research tells us which features of everyday life pose problems, how children usually handle them, and how the children's reactions change developmentally. Such applications of intelligence in action help children adapt to the physical and social problems created by parents, peers, their own body, furniture, and toys in their environment.

Although Piaget's account of the sensorimotor period came from his observations of his own children, most of his information about children past infancy came from semistructured interviews. He had little concern with the frequency of occurrence of various categories of behavior because his focus was on the underlying knowledge structures. He also did not ask which kinds of everyday environmental circumstances require the use of such knowledge as conservation or transitive reasoning and whether these circumstances are more frequent at some developmental levels than at others. On the other hand, both Piagetian and ethological approaches are concerned with how an organism adapts to its environment. Both identify biological predispositions toward learning, for example, the assimilation–accommodation process (Piaget) and specialized learning abilities (ethology).

■ *Recent Evolutionary Accounts of Development*

One recent trend across developmental psychology is toward incorporating biological–evolutionary perspectives into accounts of development. In Chapter 4 we discussed Siegler's (1996) argument that strategy variability is adaptive for problem solving and that, after a process of competition, the most viable strategies prevail. Chapter 8 will present the *modularity nativist* and *biological constraints* arguments that infants are pretuned to process certain information in certain ways in certain areas. This view was stimulated in part by the recent findings of infant precocity in areas such as language, multimodal perception, and the perception of objects, causality, and animacy referred to in earlier chapters. These competencies appear so early and so easily that it is difficult to argue that they are acquired primarily through experience. They are the sorts of competencies that humans would be expected to have acquired during evolution.

Within neuroscience a sort of "neural Darwinism" (Edelman, 1987) proposes that during development competition among groups of neurons leads to the pruning away of certain neurons and the survival and enhancement of others. More generally, the current considerable interest in developmental neuroscience (Johnson, 1998), particularly brain development, is promoting a biological perspective on development (see Chapter 8).

Recent advances in developmental behavioral genetics and developmental psychobiology, along with the growing influence of person-in-context theories (Chapter 8), have stimulated developmentalists to construct more complex models of gene–environment interaction. These new models tend to emphasize bidirectionality—children actively select and change environments while environments are affecting them. The models give equal weight to contextual and genetic influences and

include complex interactions among many levels from the level of protein production to the influence of the social environment. They tend to think in terms of holistic systems rather than take a reductionist stance. A description of these models is beyond the scope of this book, but the reader is referred to the following sources: Gottlieb et al. (1998), Lerner (1991), Plomin (1998), and Scarr (1992, 1993). A main current issue in this area is how to integrate the focus of developmental behavioral genetics on individual differences in the population with the focus of developmental psychobiology on development. Another main challenge is to integrate the mechanistic neuroscience approaches with the evolutionary and ecological study of primate behavior.

Other current evolutionary perspectives on development speculate about various aspects of social behavior. One is differences between males and females in their social behaviors, especially mating strategies and parenting behaviors, such as investment in their offspring (Bjorklund & Shackelford, 1999). Other behaviors for which evolutionary arguments have been made are male competition and violence; sex in play, risk taking, and the ability to inhibit behaviors; and parental investment in their children and child abuse (Bjorklund & Pellegrini, 2000).

Discussed below are three evolutionary perspectives currently influencing developmental psychology—cognitive evolutionary psychology, cultural transmission through social cognition, and cognitive immaturity. For additional research programs with evolutionary and biological frameworks, see various chapters in a volume edited by Langer and Killen (1998).

Cognitive Evolutionary Psychology ▪ The evolutionary perspective on cognition has had its impact mainly in recent years, though even Darwin (1890) studied the "mental power" of earthworms. Cognitive mechanisms may be the missing link between evolution and human behavior; that is, evolution may have led to changes in the brain, which changed thinking, which in turn changed behavior. Complex cognitive skills must have evolved to ensure finding a mate, hunting for food, recognizing group members, communicating with others, raising offspring, and cooperating for resources. The organism must attend to, encode, process, store, and access relevant information in order to survive and reproduce. In this way evolution would shape the neural mechanisms underlying cognition. That is, evolution selects for the psychological mechanisms that underlie adaptive social and cognitive behaviors. Cognition, then, serves to increase the chances of survival and reproduction. Thus, an evolutionary perspective is essential for understanding human cognition: "Understanding the process that designed the human mind will advance the discovery of its architecture" (Barkow, Cosmides, & Tooby, 1992, p. 3).

A subtle example of how cognition is critical for adaptation is that animals must cooperate with other members of their species in order to survive. It is important to be able to distinguish between individuals who share their genes (relatives) and those who do not. This requires complex cognitive skills such as remembering specific individuals and figuring out the costs and benefits of interacting with them, especially whether to risk one's life to help them. Cognitive skills also are necessary for group cooperative action, which is critical for gathering food, hunting, and warding off enemies.

Cosmides and Tooby (1987, 1992) are two of the main voices in this area. They have identified *Darwinian algorithms*—evolved cognitive mechanisms specific to particular domains. Each algorithm is "an expert in one area of interaction with the world" (Pinker, 1997, p. 21). The mind is like a Swiss army knife, with different tools for performing tasks well in different domains (Cosmides, 1994). Examples of these "core domains" are face recognition, language acquisition, certain characteristics of objects, and certain types of processing of social information. Infants are constrained (or, more positively, enabled) from acquiring and storing certain sorts of information needed for solving certain sorts of problems. Such behaviors bear some relation to fixed action patterns but are less tightly wired to particular stimuli; Darwinian algorithms are more flexible.

