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FROM MATING TO MENTALITY

Evaluating Evolutionary Psychology

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Evolutionary Cognitive Science

Adding What and Why to How the Mind Works

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Students who take a general psychology course often ask: How does this all fit together? Why in the world does one course range over neural biochemistry, cognitive development, group decision making, and sex differences in aggression? More broadly, how do all the scattered tidbits of wisdom in their psychology courses fit with what they are learning in their anthropology, biology, and economics courses? Psychology textbooks have not traditionally provided an overall framework that would answer these questions. Instead, typical texts have proceeded from one set of empirical findings to another. "We're done talking about neurons and hormones, now let's jump over to talk about babies and their mothers, and then let's skip to Pavlov's dogs."

Even when students advance to a course in a particular subdiscipline, such as social psychology, they again confront isolated findings rather than an integrated whole. When the first author entered the field, one of his advisors informed him that social psychologists favor minitheories. Indeed, the minitheories dealing with aggression, attraction, stereotyping, and leadership proved to be as remote from one another as they were from mini-theories about vision, psycholinguistics, or schizophrenia in the other subdisciplines. Our colleague Bob Cialdini likens a typical social psychology text to a three-ring circus—entertaining and bedazzling, but without much of a plot.

During recent decades, there have been three attempts at conceptual integration involving different areas of psychology. Cognitive science represents an interdisciplinary fusion of ideas from cognitive psychology, artificial intelligence, philosophy of mind, linguistics, and several other fields (Anderson, 1980; Gardner, 1985). Evolutionary psychology is a synthesis of developments in ethology, cognitive psychology, evolutionary biology, and anthropology, with tributaries from animal learning as well as social, developmental, and environmental psychology (Buss, 1999; Cosmides, Tooby, & Barkow, 1992; Pinker, 1997; Shepard, 1992; Sherry & Schacter, 1987). Dynamical systems theory, or complexity theory, has roots in computer science, ecology, mathematics, and physics, and its implications have been explored in fields as diverse as economics, genetics, and social psychology (Lewin, 1993; Nowak & Vallacher, 1998; Waldrop, 1993).

We believe the behavioral sciences stand on the brink of a meta-synthesis that will unite these three developments, and in the process provide psychology's long-awaited integrative paradigm. Later in this chapter, we present the outlines of an evolutionary dynamic psychology (Kenrick, Li, & Butner, 2003; Kenrick, Maner, Butner, Li, Becker, & Schaller, 2002). We argue that such attempts at grand synthesis are not just a luxury, but a necessity. If researchers don't stand back to look at the big picture, they will miss the significance of the research details they're staring at through their magnifying glasses.

This chapter proceeds in three sections, and make eight partially overlapping points. Two points deal with very general questions about why the mind works.

1. *The assassination of Archduke Ferdinand in Sarajevo on June 28, 1914, did not really start World War I.* As our high school history teachers taught us, we need to consider ultimate or background factors to understand the significance of a proximate cause. When asking about the structure and function of living organisms, including behavior and cognitive processing in *Homo sapiens*, that means putting present events in the broader context of evolutionary history. We have to ask the deeper "why" questions, and not be satisfied with a 1-day window on the news.

2. *The war is over, we all won.* The wider perspective of evolutionary history is essential in limiting our hypotheses, and helping us understand how structure and function go together. But this is not to say that psychologists should drop their laboratory experiments on attention, learning, decision making, or social interaction, buy pith helmets, and march off to Africa to live among the chimpanzees or dig up australopithecine bones.

Four of our points deal with what the mind works on.

3. *The mind is not a blank slate, it's a coloring book.* An ever-broadening base of findings suggests that humans come into the world prepared to selectively attend to, perceive, and remember some things more readily than others, and to respond to those things with innate, albeit flexible, decision-making mechanisms.

4. *The human brain is not designed to recognize printed words presented at 250 msec.* Part of the human heritage makes it possible for us to learn to process printed words, and the study of word recognition has been foundational for modern cognitive psychology. However, understanding word recognition is not sufficient for an understanding of most of the things humans are naturally inclined to think about.

5. *Human reproduction is more than just copulation.* Ultimately, evolution is about differential reproduction. But that hardly means that evolutionary psychology applies only to topics such as sexual attraction and mate selection. Our ancestors reproduced successfully only after a lot of talking, negotiating, navigating around in space, and learning about the trajectories of flying objects. Hence, an evolutionary approach to psychology is relevant to the entire field, not just selected areas of social psychology.

6. *Six minds are better than one.* Evolutionary studies of birds suggest that even their relatively parsimonious little brains process different types of information in very different ways, using different software packages and different hardware components (Sherry & Schacter, 1987). Likewise, human information processing is modular in important ways.

The last two points caution that we mind our misconceptions about evolutionary psychology.

7. *Reductionism ain't what it used to be.* Contrary to one commonly promoted misconception, evolutionary psychology is not about isolating single genes. Instead, it is about using an adaptationist perspective to help understand complex living organisms interacting with other complex living organisms in interconnected networks. To better understand how that all works, we need to integrate insights from dynamical systems theory with those of evolutionary psychology.

8. *The dynamical adaptationist map: Don't leave home without it.* This point will bring us full circle back to Sarajevo and Archduke Ferdinand. Graduate training in psychology equips researchers with analytical tools for dissecting and isolating single proximate causes of behavior. These tools are useful, but if one doesn't take an occasional look at the map, it is easy to lose the way and to make incomplete and sometimes misleading conclusions about where the local roads begin and end.

WHY THE MIND WORKS

An evolutionary perspective suggests that psychologists reconsider the point at which they are happy with a causal explanation, favoring a set-point relatively closer to the ultimate than the proximate end of the spectrum. But this is not to suggest that research addressing proximate mechanisms should be abandoned, or that evolution somehow trumps cognition, learning, or culture.

The Assassination of Archduke Ferdinand Did Not Really Start World War I

Historians point to the assassination of Archduke Francis Ferdinand as the event that ignited World War I. But a student asked to intelligently discuss the causes of that war would get a failing grade if he answered: The assassination of Archduke Ferdinand, period, and then moved on to the next question.

Causal explanations can be arranged along a continuum from "proximate" to "ultimate." Proximate explanations focus on immediate precipitating circumstances, such as Archduke Ferdinand's assassination. Ultimate explanations focus on background factors that give meaning to those proximate effects. In the case of World War I, the background factors that gave significance to a murder in the Balkans included increasing nationalism in Europe in combination with a network of military alliances. A satisfying explanation connects proximate effects with what we might call their root causes.