It is important to note that these cognitive skills enhanced adaptation for our ancestral hunters and gatherers: "Our psyche is not built for the present. It resonates to the vibrations of 200,000 generations ago" (Thiessen, 1996, p. 159). We do not do much hunting and gathering these days. Thus, the cognitive skills underlying these activities may not lead to survival and reproductive fitness in present-day humans, many of whom live in urban areas (for example, approximately three-fourths of the U.S. population). Still, we do have these ancestral ways of thinking that continue to influence our development and behavior in a world of shopping malls and computers, and the task of an evolutionary psychologist is to reveal how they are expressed in modern environments. One interesting hypothesis concerning the "modernization" of an ancestral cognitive module is that a module acquired to process information in one domain, such as the acoustical properties of the human voice, may be applied today to another domain, such as music. Music is

may not be essential for survival, but it may come from a module that (Sperber, 1994).

Cultural Transmission, Social Cognition, and Theory of Mind ▪ Evolution often works in subtle ways. By giving humans the ability to acquire certain concepts, it can set the stage for the cultural transmission of knowledge needed for adaptation. In this sense, culturally based adaptation has a biological basis. Cultural change and transmission are particularly important because they can happen much more quickly than standard biological evolution. One recent version of this argument (Tomasello, 1999) focuses on *cultural transmission*, an evolved biological mechanism that enables an individual organism to take advantage of the knowledge and skills acquired over generations by the species. That is, adaptive cultural advances can accumulate over generations. For example, human children acquire the language and tools of their social group. Although young chimpanzees can communicate and learn how to use tools from the adults around them, Tomasello argues that only humans can engage in a cumulative process in which cultural products such as language and tool use develop over many generations. Later humans build on the knowledge of early humans. In this "ratchet effect" (Tomasello, Kruger, & Ratner 1993), social transmission of this knowledge through social learning serves as a ratchet that prevents slipping backward and losing the cultural knowledge. Thus, humans "are able to pool their cognitive resources in ways that other animal species are not" (Tomasello, 1999, p. 5). A simple example, based on evidence from artifacts, is that during human evolution hammers changed from simple stones to stones tied to sticks to modern metal hammers and mechanical hammers (Basalla, 1988).

Tomasello argues that humans have evolved one very special form of social cognition—the knowledge that other humans are like themselves, with intentional and mental properties. Inanimate objects do not have these properties. Once this social cognitive skill evolved, humans could "imagine themselves 'in the mental shoes' of some other person, so that they can learn not just *from* the other but *through* the other" (Tomasello 1999, p. 6). It is critical for children to understand this intentional aspect of others because it permits them to understand *why* others are using a tool or symbol—what the person intends to do with it. They can understand events from others' point of view. With this understanding, children can engage in a human-specific form of cultural learning. Consequently, humans can work together to create new knowledge about objects, quantities, tools, and social relations that cannot be created by a single individual. In the hammer example, humans were able to improve the tool because they understood what the purpose of the tool was (that is, what people *intended to do* with the hammer); they could go beyond simple imitation of someone using a particular type of hammer. Thus, Tomasello argues that a single evolved social cognitive ability permitted cumulative cultural transmission, which caused an explosion of rapid change in the human species that continues today. Indirectly, through this chain of events, a single unique product of evolution has led to modern humans, with all their wondrous positive and destructive knowledge and skills.

Newborns emerge into this situation. In a sense they encounter "ever-new artifacts and social practices which, at any one time, represent something resembling the entire collective wisdom of the entire social group throughout its entire cultural history" (Tomasello, 1999, p. 7). An infant can take advantage of the collective wisdom of the species and "participate in the collectivity known as human cognition, and so say (following Isaac Newton) that she sees as far as she does because she 'stands on the shoulders of giants'" (p. 8). In other words, children grow up surrounded by the very best tools and symbols that the species has developed. Much of development involves the internalization of these tools and symbols. Moreover, humans improve on these cognitive shoulders, and so the intergenerational cycle continues.

Young infants have come to experience themselves as intentional agents—they are trying to achieve some end, such as grasping a rattle just out of reach. Tomasello refers to the "9-month revolution" in which infants begin to understand others as intentional beings. They see others as similarly motivated by goals and thus begin to share attention, with other people, toward objects and events. They are sharing intentions as they are sharing attention. Consequently, they can begin to engage in cultural learning by imitating others. Later, this understanding of intentionality develops into the notion of the self as a mental agent with thoughts and beliefs that can differ from those of other people and from reality. This is, of course, the core notion in a theory of mind. This concept obviously sets in motion all sorts of useful further social and cognitive development, such as metacognition, self-regulation, and the construction of social relationships. Because of these species-specific socia cognitive skills, throughout their development children engage in sev eral types of cultural learning, including imitative learning, instructe learning, and collaborative learning (Tomasello et al., 1993).

In this process, language is particularly important. It transmits to young humans the ways of carving up the world into categories that have proved useful to the species. Another value of a language is that it assigns different words to a situation, thereby teaching children to represent a thing in multiple ways. Tomasello gives the example that a place can be labeled a "coast," "shore," "beach," or "sand," depending on the needs of a person and what he wishes to communicate. In addition to imparting this cognitive flexibility, language ensures that children engage in complex interactions with others that demand negotiation. These interchanges may lead to many useful social and cognitive developments, such as a more advanced theory of mind and the internalization of dialoguelike ways of thinking, described by Vygotsky (see Chapter 7).

Currently, a very active area of research among developmental comparative and evolutionary theorists concerns the similarities and differences between the social cognition of humans and that of other primates. There is considerable genetic similarity: chimpanzees and modern humans, for example, share approximately 99 percent of their genetic material, a proportion similar to that of species pairs such as lions and tigers or rats and mice (King & Wilson, 1975). Nonhuman primates clearly have certain humanlike cognitive and social skills. They can count, communicate, recognize themselves in a mirror, and understand object permanence. They also can deceive conspecifics (members of the same species), engage in pretense, and predict others' behavior on the basis of their emotional states and direction of locomotion. One example of deception is that chimpanzees learned to direct humans to a box without food so that the chimpanzees could obtain the one with food, although learning this took many trials with feedback (Woodruff & Premack, 1979). Also, chimpanzees have been observed pretending to pull an imaginary pull toy and even carefully disentangling the imaginary string (Hayes, 1951). Chimpanzees understand kinship and dominance relations, and they will select an appropriate ally, such as someone dominant over their opponent. Moreover, chimpanzees can be acculturated. Those raised by humans often show more humanlike linguistic and cognitive abilities than do mother-reared chimpanzees (Bjorklund, Bering, & Ragan, 1999; Call & Tomasello, 1999). Finally, monkeys can acquire new behaviors by imitating others. After receiving sweet potatoes, which were often sandy, one young monkey learned to wash them in sea water before eating them. Troop members imitated this and subsequently taught it to infants (Kawai, 1965).

As the above examples show, nonhuman primates clearly have some social understanding and engage in some sort of social learning. The issue is how how to interpret such examples. Tomasello concludes, after surveying the evidence (Tomasello & Call, 1997), that "nonhuman primates are themselves intentional and causal beings, they just do not understand the world in intentional and causal terms" (Tomasello, 1999, p. 19). They do not understand that there are underlying, unobservable physical and mental "forces" that mediate between an antecedent event and a consequent event. Only humans understand that the sharpness of a knife causes food to split in half or that another person reaches for an object because she desires it. Thus, only humans can engage in *cultural* learning. However, some investigators attribute a more advanced social cognition to nonhuman primates because of certain behaviors, such as deceiving conspecifics in order to obtain resources, and other sorts of creative intelligence that seem to reflect this understanding (Byrne, 1995).

A main forum for debates concerning the biological basis of social cognition is children's theory of mind—their understanding of the nature of mental states and activities such as desiring, representing, and believing. Research on biological contributions focuses on normal children versus autistic children and nonhuman primates (e.g., Baron-Cohen, 1995; Povinelli & Eddy, 1996; Whiten, 1998). This "mind-reading" skill clearly is fully developed only in normal humans and has obvious adaptive functions. The ability to interpret other people's behaviors by inferring the appropriate mental state is essential for predicting how someone else will treat oneself, for teaching the young, for engaging in cooperative activities with others, and so on. As discussed above, there is less agreement on whether chimpanzees engage in behaviors that reflect any understanding that people have beliefs (representations), especially ones that are false. Regarding people with autism, these children and adults have trouble interacting with other people. Consistent with this, they perform poorly on theory-of-mind tasks that most 4- and 5-year-olds have no trouble with, although they perform well on other, nonsocial tasks (Baron-Cohen, 1995). Children with mental retardation, such as from Down syndrome, do perform well on the theory-of-mind tasks. Thus, low general intelligence does not underlie the poor performance of autistic children on these tasks. The deficit is specific to the social–mental realm. This evidence taken together may point toward a specific biologically based ability to understand minds.

Advantages of Immaturity ■ From an adult-centric view, children should show behaviors that are adaptive in that they prepare children for adulthood. Yet this may not be true. Some characteristics of infants and children may have evolved because they serve an adaptive function at a particular time in childhood. A case in point is certain reflexes, such as the grasping reflex, that are present in newborns but then disappear several months later after they have served their purpose of aiding survival during that particular period. Another example is the immaturity of young humans. As mentioned earlier, a general ability to learn is more useful to infants at that point in their development than a rigid set of fixed action patterns in response to sign stimuli. It is a risky strategy for the human species, because infants cannot obtain food or flee from enemies. Still, an extended childhood may be essential for learning all that is needed to survive to the age of reproduction in their particular complex and rapidly changing physical and social environment. For example, immaturity during childhood allows time for play. Although play probably has many functions, one may be to provide a sense of mastery and self-efficacy that encourages children to try out new activities and roles. These activities and roles provide opportunities for learning new skills.

This immaturity may play a more subtle role, however (Bjorklund, 1997; Bjorklund & Pellegrini, 2000). For example, young children have poor metacognition. As we saw in Chapter 4, they vastly overestimate how well they perform, even after feedback that they have performed poorly. More generally, until approximately age 7 children unrealistically think of themselves as "one of the smartest kids in my class" (Stipek, 1984). This seemingly nonadaptive characteristic may in fact be quite adaptive. This Pollyanna attitude may encourage them to keep trying to do activities that are beyond their current ability level. In this way they obtain valuable experiences that strengthen their skills. Because they do not expect to fail, they may not be afraid to try out a variety of new activities. Continuing to use strategies that do not yet help them—the utilization deficiency described in Chapter 4—may also reflect children's tendencies to not notice or to disregard negative feedback about their performance.

A particularly striking example of how an apparent deficit in young children actually may be an asset for adaptation in that particular developmental period is the notion of egocentrism, Piaget's concept discussed in Chapter 1. Children's bias toward perceiving and conceptualizing in terms of their own perspective obviously limits social understanding and interaction, but it may help them in other ways (Bjorklund, 1997). Given that people tend to remember better when they relate the information to themselves (e.g., Pratkanis & Greenwald, 1985), egocentrism actually may help young children's recall.

Even toddlers' limited working-memory capacity can be seen as adaptive rather than as a liability (Bjorklund & Schwartz, 1996; Elman, 1994; Newport, 1991). Restricting how much language information can be processed simplifies the language corpus that is analyzed, and this in turn simplifies the process of acquiring language. Children first may acquire single syllables and then gradually deal with more information and increasingly complex information. If children could initially process more linguistic information, they might be overwhelmed by the amount of information and not be able to extract anything useful. In this case, less is more (Newport, 1991).