Perhaps because we have been infatuated with the control offered by the experimental method, and perhaps because of the strong influence of behaviorism during the last century (which eschewed inferences about hidden causes in favor of empirical measurements of the immediately observable), psychologists have often been satisfied with proximate explanations. But looking too closely at a phenomenon leads us to incomplete, and sometimes even incorrect, conclusions.

For example, before the cognitive revolution, social psychology was dominated by behaviorist models. Behaviorists, by definition, were opposed to the practice of searching for "underlying causes," and would stop searching when they determined that a particular class of stimuli would increase or decrease the probability of a response. The most popular theory of interpersonal attraction was inspired by behaviorist principles, and viewed attraction in terms of very simple principles of classical conditioning (Byrne, 1971). In that model, people were seen as attracted to physically attractive others because attractiveness was "rewarding," and sure enough, experiments demonstrated that people would work harder to gaze at good-looking than less good-looking people, and that it made people feel good to gaze at good-looking others (e.g., Byrne, London, & Reeves, 1968; Dion, 1977).

However, the reinforcement-affect theory told us little about why certain features are judged as physically attractive in the first place. And it also begged the question of why the features that make for an attractive woman are sometimes very different from those that make for an attractive man (consider jaw size, shoulder size, and waist-to-hip ratio, for example). When asked why certain features are rewarding, social learning theorists assumed that it was a function of a past history of rewards—the models in advertisements having fun at the beach were tall athletic-looking people with shiny hair, smooth skin, and small waists as opposed to short people with thin arms, large waists, dry hair, and pock-marked skin. To prove a causal role for such learning factors, it would be necessary to show that attractiveness preferences differ among people who have had differing amounts of exposure to such social stimuli. We are not aware of any social learning theorists who made such tests. However, Cunningham and his colleagues have collected cross-cultural data on attractiveness judgments that are not consistent with this assumption, but instead suggest some common criteria for attractiveness across different cultures (Cunningham, Roberts, Barbee, Druen, & Wu, 1995).

Moving to a slightly less proximate level to explain attraction, some social psychologists have invoked the concept of "culture" (which can be conceptualized as a lifetime of learned reward contingencies). It is in fact easy to observe that many preferences are shared by everyone in the local culture, and the cultural genesis theory was often accepted as the ultimate cause without further ado. American social psychologists, for example, had frequently explained gender differences in mate preferences in terms of the current norms of North American culture. But these explanations were rarely based on comparisons across the range of human cultures. With regard to age preferences in attraction, for example, Kenrick and Keefe (1992) found a number of problems with the existing explanations, most of which focused on local cultural determinants. To begin with, most psychologists had slightly mis-described the phenomenon by saying that men are attracted to women who are slightly younger, whereas women are attracted to men who are slightly older. This pattern indeed seemed to fit with obvious norms in American society. One team of researchers, who observed a difference in preferred ages stated by men and women in singles ads, explained the difference in terms of "traditional sex-role specifications . . . frequently valued as sex appropriate in American Society," which specify that women should "look up to" their partners (Cameron, Oskamp, & Sparks, 1977, p. 29). Deutsch, Zalenski, and Clark (1986) similarly speculated about a "double standard of aging" in our society.

In the face of additional data generated from an evolutionary perspective, though, the theory that age preferences originated in American cultural norms in which women look up to men and men look for women with less power started to unravel. For one thing, teenage males, normally very sensitive to sex-role norms, didn't seem to get it. Teenage boys are attracted to relatively older women in their twenties, even though they realized that these women had no reciprocal interest in them (thereby violating the normative and reward theories) (Kenrick, Gabrielidis, Keefe, & Cornelius, 1996). And men in their twenties hardly had an aversion to women a couple of years older, on average advertising for women up to 5 years older (Kenrick & Keefe, 1992). It was only older men who showed a strong preference for relatively younger women, and that preference got stronger and stronger as the men aged, so that men above 40 were not generally interested in women their own age at all, but sought much younger women. Furthermore, data from a number of different cultures and historical periods revealed the same general pattern found in North America. Indeed, as one got further away from modern urban societies such as the United States and Holland, older men's preference for younger women tended to get stronger rather than weaker. For example Kenrick and Keefe (1992) examined data from the U.S. and the Philippines (Fig. 2.1).* Since then, other researchers have replicated the pattern in Africa, Asia, and South America (e.g., Harpending, 1992; Otta, Queiroz, Campos, daSilva, & Silveira, 1998).

We believe a more parsimonious explanation of age preferences in mates requires a move far beyond the proximate realm, considering human mate preferences not simply in terms of rewards or local norms, but in terms of the conditions of human reproduction. Human beings, unlike 95% of other mammals, tend to pair up to care for their offspring. Both males and females contribute to those large-brained offspring, but they contribute slightly different resources. A woman contributes direct bodily resources, carrying the fetus inside her body and afterward nourishing it with the rich milk produced by her body. A man can do neither of these things, but can contribute indirect resources, such as food and shelter. Women's ability to carry and nurse children is low before the full onset of puberty, very high throughout the twenties, and then progressively drops in the thirties and forties until it completely terminates in menopause. Men's ability to gather food and gain positions of trust and status within cooperative alliances is low when they are teenagers, and tends to increase with age (at least until senescence). Hence, women at all ages are attracted to men who are somewhat older. Young men, like women, are attracted to relatively older partners, whereas men in their twenties are attracted to women of their own age, and men over 30 are attracted to relatively younger and younger women.

Consider the interesting case of the Tiwi of North Australia, which at first glance seems to be an exception to the pattern. Among the traditional Tiwi, a young man often married a much older woman (Hart & Pillig, 1960). Do Tiwi preferences actually violate the seemingly parsimonious life history model that Kenrick and Keefe (1992) laid out? As it turns out, the unusual cultural prac-

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*Although marriage data from the U.S. sample indicated that males had brides younger than themselves—and that this tendency was more pronounced the older the male—the trend was even more evident in the sample from the Philippines.