It is interesting that a connectionist simulation (see Chapter 4) appears to follow the same principle—"the importance of starting small" (Elman, 1994). Elman found that the connectionist network did not acquire a grammatical rule (subject–verb agreement for number) when the initial set of examples was a large corpus of sentences. Only after simplifying the corpus and then gradually introducing complexity did the network learn. Similarly, beginning with a small working memory and then gradually increasing it permitted the network to learn from a corpus of simple and complex sentences. In both cases, initial limitations (in the corpus or working memory) made language learning possible.

Thus, Bjorklund's evolutionary approach leads us to ask certain questions that other approaches do not. Specifically, although certain attributes of young children are nonadaptive in some ways, an evolutionary psychologist would ask whether these attributes might in fact also be adaptive in some way. We tend to see young children's apparent limitations as evidence that they are less advanced than older children and adults. Yet they may be quite well adapted to the demands of the particular developmental period. Bjorklund's argument reminds us that how we view development affects how we see children develop: Do we accentuate the positive or the negative?

MECHANISMS OF DEVELOPMENT

Because ethologists have chosen to focus on behaviors with a strong biological component, they stress biological processes as mechanisms of development. Physical maturation, including hormonal changes,

locomotor development, and increased efficiency of the nervous system, underlies the emergence of sensitive periods or of fixed action patterns at appropriate times. For example, nest-building behavior surfaces when a bird matures to the point where reproduction is possible. All of the biological mechanisms of behavior interact with experience, of course. In addition, innate general and specific learning abilities built into the nervous system allow the organism to profit from its experience.

Although ethologists emphasize biological mechanisms, they also study learned behaviors that lead to adaptation. For example, even if it turns out that dominance hierarchies and altruism in children are entirely learned, such behavior patterns are still of interest because they lead to a socially cohesive group, which is considered an adaptive system.

POSITION ON DEVELOPMENTAL ISSUES

■ *Human Nature*

Human nature is just one hodgepodge out of many conceivable.

—WILSON, 1978, p. 23

Humans are social animals with certain species-specific characteristics. They are biological organisms that have evolved within a particular environmental niche. Human intelligence, language, social attachment, and perhaps even aggression and altruism are part of human nature because they serve or once served a purpose in the struggle of the species to survive. Children's developmental level, therefore, is defined mainly in terms of the biologically based behaviors they possess.

Identifying the theory's world view highlights the differences among ethological theorists. Lorenz stressed the mechanistic, automatic, elicited nature of behavior, such as sign stimuli that elicit fixed action patterns. He drew loosely on the reflex model and the hydraulic or "flush toilet" model (Dewsbury, 1978). Sign stimuli, fixed action patterns, and reflexes were hallmarks of the reflex, mechanistic, stimulus–response model, based on early views of how the nervous system operates. In contrast, Bowlby and many modern ethological theorists are more organismic. Humans spontaneously act to meet the demands of their environment. They actively search for the parent, food, or a mate. Children explore, play, solve problems, and seek out playmates. In Bowlby's control-systems approach, an infant seeks to maintain a certain state, for example, an acceptable degree of proximity to the caretaker. Finally, the theory is contextual in its focus on the links between the species' distant evolutionary history and the present and on the nature of the organism's immediate physical and social setting, to which it must adapt.

■ *Qualitative Versus Quantitative Development*

Ethology allows for both qualitative and quantitative change. It is not a stage theory and therefore does not posit large-scale qualitative changes in development. In a sense, there is qualitative change when biological maturation proceeds to the point where a sign stimulus triggers a fixed action pattern that has never appeared before. In this way, a new behavior appears in a more or less discontinuous fashion. Qualitative change also occurs when a system is expressed in different behaviors as the child develops. One such instance is attachment, the desire for which is expressed at first by crying or smiling and later by crawling toward the mother or talking to her. The underlying attachment, however, is changing quantitatively, usually toward increased organization, security, and efficiency.

■ *Nature Versus Nurture*

Although ethologists focus on the biological basis of behavior, like most of the theorists in this volume they are interactionists with respect to the effects of heredity and environment. The genotype and the environment operate together to produce changes in children over their lifetime. One implication of this interaction is that a particular experience has more impact if it occurs during a relevant sensitive period rather than at another time. Moreover, a given genotype is expressed differently in different environments. Also, one way to think about the importance of the environment is to note that it selects for or against genetic mutations that occur.

To complicate matters even more, genotypes influence what sort of environments people select; children seek environments that are compatible with their genotype. These selected environments in turn affect the expression of the genotype and also define the nature of th

settings to which people must adapt. Still, many behaviors are similar within a species because its members tend to have similar environments. In a sense, children inherit not only genes but also the "expectable" environment within which the species evolved that particular set of genes. It is the fit between the genes and a particular environment that is adaptive, not just the genes themselves. For example, ducklings still in the egg who are prevented from hearing both their mother's vocalizations and their own cannot recognize the call of their own species after birth (Gottlieb, 1976, 1991, cited by Bjorklund, 2000a). Ducklings with normal rearing can recognize the species' call because they inherit not only a genetic predisposition to do so but also the environment typical for their species, which provides the relevant experiences for expressing this predisposition.

Evolutionary theories' emphasis on the biological adaptiveness of human traits does not mean that the current human situation is "natural" and thus should be retained. Evolved human traits are not necessarily *ideal* adaptations. They are simply the best that the species could do, given what it had to work with.

■ *What Develops*

The most important behaviors to develop are species-specific behaviors that are essential for survival. These include such behaviors as social attachment, dominance–submission, eating, mating, social cognition, and infant care. Both general abilities to learn or process information and specific behaviors such as fixed action patterns or domain-specific cognitive algorithms are applied to the environment at hand. The theory seeks to explain similarities in what behaviors are acquired and how they develop in all humans and in both humans and other animals. The focus has been on what is universal for a particular species. Although interspecies differences in development are of interest, little attention is given to individual differences within a species. Phylogenetic outcomes constrain the range of possible differences between cultures or within a culture.

APPLICATIONS

Ethological work on attachment has had the most impact on real-life topics such as orphanages, adoption, day care, prolonged separation from the mother, and early contact between mother and child. Bowlby found pathological behaviors in children when they did not receive adequate attention from a caretaker early in life. Contemporary attachment research has identified lifelong relationship problems stemming from disordered early relations between mother and child. A main implication for parents is to respond promptly and appropriately when infants signal their needs. For a securely attached child, a parent serves as a safe base from which to explore the environment and establish independence. Parents should be sensitive to their children's emotional needs during separation caused by hospitalization or other events.

Charlesworth's work on children's strategies for obtaining resources provides a new perspective for thinking about children who have mental or physical limitations or who come from physically or psychologically impoverished environments. Such children may be at a disadvantage in obtaining the resources necessary for satisfactory development.

EVALUATION OF THE THEORY

■ *Strengths*

Both realized and potential contributions of ethology to developmental psychology are explored in three areas: theory, method, and content.

Theoretical Contributions ▪ Ethology broadens our perspective on what constitutes an explanation of development. We can fully understand the child's behavior only if we expand our vision to include a larger space (the larger social context) and a larger time span (the history of the species). Tinbergen (1973) has identified four types of questions about the causes of behavior that developmentalists should try to answer about their topic of study. The questions are based in part on the time span involved, which varies from seconds to centuries. These "four whys" pertain to causes that are immediate, ontogenetic, functional, and phylogenetic.

1 *Immediate* causes are the antecedent external or internal events that come directly before the behavior. An infant smiles after viewing a human face or cries as a result of hunger pangs. Physiologically based motivation states are common immediate causes.

2 *Ontogenetic* causes encompass a longer time span—the genotype and the environment interact to produce changes in behavior over the child's lifetime. In this process, earlier events contribute to

later events, as when a secure attachment may later on allow the child to explore new environments confidently and even later encourage various independent behaviors.

3 *Functional* causes involve the immediate adaptive value of a behavior. An ethologist asks, "What is this behavior trying to achieve?" Children behave in certain ways in order to obtain food, protection, desired resources, and so on.

4 In *phylogenetic* causation, the cause of a behavior lies in the earlier forms of the behavior as it was shaped over generations as a result of the food supply, types of predators, mating patterns, and so on. Thus, a developmental psychologist seeking a phylogenetic cause of sex differences in behavior would consider environmental pressures in the early history of the human species.

Most developmental research has examined immediate causes or ontogenetic causes rather than phylogenetic causes or the behavior's functions (immediate function or survival value). Development cannot be completely understood, however, until researchers identify all these functions and causes. With the exception of Gibson, socioculturalists, and person-in-context approaches (see Chapter 8), most theories either have ignored the larger context of behavior or have simply acknowledged its influence but have not studied it. Piaget was concerned with adaptation to the environment but did not link it to evolutionary processes.

Related to the notion that there are various valid types of causes is the belief that there must be various levels of analysis of behavior. The organism, with its genetic, physiological, psychological, and behavioral aspects, is part of a system that includes the environment, with its physical, interpersonal, and cultural aspects (Hinde, 1992). Therefore, ethologists study each of these levels and their interaction, with the ultimate aim of understanding the entire organism–environment system. Each level of analysis contributes to our understanding of behavior and has its own set of principles. Behavior can never be reduced to any single level, such as the physiological. Only a theory with multiple levels of analysis is likely to disentangle the complex interweaving of innate and environmental forces during development. Although human developmental research currently proceeds at all these levels, progress at relating the various levels has been very slow. Ethological principles, because they concern many levels and their interrelationships, are potentially a unifying force in developmental psychology.

Ethology's focus on the function of behavior helps the investigator relate a child's behavior to its natural context. The way that investigators think about children's aggressive behavior changes if they discover that one of its functions is to increase the overall stability and cohesiveness of the group. The focus changes from a problem in the child to a feature of human groups. Thus, looking at function gives a broader context in which to embed a particular behavior.

Questions about function usually lead to questions about adaptation. Eibl-Eibesfeldt (1975) argues that ethology can fruitfully study cultural adaptation as well as the biologically based phylogenetic adaptation that is the theoretical core of ethology. Most human behaviors are not a matter of life and death. Few behaviors of the human child literally and directly avoid predators or avert starvation or exposure. Moreover, today infants with mental disabilities, poor health, or physical disabilities may survive and reproduce. In short, many of the evolutionary forces that operate on other species are less influential for human survival. Thus, the notion of adaptation in humans may be most fruitfully applied to the question of how behaviors taught by a society produce *optimal adaptation* (rather than biological survival). Optimal adaptation might include happiness, a feeling of competence at play, success at school, efficient use of tools (for example, eating utensils, scissors, and pencils), and so on. When Charlesworth studied how children solve problems, he did not see mistakes and inefficient problem solving leading to death and success leading to survival. He did, however, see how infants, by applying their intelligence, increase their control over their physical and social environment. If ritualistic behaviors, such as greeting, giving gifts, and communicating dominance or submission to others, lead to a more stable group, they are of interest to ethologists even if they turn out to be culturally based rather than biologically controlled adaptations. As these examples illustrate, looking at phylogenetic adaptation in other species can suggest hypotheses about cultural adaptation in humans.