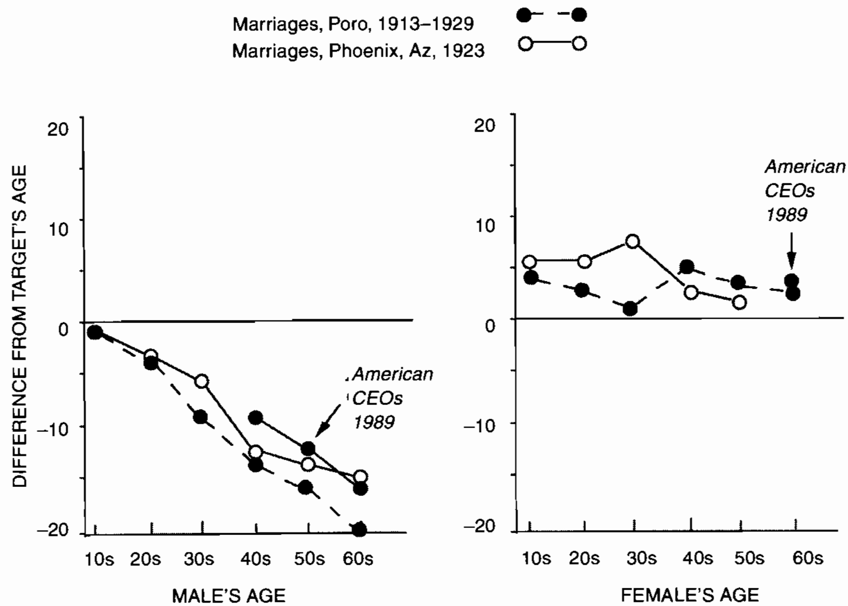


FIGURE 2.1. Age differences between men and their wives (left), and between women and their husbands (right) on a small Pacific island early in the 20th century, in Phoenix, Arizona in 1923, and in a population of wealthy chief executives of American corporations (based on Kenrick & Keefe, 1992; Kenrick, Trost, & Sheets, 1996). Marriages from other societies and times, and mating advertisements from different cultures suggest that the sex difference is universal.

tices of the Tiwi actually support the model quite nicely. How can this be? Among the traditional Tiwi, all women were required to be married. Widows were remarried at their husbands' gravesites, and infant girls were betrothed at birth. It was not required that men be married, on the other hand, and because the society was polygynous, many men remained single for a good portion of their lives. There were two ways for a man to get a wife—to have an older married man betroth his infant girl to cement an alliance, or to marry an older widow to gain her resources, thereby cementing an alliance with her male relatives. As it turns out, traditional Tiwi men married older women not because of a reversal of normal attraction preferences, but as a pathway to gaining the younger wives they found most desirable.

Evolutionary theorists do not assume that people are aware of the ultimate causes of their behavior, any more than they assume that other animals are aware of the connection between their behaviors and their inclusive fitness. A bee-eater is a bird that sometimes helps its parents at the nest, but the helping is contingent on whether or not it has a chance to raise offspring of its own this season, and whether its parents' new hatchlings are its full siblings or half-siblings (Emlen, Wrege, & DeMong, 1995). Biologists do not assume the bee-eater consciously calculates benefits to its inclusive fitness. Instead, they simply assume that animals with certain environmentally sensitive behavioral mechanisms were successful in passing on copies of their genes; other animals with other behavioral proclivities were less successful.

A satisfactory explanation of a natural phenomenon traces a behavior to its functional roots, rather than focusing on only proximate triggers. We ask *why* is it that men feel attraction toward women in their twenties with low waist-to-hip ratios rather than toward high-status women with broad shoulders, and why is it that bee-eaters only help their own siblings, and reduce that help when they are half-siblings (Emlen et al., 1995; Kenrick & Keefe, 1992). We don't hope to arrive at an answer by asking the bee-eater or the middle-aged man with a trophy wife. Instead, researchers must dig beneath the surface and examine a nomological network of data obtained from different methods applied to different species.

There is a line in a movie about the Mafia in which Joe Mantegna introduces an aging Don Ameche to a younger hoodlum by saying, "This is the guy behind the guy behind the guy." We are arguing that a complete analysis of a behavioral phenomenon needs to look for the "why" behind the "why" behind the "why." But how far does one carry the search for background causes? To the genesis of life on Earth, or further back to the Big Bang? If this were the case, a student could answer all causal questions in every course with the same answer: Big Bang. Of course, tracing things that far would be not only unnecessary, but also unproductive. When searching for the root causes of the behavior of living organisms, the satisfactory stop-point is the point at which we connect the current proximate causes to their adaptive function—the particular way in which behaviors of this sort might have served ancestral survival and reproduction. It is important to note that a causal explanation that simply pointed to "differential reproduction" would be going one step too far up the ladder, as it would not distinguish the explanation for a bat's sonar capacities, human color vision, and bee's ability to detect ultraviolet light. We want to understand the particulars—why it is that these different organisms have such different sensory capacities. A more satisfying, and more useful level of explanation, for example, would connect the bat's sonar with the demands of flying about hunting for flying insects at night. This was a problem that ancestral bats, but not ancestral humans or bees, needed to solve. Thus, an adaptationist account seeks to answer how an animal's cognitive and behavioral mechanisms are connected to the demands and opportunities its ancestors regularly confronted in dealing with the particular physical and social environments.

The War Is Over, We All Won

When Shoichi Yokoi was asked why he hid in a cave in the jungles of Guam for 28 years after World War II ended, he explained: "We Japanese soldiers were told to prefer death to the disgrace of getting captured alive." Psychology certainly has its share of Shoichi Yokois, who have taken it as a matter of pride to continue resisting the evolutionary revolution for decades.

Would embracing an evolutionary explanation mean giving up research on ongoing phenomenology or learning processes or culture? Imagine that the historical issue raised earlier was framed as a multiple-choice rather than an essay question:

World War I was caused by:

a. The assassination of Archduke Ferdinand.
b. Military alliances and nationalism in 1914.
c. Historical and cultural trends in Europe with roots that began in the decades preceding 1914.
d. An interaction between cultural factors in 20th century Europe and fundamental human motivations such as self-protection.

A student reading that question would probably turn the page to see if the typist had somehow misplaced "e. All of the above." A complete explanation of a phenomenon covers a range from proximate to ultimate causes. An explanation in terms of adaptive function does not somehow negate the requirement that we understand the proximate causes of a behavioral or cognitive phenomenon. And a consideration of the evolutionary roots of behavior does not put experimental psychologists out of business, and require that we all devote our time to studies of hunter-gatherers, gorillas, or Neanderthal excavation sites. In fact, because we carry the vestiges of ancestral adaptations around inside our heads, one of the best ways to gather evidence regarding the adaptive significance of human behavior is to study the biases used by modern humans in solving problems. There are serious limitations to what we could learn about behavior and cognition from studying pottery shards and skull fragments. Much more can be learned from studying living human beings as they think and behave.