Methodological Contributions ▪ What can we learn from scientists who spend hours staring at crabs and birds? The most timely contribution of ethology is its method of observing behavior in its natural context. As Charlesworth commented, "the lab coat and microscope used

to isolate biological variables to generate universal principles are no more important to acquiring understanding of the biological nature of human development than walking shoes and a clipboard used to discover organism–environment connections to identify significant individual differences in adaptation" (1992, p. 13). The field of developmental psychology has slighted its natural-history phase, which would have established a database. It has been suggested that the field moved too quickly into its experimental phase. Bronfenbrenner characterized much of developmental psychology as the "science of the strange behavior of children in strange situations with strange adults for the briefest possible periods of time" (1977, p. 513). Ethology can play a heuristic role in the field's relatively new interest in ecology. Although it certainly is not new for developmental psychologists to observe children at school or at home (for example, Barker & Wright, 1955), ethology provides *theoretically based* observational methods that supplement the more common empirical, atheoretical descriptions of ongoing behavior. Ethology suggests which behaviors are most important, stresses the need to note what environmental events precede and follow the behavior, and provides a detailed analysis of how the organism and environment interact. Such an analysis can show exactly how infants and their parents control and modify each other's behavior. It also describes the structure of the behavior and suggests how behaviors can be classified and compared with other species, cultures, or ages. In addition, federal social policy relevant to children badly needs a description of the present environments of children and an understanding of how these environments enhance or disrupt development.

Ethological observations of, for example, everyday problem solving can fruitfully be combined with traditional developmental laboratory methods and intelligence tests. Developmental psychologists, particularly those studying cognition during childhood, have relied too heavily on the questioning of children. As Charlesworth comments, "As soon as a research subject has the appropriate Piagetian operations and can talk, researchers stop observing and start asking. It's less strenuous that way" (1988, p. 298). Ethological observation could reveal how children vary in the form of a behavior, its time of acquisition, and its frequency. Another possibility, largely untapped, is ethologically based longitudinal research, in which the same children are observed over a period of months or years. This method could identify continuities and discontinuities not only in the child's behavior—the usual focus of longitudinal studies—but also in the child's environment and the interaction between the child and the environment. Ethology includes a changing physical and social world as well as a changing child in its account of development. The social environment changes its demands on the child during development, and the frequency of certain child behaviors changes.

The criticism in Chapter 4 that information processing is decontextualized points to the need for observational studies of cognitive and perceptual development. As an illustration, consider what ethologically oriented observational studies might contribute to the understanding of the development of attention. Developmental psychologists nearly always examine attention in the laboratory. They typically examine infants' preferences for attending to one of two stimuli placed in front of them or older children's attention to physical attributes, such as shape, color, or size. The child looks preferentially at one object rather than another, sorts the objects, or tries to remember them. An ethologist, in contrast, would ask the following questions: What types of objects or events does the child look at or listen to at home and at school? What events elicit attention, maintain it, and end it? What events distract the child? How often do distractions occur? Does efficient attention lead to efficient problem solving or other adaptive behaviors? How does attentional behavior differ from setting to setting? Does playful, exploratory attention resemble that observed in other primates, humans of other ages, and other cultures? We know, for example, that ethologists sometimes can infer the dominance hierarchy from who looks at whom and for how long.

Such questions are seldom, if ever, raised in studies of attention. The questions about how attention actually operates cause a shift in focus that makes previous research appear narrow and stripped of context. Paralleling Charlesworth's ethological studies of intelligence, it is likely that many distractions and other events controlling attention are social and dynamic, rather than nonsocial and static, as is assumed by laboratory researchers. Laboratory studies tell us what *can* happen during the attentional process. Ethological studies tell us what in fact usually *does* happen and what function the behavior has. Such studies suggest new variables to be examined in depth in the laboratory. In a similar way, ethological methods could be applied fruitfully to the other theories examined in this volume. We know little about the natural context of the spontaneous occurrence of defense mechanisms, mathematical reasoning, memory strategies, visual search for objects, and operant conditioning. A final example is the recent work on children's theory of mind. Although we now know a great deal about children's developing

understanding of the mind, we are only beginning to study how they actually use this knowledge in their daily lives to function effectively in their social environment.

Content Contributions ▪ Ethology has influenced developmental psychology by bringing certain content areas to the attention of investigators. Bowlby's ethological account of attachment challenged learning theory and stimulated hundreds of studies not only of attachment but also of such related topics as sensitive periods and later social competencies, self-concept, and theory of mind. Also, ethology brought new life to research on peer interaction (for example, dominance hierarchies). In addition, ethology pointed out overlooked behavior such as averting one's gaze, hunching one's shoulders, sticking out one's tongue, and regulating the distance between the self and the mother. More distant causes that developmentalists have begun to examine include the evolution of self-knowledge and deception and the development of reproductive strategies (Bjorklund & Pellegrini, 2000). Finally, evolutionary approaches are aware of the importance of kinship relations, while experimental developmental psychology gives little attention to this social structure other than parent–child and, occasionally, sibling relations.

■ *Weaknesses*

The following are critical shortcomings in theoretical, methodological, and substantive areas that must be addressed by ethological theory if it is to fulfill its promise as a theory of development. Some of these shortcomings merely reflect a lack of developmental research in certain areas; others are more serious because they reflect the incompleteness of the theory itself.

Theoretical Limitations ▪ As is true of other theories, ethology describes more than it explains. Many of the ethological notions that are most useful to developmental psychology require further elaboration if they are to serve as specific explanations of development. For example, concluding that children acquire a behavior "because" they are in a sensitive period is similar to concluding that they acquire conservation because they are in the stage of concrete operations. These general descriptive notions are only a first step. Invoking a sensitive period does not explain why the organism is pretuned to certain experiences at one

time rather than another. A sensitive period must be understood not as a particular period of time but as a particular developmental level. A developmental level is a specific organization of capabilities that allows the [illegible] to interact with the environment in certain ways but not other ways. We need to be able to specify in a detailed way the exact process by which sensitive periods operate. What causes them to begin, have their effect, and end? More generally, what moves development along? Are the effects of extra contact between mother and infant in the first few hours after birth due to biological, perceptual, or cognitive variables or all these variables in interaction?

The lack of detailed explanation also can be seen in an example drawn from a typical topic of ethological research: the dominance structure of peer groups. By what process do children detect and understand the existence of this hierarchy and their own place in it? How do they use feedback from their interactions with other children in order to adjust their subsequent behavior? For example, the development of transitive reasoning ($A > B > C$ . . .) may be related to the perception of the dominance hierarchy in groups (Edelman & Omark, 1973). Since most human behavior is cognitively mediated, we need an account of the cognitive processes involved when social cues in the environment are interpreted and influence subsequent social behavior. In other words, how is information about the environment assimilated and linked up with behavior?

Similarly, in the area of attachment, there are no clear theoretical predictions as to what specific aspects of a secure or insecure attachment should predict what specific future social competencies. For example, "It is as important to determine what a secure attachment does *not* predict to, and why, as it is to understand its network of predictable consequences" (Thompson, 1998, p. 48). If it is true that different attachment patterns are adaptive for different environmental situations, then the expected long-term outcomes of each attachment type are less than obvious. Moreover, the specific mechanisms by which a child's early attachment leads to a particular set of outcomes need to be specified in more detail.

Another problem concerns identifying the function of a behavior. The phylogeny of anatomical structures can be gleaned from fossils, but we have no fossils of human behavior. At best we can examine other primates, contemporary hunter-gatherers, skulls, and archeological data such as diseases, housing, social structure, age distributions, and tools. We can speculate about how an upright stance, enlarged brain area, and

increasingly sophisticated tools reflect changes in human behavior in our history. We can hypothesize what sorts of cognitive demands were made on early hunters and gatherers and the extent to which these demands are similar to or differ from those in modern human environments. What was adaptive generations ago may not be adaptive today, however.

To add a further complication, since the selection pressures differ at different ages, it is necessary to infer the adaptation for a particular developmental period. That is, one must make comparisons between human ancestral infancy and current infancy, between ancestral childhood and current childhood, and so on. It has been argued (Bjorklund & Pellegrini, 2000; Geary, 1995) that differences in ancestral and current environments may explain why some children have trouble adjusting to certain aspects of formal schooling that are not "natural," such as reading and higher mathematics. Some (Jensen et al., 1997) have even proposed that attention-deficit / hyperactivity disorder (ADHD) may consist of tendencies that were adaptive in early humans. Rapid scanning, quick responses, and high motor activity work better for monitoring threats and escaping from enemies than for reading and concentrating on homework.

Another problem with identifying a behavior's function is that the behavior may have a delayed function that cannot be validated until much later. For example, one function of attachment is to establish the mother as a secure base for the child's exploration later on. Moreover, the function of a behavior may be far from obvious. "Morning sickness" and the food aversions associated with it during early pregnancy may protect the fetus from toxic foods at a time when it is most vulnerable (Profet, 1992). Food aversions are most common for foods high in toxins. Moreover, women who have morning sickness have fewer spontaneous abortions than do pregnant women who do not (Weigel & Weigel, 1989).

It is important to note that not all behaviors are the result of evolution, and thus not all behaviors aid survival. A behavior may be an expression of some adapted cognitive mechanism that in fact did evolve, as in the example of music from a linguistic–acoustic processing module mentioned earlier. Or the behavior may have co-occurred with another behavior that was adaptive. As long as it did not hinder survival, it would continue to be transmitted across generations. Moreover, some characteristics that humans have retained during evolution because they

held benefits also have certain costs. A cognitively flexible infant is also an at-risk organism because of reliance on adults. It is believed that benefits must outweigh costs in order for such characteristics to be retained.

Methodological Limitations ▪ One obvious limitation to applying ethological methods to humans is that the most critical experiments are unethical. We cannot perform deprivation experiments such as preventing an infant from seeing a human smile for the first few weeks of life in order to see if the social smile is innate. In an early misguided experiment, Frederick II (1194–1250) raised babies in silence and near isolation to find out if there is a "natural" human language. The babies, not surprisingly, died before the outcome was clear (Wallbank & Taylor, 1960). Instead of deprivation experiments, we must rely on naturally occurring deprivation, such as infants born blind or deaf, or maternal absence during early infancy. Bowlby's hypothesis concerning the effects of disrupting the early bond between mother and infant cannot be evaluated adequately because this event is confounded with changes in the organization of the entire family, economic changes within the family, changes in the father's behavior, the mother's detachment from the infant when she returns because she has changed during her long illness, and so on. For ethical reasons the necessary experimental manipulations cannot be performed.

Another limitation to applying the methods of ethology lies in three basic problems inherent in observational research. First, it is difficult, often tedious, research to do. One must invest large amounts of time and effort in videotaping, making detailed descriptions of the behavior, classifying the behavior, and establishing adequate interobserver reliability as to when the behavior begins and ends and how it should be classified (for example, as fear). Furthermore, it may be necessary to observe children in many different settings to obtain a description of typical behavior because it is not clear what constitutes a "natural environment" for children in a highly technological society. Should we study children running through a meadow, sitting in a classroom, or playing electronic games? Finally, so many events may be occurring simultaneously that not all the behaviors can be attended to and recorded. Even taping may miss certain important behaviors, such as facial expressions. In short, a comprehensive, detailed ethogram of a species is a large undertaking. As Charlesworth notes, "Unlike most tests, which throw ou

a small net with a small mesh, the present method throws out a big net with a small mesh and thereby catches many small fish. Herein, of course, lies a big problem of effort and cost. The net gets awfully heavy very quickly" (1979, p. 522).