At the same time, a consideration of information at multiple levels can help us gain an understanding of a phenomenon that would not be possible if only one level were considered at a time. For example, experimental social psychological studies suggest that nonverbal indications of social dominance increase the sexual attractiveness of males, but not females (e.g., Sadalla, Kenrick, & Vershure, 1987). Comparative studies done with other animals indicate a link between an individual's testosterone level and his or her social rank (e.g., Rose, Bernstein, & Holaday, 1971). Physiological studies indicate that males typically produce more testosterone than do females (Mazur & Booth, 1998). Correlational studies indicate more antisocially competitive behavior among individuals with high testosterone, particularly when other paths to social success are blocked (Dabbs & Morris, 1990). Together, these and other sources of evidence provide a nomological network of findings that fit together nicely to tell a compelling story about sexual selection and gender differences (Geary, 1998). No one source of data is superior to the others, and none is superfluous—each is necessary to understand a complicated but ultimately sensible natural process. Although data from psychological experiments are not, by themselves, sufficient, they are, in alliance with data from other disciplines and methods, necessary for complete explanations of behavior.

WHAT THE MIND WORKS ON

To understand the why question—the ultimate function of a behavioral mechanism, evolutionary psychologists believe it is important to consider the what question—examining specific content as well as general process (Kenrick, Sadalla, & Keefe, 1998; Tooby & Cosmides, 1992). We argue in this section that humans, like other animals, come pre-equipped with a number of specialized psychological mechanisms designed to deal with particular problems confronted by our ancestors, and we offer some preliminary ideas about some of the key problem domains.

The Mind Is Not a Tabula Rasa, It's a Coloring Book

When the senior author of this chapter was a graduate student, psychologists still talked with a straight face about the mind as a *tabula rasa*—a blank slate on which experience wrote. Since that time, sufficient numbers of discordant findings have proliferated to make the blank slate look like the grafitti-filled wall of a New York subway station.

Several large bodies of literature have undermined the blank slate viewpoint.

Behavior Genetic Research. Research from studies of twins and adoptees suggested that behavioral, affective, and cognitive capacities and predispositions are indeed passed from one generation to the next (Plomin & Caspi, 1999; Rowe, 1997). Examples include personality traits such as extraversion and conscientiousness (Loehlin, 1992), sexual orientation (Bailey & Pillard, 1991), and general intelligence (McGue, Bouchard, Iacono, & Lykken, 1993).

Cross-Cultural Findings. Viewed through the standard ethnocentric lenses, our eyes are drawn to the strange and unusual, the ways in which "they" are different from "us." But beneath the sometimes colorful differences, like those separating Tiwis and Tierra del Fuegans, ours is one species, and our neighbors the world over share certain important ways of behaving, thinking, and feeling (e.g., Daly & Wilson, 1988; Ekman & Friesen, 1971; Kenrick & Keefe, 1992). Some well-known examples of broad human commonalities include emotion recognition (Ekman & Friesen, 1971), color perception (Rosch, 1973), and a facile ability to learn a complex spoken language (Pinker, 1994).

Cross-Species Comparisons. Findings from different animal species reveal that our species, though unique in some ways, also shares many common behavioral and psychological mechanisms with other animal species. Comparative research has revealed powerful principles such as inclusive fitness, differential parental investment, and sexual selection that can help explain many of the patterns found in animal behavior (Gould & Gould, 1989; Trivers, 1985). Functional analyses have proven essential to understanding why some animals, but not others, see in color, whereas others don't see at all; why some have dominance hierarchies; and why some have females that are more colorful and competitive than males (Alcock, 2001; Mollon, 1989; Williams, 1996).

Developmental Findings. A few years ago, the first author asked the current editor of *Child Development* what was new and exciting in the field. She responded that there was more and more evidence coming in to suggest that human infants enter the world equipped with specialized perceptual and cognitive abilities (see Spelke & Newport, 1998, for a review). For example, preverbal infants respond to colored lights not in terms of a continuous distribution of physical wavelengths, which it is, but in categorical terms that match the verbal labels adults use, breaking blue, green, yellow, and red just as adults do (Bornstein, 1979). Infants are also highly attentive to features of human faces (Johnson, Dziurawiec, Ellis, & Morton, 1991), and to the sounds of human phonemes (Pinker, 1994).

But although the blank slate doesn't work as a metaphor, neither does the prepainted canvas. A better metaphor is that of a coloring book. It has been three decades since Seligman and Hager (1972) brought together an impressive selection of papers on what they called *Biological Boundaries on Learning.* The point of that body of work was not to say that animals come pre-equipped with answers, but with a strong inclination to follow clues of the particular sort that would have solved the particular problems their ancestors were likely to confront. For example, Wilcoxon, Dragoin, and Kral (1971) reported that quail, which use vision to locate food, condition nausea more easily to visual cues than to tastes, whereas rats, who normally use taste and smell to locate food, show the opposite pattern. In other work, Öhman and Dimberg (1978) demonstrated that people have difficulty extinguishing fear responses to snakes and spiders and to angry, but not happy or neutral, faces (Öhman & Dimberg, 1978; Öhman, Erixon, & Lofburg, 1975). Each of these phenomena indicates learning, but learning that is directed in adaptive ways.

Research on human language also fits the view that organisms come equipped with a collection of psychological mechanisms to assist them in selectively learning particular information in particular categories. For example, we noted earlier that infants are particularly attentive to human phonemes. And human language all around the world is similar in a number of nonrandom ways, including level of complexity and types of mistakes that are more or less likely during acquisition. But of course the well-equipped child must learn a particular language through experience. There may be a language instinct, but there is not a Spanish or Italian instinct. And just as birds have song-imprinting mechanisms that help them narrow their song learning in adaptive ways, there appear to be imprinting-like mechanisms in human language learning as well (Marler, 1970). Although 3-month-old babies can discriminate all the phonetic possibilities of any human language, the ability is lost by 12 months, when infants categorize phonemes just like the adults who speak around them (Werker & Desjardins, 1995).

The Human Brain Is Not Designed to Recognize Words Presented at 250 msec.

It may sound obvious to say that understanding how people process written words may give an incomplete understanding of most of the things humans are naturally inclined to think about. But in the introductory chapter for their influential cognitive psychology textbook, Glass and Holyoak (1986) stated that reading "calls into play virtually every aspect of the cognitive processes that we will explore in this book" (p. 15). The fascination with written words may trace to many sources: Words are abstract representations, ideally suited to a model of pure information processing; words have features that are eminently controllable; and so on.

When social psychologists joined the cognitive revolution, they adopted the approach quite literally. Indeed, experiments on social cognition for a long time consisted of directly importing paradigms from cognitive studies of word recognition, such as the work on lexical priming. Hence, the social stimuli in experiments on impression formation or group prejudice were often rapidly presented words (e.g., Bargh & Pietromonaco, 1982). Along with these paradigms, cognitive social psychologists explicitly adopted a central assumption of traditional cognitive psychology—that the same general cognitive processes applied in like manner to all types of content, with social and nonsocial stimuli of various types being more or less interchangeable (e.g., Markus & Zajonc, 1985).