A second problem with applying the observational method is that with humans there is a danger that the very presence of the observer changes the child's behavior. This is less of a problem when children are involved in group activities of interest to them and have become used to the observer's presence.

Third, there are conceptual problems in dividing the stream of behavior into units. It is not always clear what behaviors are relevant. An observer unfamiliar with Bowlby's work might well record that the infant crawled to the door of the adjoining room but would probably not record the distance between the mother and the infant. If one is interested in dependency behaviors, does one include touching others, looking at others, or asking for help? A related problem is that many behaviors have multiple meanings. When one child hits another child, this behavior may function as a sign of aggression or affection or playfulness.

Content Limitations ▪ Certain psychological phenomena that are not consistently reflected in spontaneous behavior may not be easily studied from the ethological perspective. Charlesworth found it necessary to limit his investigation of problem solving to overt behaviors, such as removing a physical barrier blocking a desired object. Since behavior becomes more mediated and motivation becomes more complex with increasing age, observation of overt behavior may in general be more informative in infants and toddlers than in older children.

SUMMARY

Ethology, along with other evolutionary perspectives, is one of zoology's main contributions to developmental psychology. Thousands of hours spent observing animals have revealed important concepts concerning behavior. Each species, including humans, has a set of innate behaviors, specific to that species. These behaviors have evolved phylogenetically because they have increased that species' chances of survival in its particular environment. Some of the most important behaviors are social, such as mating dances, imprinting, dominance behaviors, and some forms of communication. Of particular interest are fixed action patterns elicited by sign stimuli. Even learned behaviors have a strong genetic component because each species has particular learning predispositions in the form of sensitive periods or general and specific learning abilities. Ethologists study behaviors by conducting both observations in natural settings and experimental studies in laboratories.

The ethological point of view has most influenced developmental psychology by stimulating work on attachment. There is some evidence that the very young infant and the adult are pretuned to respond to each other. This work has expanded to include the long-term effects of each pattern of attachment, individual differences, the role of fathers, bonding in newborns, and other social and social cognitive behaviors. Observation of dominance hierarchies in mammals and other animals has led to studies of the human peer group, especially in preschool groups. Investigators also have asked what kinds of problems children attempt to solve and how they try to solve them in natural settings. Main examples of contemporary developmental approaches are cognitive evolutionary psychology, the adaptive advantages of immaturity, and the biological basis of cultural transmission, especially regarding social cognition and theory of mind.

With respect to developmental issues, ethologists see humans as a species that has evolved in order to survive within a particular environmental niche. Theorists vary in whether this adaptation is primarily passive, in response to drives or sign stimuli, or active and self-regulating. Behavior changes both quantitatively and qualitatively as innate and environmental factors interact during development. The result is an organism that can operate efficiently within its environment.

Ethology has several strengths to offer the current field of developmental psychology. With respect to theory, it provides a broad evolutionary perspective on behavior that has encouraged investigators to look at the function of children's behaviors. Ethologists advocate more observational studies of children in natural settings in order to determine the function of particular behaviors. A final contribution is the identification of several content areas as particularly important in development, such as dominance hierarchies, attachment, and cognition.

Ethology has certain weaknesses, however, that limit its usefulness for developmental psychology. Its theoretical notions, such as sensitive periods, have not yet reached an explanatory level. With respect to methodology, the observational method poses difficulties, and deprivation experiments are not possible with humans. Finally, ethologists find

it difficult to study certain aspects of development, such as language and abstract thought in older children.

In conclusion, ethology is a fruitful source of working hypotheses about what behaviors are important and why they are acquired. An ethological attitude opens the investigator's eyes to a broad context that spans space and time and various levels of analysis. In particular, ethologically based observations in the early phases of a research project can give the "big picture" of the behavior that will later be studied in a controlled laboratory setting.

SUGGESTED READINGS

The following readings survey evolutionary, including ethological, research on humans and animals:

Eibl-Eibesfeldt, I. (1989). *Human ethology*. New York: Aldine de Gruyter. This 848-page book provides a comprehensive journey, with many photographs, through work on human ethology. Much research on children is included.

Bjorklund, D. F., & Pelligrini, A. D. (2000). Child development and evolutionary psychology. *Child Development, 71,* 1687–1708.

Smith, P. K. (1990). Ethology, sociobiology and developmental psychology: In memory of Niko Tinbergen and Konrad Lorenz. *British Journal of Developmental Psychology, 8,* 187–200. Smith presents an interesting historical account of the main leaders and ideas in ethology.

The following works focus on attachment:

Ainsworth, M. D. S., & Bowlby, J. (1991). An ethological approach to personality development. *American Psychologist, 46,* 333–341. In this interesting article the authors provide a historical account of their research and theorizing on attachment.

Bowlby, J. (1982). *Attachment and loss: Vol. 1. Attachment* (2nd ed.). New York: Basic Books. This classic work is Bowlby's influential statement about attachment.

Cassidy, J., & Shaver, P. R. (Eds.). (1999). *Handbook of attachment*. New York: Guilford Press.

The chapter cited below describes contemporary models of genetic and environmental interactions during development:

Gottlieb, G., Wahlsten, D., & Lickliter, R. (1998). The significance of biology for human development: A developmental psychobiological systems view. In W. Damon (Series Ed.) & R. M. Lerner (Vol. Ed.), *Handbook of child psychology: Vol. 1. Theoretical models of human development* (5th ed., pp. 233–273). New York: Wiley.

Lorenz delights us with this account of his life with animals:

Lorenz, K. Z. (1952). *King Solomon's ring*. New York: Crowell.