However, different content categories are processed very differently. Humans are immensely better at attentional, memory, and problem-solving tasks when they involve certain types of content as opposed to others. Indeed, certain types of social information seem to have favored status, and to operate according to different rules from other types of social information. We are quicker to detect an angry than a happy face, for example (Hansen & Hansen, 1988). We are adept at solving otherwise difficult logical problems if they involve the detection of cheaters on social contracts (Cosmides & Tooby, 1992). Even words are processed differently when we think they are about people. Warm goes with friendly, hot goes with sexy, and cold goes with calculating when subjects are thinking about people, but not when they are thinking about metal objects (DeSoto, Hamilton, & Taylor, 1985). And humans are universally much better at learning to transmit, receive, and process spoken language than written words (Liberman, 1988). Many human cultures had no written language, and most humans throughout history, even in cultures with written language, have been illiterate. Just think of the papers written by your undergraduate students, and consider that they are in the top percentile of literacy by the standards of most of their ancestors. Yet these terrible writers pick up the complexities of spoken language with no formal training at all, and humans the world over, literate or illiterate, use language of the same high level of complexity (Pinker, 1994).

From an evolutionary perspective, the human brain was not designed to deal with general information, which can be represented by abstract symbols. It was instead designed to assist our human ancestors to deal in particular ways with the variety of different cognitive tasks normally involved in successful reproduction for a member of a human group. The next two sections consider what we mean by that.

Human Reproduction Is More Than Just Copulation

The bottom line of natural selection is differential reproduction. Because the *sine qua non* of successful reproduction is sexual intercourse, and because sexual reproduction involves a division of tasks between males and females, evolutionary psychologists have developed the reputation of being "obsessed with sex." However, successful human reproduction involves a diverse array of tasks—making friends, negotiating a status hierarchy (which may involve tasks from throwing a baseball to programming a computer), maintaining long-term relationships, child care (including not just providing resources, but training and supervising the child as he or she negotiates all of the above). And to participate in all these social activities, the would-be reproducer must navigate all sorts of challenges and opportunities in the nonsocial world as well—distinguishing edible from inedible foods, keeping out of the rain and the midsummer sun, finding the way back to camp after a hike, remembering where the fruit trees and good fishing holes are located, and so on. Indeed, there is a relatively high ratio of hours spent in all these other tasks to hours clocked in copulation, even for famous athletes or rock stars.

Thus, although the brain may in one sense be an extension of the gonads, its functions are more complex than directing us toward copulation, and an evolutionary analysis should help us understand all its functions. One of the lessons of evolutionarily informed research, as we suggested earlier, is that we need to expand our view of human motivation beyond the general rule offered by the learning perspective: "Do it if it feels good." It turns out that what feels good depends importantly on what functional motive is active at any given time.

In the next section, we consider one way to think about this issue of domain specificity.

Six Minds Are Better Than One

Psychologists' commitment to a domain-general view can be traced to a number of sources, including Lashley's (1929) *equipotentiality theory* of cortical functioning. Lashley found that when increasingly larger areas of the cortex were destroyed in rats, there was gradually greater disruption of memory, and that other areas could sometimes take over function for the damaged area. Such findings stood alongside abundant support for localization in findings such as Broca's observation that aphasics all had damage to the left frontal lobe. The view that brain functions could be localized, however, may have been tainted by a perceived association with phrenology. Another important historical influence was domain-general learning theories. Traditionally, prominent theories of learning assumed that all behaviors, regardless not only of content domain but even of the species manifesting them, could be explained in terms of one or a few simple domain-general mechanisms (e.g., Skinner, 1953).

The assumption of a general learning mechanism that operates according to a few general purpose learning rules is more parsimonious than the assumption of domain-specific mechanisms. And there is no doubt that principles such as classical and operant conditioning have a wide range of applicability. Further, it would be a mistake to assume that each cognitive module must be completely independent of the others, or that the processes used by different modules are all housed in spatially nonoverlapping regions of the brain.

Nevertheless, evolutionary approaches to cognition have generally favored the view that organisms' brains are composed of some number of content-specific mechanisms, designed to deal specifically with particular cognitive problems confronting particular species. Sherry and Schacter (1987) reviewed evidence that different types of memory tasks are sometimes functionally incompatible. For instance, song learning in birds often occurs during a very restricted period in which the bird is sensitive to whatever songs it hears. Several months may pass before the bird actively reproduces the song, and learning of new songs is closed after the critical period. On the other hand, to remember where it stored its food caches, a bird needs to continually update its memory for novel locations, because it may store food in many places over the course of the season. A shared memory process for these two types of learning would be highly inefficient. In fact, each system is associated with particular neural structures. Sherry and Schacter (1987) are conservative in proposing modules, arguing that different systems may evolve only when the demands of one system are incompatible with another. It is also quite feasible that cognitive modules may be incompatible in certain ways, yet share some general processing mechanisms with other modules for certain subtasks.

Beyond the empirical justifications for assuming content-specific mechanisms, evolutionary cognitive psychologists believe there are compelling theoretical reasons (Kenrick, Sadalla, & Keefe, 1998). Tooby and Cosmides (1992) have noted that evolution generally favors specific organs designed to solve particular tasks. Rather than having a general "sense organ," for instance, we have special organs designed to process sound waves, light waves, touch, smell, taste, and temperature. Again, at the neurological level, there is evidence for distinct brain mechanisms for analyzing color, shape, movement, depth, and other complex features of visual stimuli (Livingstone & Hubel, 1988). Human beings also appear to have separate mechanisms for analyzing different features of auditory input, others designed for understanding spoken words, and still others designed for producing spoken words, and so on.

How modular is the mind? The jury is still out on this question. The most fruitful model might posit hundreds of separate processing modules; a smaller number of executive subsystems, or some hierarchical combination of overlapping modules and submodules (e.g., Kenrick, Sadalla, & Keefe, 1998).

Rather than thinking of modules in terms of spatially isolated suborgans in the brain, another approach is to think about the functionally separable types of information involved in different problems that humans have traditionally faced. What are the main categories of adaptive problems with which humans living in social groups have had to concern themselves? A number of researchers have reviewed literature relevant to this question, and there is some overlap in the schemes proposed (Bugental, 2000; Buss, 1999; Kenrick, Li, & Butner, 2003; Kenrick, Neuberg, & Cialdini, 1999). Our overview of this literature led us to postulate six domains: coalition formation, status, self-protection, mate choice, relationship maintenance, and offspring care. Our ancestors would have fared better generally in the game of successful reproduction to the extent that they:

- Belonged to a cooperative group that shared resources and skills
- Gained and maintained status within that group
- Protected themselves from threats from those outside and inside the group
- Chose a fit mate
- Hung onto that mate
- Cared for any children resultant from that mateship

Each of these problem domains is associated with a different fundamental goal, and a different set of decision-making biases, which we summarize in Table 2.1. They are also likely to be associated with different social geometries, as shown in Figure 2.2 (based on Kenrick, Li, & Butner, 2003).

Note, for example, that cooperative alliances are assumed to involve loosely overlapping groups, in which family members share resources with one another, while simultaneously developing alliances with members of other families. There is loose overlap because, given the power of inclusive fitness, if you help a

TABLE 2.1. Domains of Adaptive Problems, Fundamental Goals Associated with Each Domain, Examples of Evolved Decision Constraints, and Evolutionary Principles Underlying Decision Constraint

Social Problem Domain	Fundamental Goal	Evolved Decision Constraint
Coalition formation	To form and maintain cooperative alliances	Cooperation is more likely to the extent that others: (a) share genes, or (b) have shared resources in past.
Status	To gain or maintain respect from, and power over, other group members	Males take more risks to gain and maintain status.
Self-protection	To protect oneself and alliance members against threats to survival or reproduction	Potential threats or costs lead to reciprocal exchange of aggressive behavior, particularly among nonkin.
Mate choice	To obtain a partner or partners who will enhance one's own fitness	Males, compared with females, are generally more inclined toward an unrestricted mating strategy (i.e., multiple mates, shorter courtship before sex)
Relationship maintenance	To maintain a mating bond with a desirable partner	Males are inclined to break a bond if a partner is sexually unfaithful, or if there are physical attractive alternatives available.
		Females aree inclined to break a bond if a partner compromises resources, or if a high status alternative is available.
Parental care	To promote the survival and reproduction of individuals carrying one's genes	Familial provision of resources and care will follow the order: (a) self > siblings (b) own offspring > stepchildren

member of my family, you indirectly help me. On the other hand, self-protection stems from competition over resources between groups (and sometimes within groups). This conflict leads to the formation of barriers: If you hurt a member of my family or tribe, you thereby reduce my fitness, so you and those associated with you are relegated to the outgroup category with all the nasty implications that follow. Self-protection considerations promote the development of large groups, whereas mating alliances promote the development of dyads, given the male's concern with inadvertently raising offspring that are not his own, and the female's concern with losing the father's resources for her offspring. We review the evidence for these assumptions elsewhere (Kenrick, Li, & Butner, 2003). For the purposes of this chapter, we will note that the decision rules and social geometries associated with each of these domains have implications for connecting evolutionary psychology and complexity theory, as we discuss in the next section.

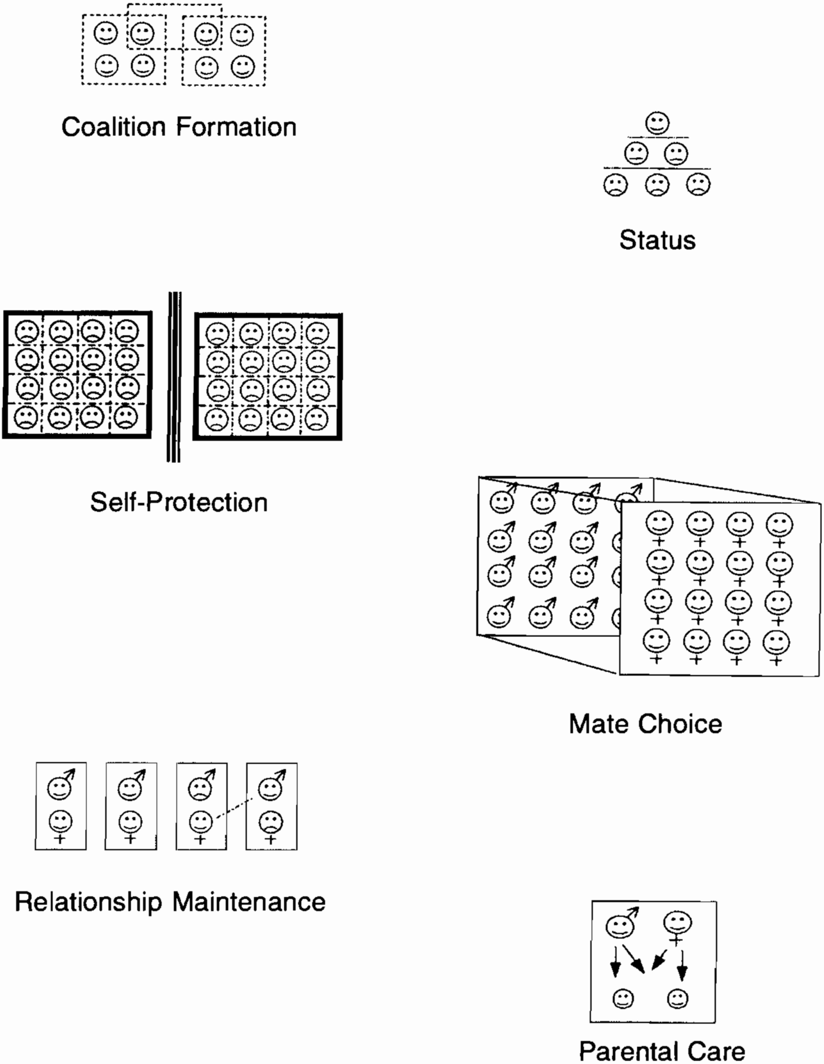


FIGURE 2.2. Different social geometries are associated with decision rules used in different social domains (from Kenrick, Li, & Butner, 2003).

MINDING OUR MISCONCEPTIONS

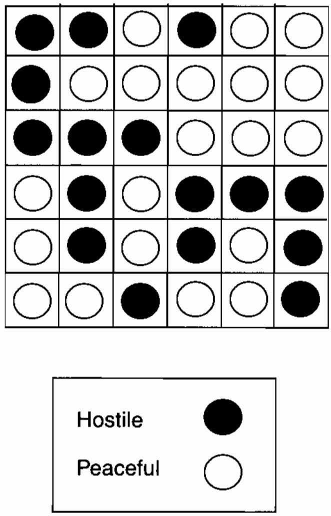
In this section, we address two misconceptions about evolutionary psychology: That it is ultimately about isolating genes for particular behaviors, and that it is a perspective that most psychologists don't need to really think about. On the contrary, evolutionary psychology considers dynamic interactions at all levels, and has relevance for the whole field of psychology.

Reductionism Ain't What It Used to Be

Because evolution ultimately boils down to the survival of "selfish genes," evolutionary theorists have often proudly described themselves as reductionists (Wilson, 1998). But a given gene is only naturally selected if it fits within a network of other genes to produce individual cells that, in turn, must function in the context of the network of other cells that make up organs, and these in turn must function in the context of a network of other organs making up a complete organism. Furthermore, that organism must coordinate its behavior with a network of other organisms with which it shares an ecosystem. Evolutionary theorists are acutely aware of these interdependencies, as modern evolutionary biology has coevolved with the development of the field of ecology. Notions such as frequency-dependent selection presume that the success of a given strategy is dynamically linked to the success of other strategies. For example, the ratio of predators to prey is maintained in a delicate balance—too many predators and the prey will begin to disappear, which will in turn reduce the population of predators.

As noted, we believe that the coming paradigm will involve an integration of ideas in evolutionary psychology and cognitive science with those in dynamical systems theory (Kenrick, 2001). Dynamical systems theory is concerned with the study of complex multicomponent systems (ranging from the microscopic—genes or neurons, to the macroscopic—all the animals and plants in a forest ecosystem, or all the millions of consumers in an economic market). Two key features of the dynamical approach are the study of *changes over time* and an emphasis on *nonlinear processes* (Nowak & Vallacher, 1998). A single snapshot is insufficient to understand the balance of predators and prey, plants and animals, parasites and hosts in a forest ecosystem, for example. And the changes that occur in ecosystems are often sudden rather than gradual. For example, the removal or addition of one key species in a coral reef or ponderosa pine forest can radically change relationships between the remaining species, and lead to a sudden and catastrophic alteration of the entire habitat (Wilson, 1992). The dynamic approach thus also emphasizes the *bidirectional causality* found in most natural systems.

Observations across a wide variety of complex systems have yielded a pair of critical insights. First, dazzling complexity can emerge from a few variables interacting according to a few simple rules (Holland, 1998). Second, complex systems at every level reveal *self-organization*—order emerging out of initial disorder (Latané, Nowak, & Liu, 1994). The top left segment of Figure 2.3, for example, depicts a group of individuals engaging in either cooperative or hostile behavior. When each individual attempts to match the majority of his neighbors,



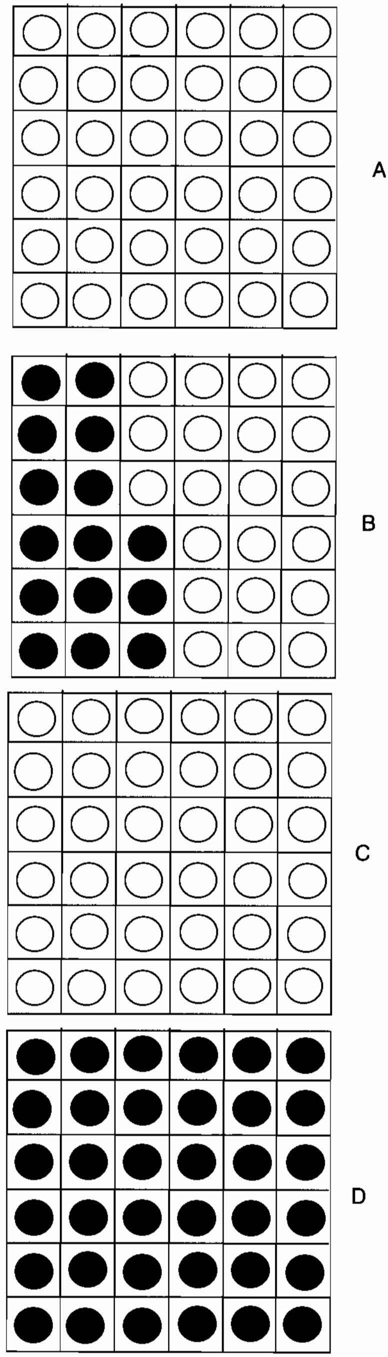


FIGURE 2.3. The neighborhood at the left depicts individuals acting either aggressive or peaceful. If all attempt to match the majority of their neighbors, the neighborhood will self-organize into peaceful and aggressive clusters (or simply go completely over in one direction). If all individuals use a rule of attempting to match the majority of their neighbors, this initial pattern will stabilize into a totally peaceful neighborhood. If some individuals have very low thresholds for aggression (as marked), this can change outcomes for the whole neighborhood, depending on their location and random variations in their neighbors' behaviors (based on Kenrick, Li, & Butner, 2003).

the neighborhood ends up completely peaceful after several rounds of interaction (Figure 2.3A, top right). When individuals influence their neighbors, communities often end up organizing into self-maintaining pockets over time, even when initial behaviors are random.

Complexity theorists have discovered broad principles that apply across different types of phenomena, and indeed, natural selection is an excellent example of dynamical self-organization. However, the success of any organism, and its dynamic relationship to the other organisms in its network, are ultimately linked to particulars. The particulars of the decision rules used by a group of organisms, and the particulars of individual differences between them, can have profound effects for network dynamics. As shown in examples B and D in Figure 2.3, one or two individuals with low thresholds for aggressive behavior could dramatically alter the outcomes for the rest of their community.

In another series of simulations, we examined how male and female differences in decision rules about restricted or unrestricted sexual behavior can result in very interesting group dynamics, and how random spatial placement and the possibility of migration can combine with such individual differences to result in the emergence of distinct subcultures (Kenrick, Li, & Butner, 2003). Using normal decision rules, for example, most communities of men and women end up in relatively restricted monogamous relationships. However, if the females in a neighborhood use slightly different decision rules (akin to those used by males, which are slightly more inclined toward unrestricted behavior), a neighborhood will generally become highly unrestricted, even though the males have not changed their decision rules at all. Again, relatively small changes in individual decisional rules can have much larger implications at the societal level.

To summarize this section, a dynamical evolutionary position hardly implies that all psychologists should begin to search for isolated genes. On the other hand, because dynamical processes at one level often emerge bottom-up from decision-rules affecting behavior at lower levels, this approach also counsels against a content-free holism that eschews any analysis of system components. Even single genes can have effects on the whole system of genes, and ultimately on the development and behavior of the organism (Ridley, 2000; Weiner, 1999). The field of psychology is probably best served by dogmatically embracing neither a reductionism that ignores emergent processes nor a holism that ignores the substrate out of which higher-level patterns emerge. Instead, a full understanding of adaptive problems faced by complex organisms living in groups of other complex organisms will come from simultaneous consideration of multiple levels of causality.

The Dynamical Adaptationist Map: Don't Leave Home Without It

The social sciences are littered with theories that would never have been advanced if their authors had understood the broader principles of evolution by natural selection. These include Freud's ideas about the Oedipus complex, the notion that adult sexual behavior would follow from consistently labeling someone as "male" or "female" or teaching them a particular "sexual script," the *tabula rasa* view of human nature, and the explanations of various sex differences in social behavior in terms of the norms of American culture (e.g., Daly & Wilson, 1988, 1990). Furthermore, a number of psychological phenomena, such as the cognitive errors with which psychologists like to taunt their students, take on a completely different significance when considered in light of their value as possible functional adaptations (e.g., Funder, 1987; Haselton & Buss, 2000). Hence, we argue that it is essential, at least on occasion, to consider the broader evolutionary significance of the phenomena we study.

Besides helping us avoid blind alleys, a broader evolutionary perspective can also provide the intellectual satisfaction of seeing how the different roads flow together. Figure 2.4 provides an example of how a number of findings on social behavior can be linked with a broad set of evolutionary principles (from Kenrick & Trost, 1996). Adding just a link or two could probably bring you to any particular behavioral phenomenon of interest.

Just as there are topographic maps and road maps, there are different angles one can take on the increasingly interdisciplinary terrain of psychology. Table 2.2 provides another way to look at the space where an evolutionary psychological view interacts with a dynamical systems view (from Kenrick et al., 2002).

One dimension of the framework in Table 2.2 is equivalent to the proximate-ultimate continuum of causality. The other dimension divides questions into those dealing with the interactions of components inside the organism, and those dealing with interactions between organisms. Events at one of these levels are intrinsically linked to those at the other levels. The connections between attentional, memory, and emotional processes inside the organism are linked in one direction to events in the social environment, and in the other to ontogenetic and phylogenetic history. And each momentary interaction between individual and environment can be seen as one frame in the neverending dynamic story of natural selection. Mathematicians and biologists have begun to model such evolutionary dynamics using dynamic simulations of the sort we have used to study ongoing person–environment interactions (e.g., Killingback & Doebeli, 1996). These sorts of simulations provide tools to enhance the theory-building phase of science, but those tools are most useful when they are educated by experiments and naturalistic research that elucidate the underlying decision rules actually used by human beings making important decisions related to problems of survival and reproduction.

Consider that all the issues that could be raised about any given domain of social life have yet to be addressed for any level of analysis (e.g., the upper left box in Table 2.2). If you further consider that a parallel set of questions could be raised about nonsocial problems, and that the intrinsic interconnections also need to be explored, it becomes clear how ridiculous were the claims a few

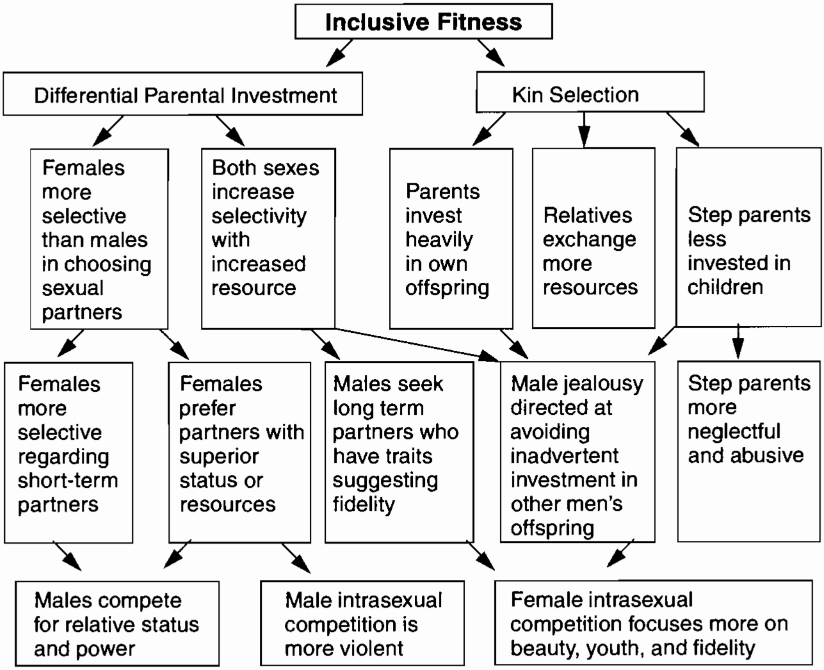


FIGURE 2.4. Patterns of social behavior across a wide range of animal species and human cultures may be linked via broad evolutionary principles. The theory of inclusive fitness is the assumption that natural selection favored animals with traits that led to behaviors favoring replication of their genes in their own offspring and other relatives. A number of midrange theories flow from this, and these can help connect a diverse network of empirical observations. Differential parental investment theory is the assumption that animals are more selective about mating to the extent that they invest in any likely offspring. Selectivity in one sex is presumed to increase competition in the other. Human males and females may both invest in offspring, but they invest somewhat different resources, and these differences affect mate selection criteria. Kin selection theory is based on the assumption that organisms aree selected for traits that favor the investment of resources in genetic relatives, and that disfavor investment of resources in nonrelatives (such as stepchildren). (Based on Kenrick & Trost, 1996).

years back that we are nearing the "end of science." Indeed, when it comes to exploring the human mind, we are still near the beginning of the journey, but we are beginning to see the outlines of a map of the coastline.

Rather than being put out of business by opening passageways to evolutionary biology and general complexity theory, those paths help us realize the vastness of the new territories left to explore. And instead of being left on the dock, psychologists who study psychological mechanisms may yet have their day as head scouts in science's most important expedition to date.

TABLE 2.2. A Framework For Organizing Questions about Dynamics and Evolved Mechanisms

Units	Short-Term Time Frame	Developmental	Evolutionary
Within the person	How do an individual's internal characteristics (motives, problem-solving strategies, hormone levels) interact across situations? *Example:* Activating a self-protection motive re-organizes attention, motivation, and perception.	How does the internal ecology of an individual's characteristics change over the lifespan? *Example:* The linkage between aggressive behavior and testosterone level changes at puberty	How do constellations or syndromes of traits coevolve? *Example:* Inherent connections between female reproductive physiology, parenting behavior, and attitudes about casual sex
Between people	How do the interactions between individuals in interconnected networks self-organize into group level patterns? *Example:* Mutual cooperation or conflict in a social dilemma situation	How do social groups organize and reorganize themselves over the lifespans of the individuals involved? *Example:* Dynamics between the sexes change at puberty.	How does the local population of types mutually constrain one another? *Examples:* Physical and behavioral characteristics of males coevolve with those of females.

Based on Kenrick, Maner, Butner, Li, Becker, and Schaller, 2002.

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