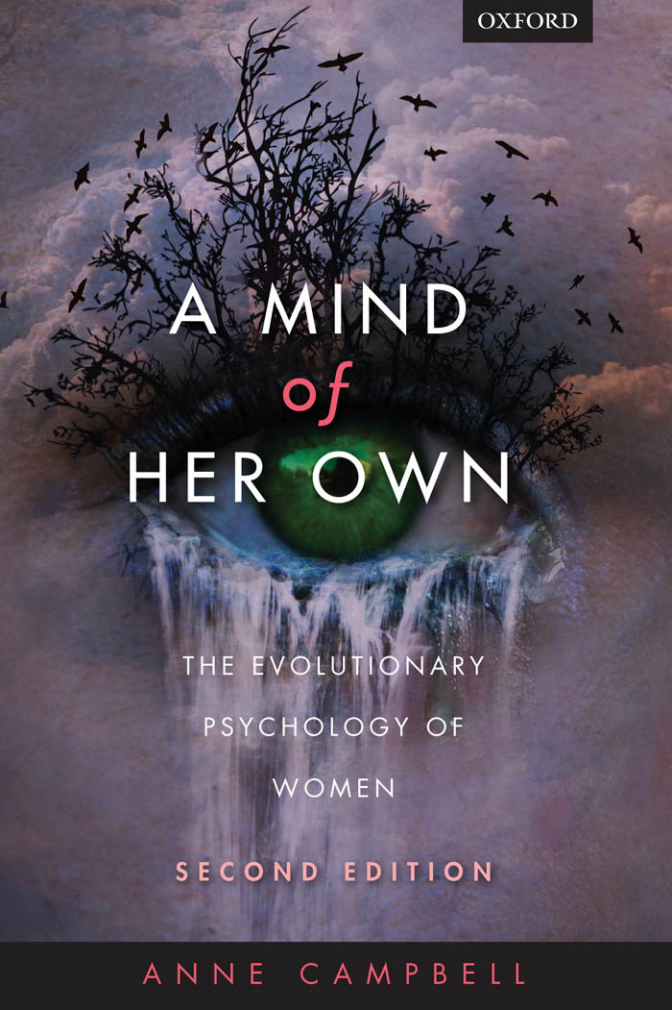
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A MIND of HER OWN
THE EVOLUTIONARY PSYCHOLOGY OF WOMEN
SECOND EDITION
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The evolutionary psychology of women

SECOND EDITION

Anne Campbell

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To Jamie

Acknowledgments

Books need researchers. Without frontline scientists doing research, there is nothing to write about. So my first debt of gratitude is to all the academics whose ideas and results have fueled this book. It is in conversations that nebulous ideas take shape and get formalized into words and hypotheses. For these, I thank my work colleagues and graduate students (especially Kate Cross, Helen Driscoll, Simon Hampton, and Lee Copping). Durham University undergraduates have also kept me on my toes with incisive and enthusiastic questions. Closer to home, thanks to Table 7 for the anecdotes, debates, therapy, and laughs.

Finally, I thank my family who have graciously shared their home with an "evolution" obsessive. In fact, my husband brought this on himself many years ago. I trace his responsibility to his disgusted expression when he learned that I was not familiar with (indeed had never heard of) the work of John Maynard Smith. There was no choice but to remedy my parochialism by reading about game theory. (From whence it was a short hop to Martin Daly and Margo Wilson, George Williams, John Tooby and Leda Cosmides, Sarah Hrdy, etc. . . .). All this set me wondering if the sole role of women in evolution was to vet male genes. After all, if women were all breeding at their maximum with little or no variation between them, that seemed the limit of their contribution. The innocence of this question is belied by the 18 years that I have spent struggling with it. This book is my attempt at an answer.

Contents

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Chapter 1

The essential woman: Biophobia and the study of sex differences

Each of us lives only one version of a human lifetime. We live it as a man or woman. What would it be like to perceive, to think, and to feel as a member of the opposite sex? A few transgendered individuals may get a glimpse across that invisible wall but the sex chromosomes that we arrive with, whether XX or XY, are the ones we leave with. The psychological worlds of men and women have been a focal point of interest for scientists and feminists. But these two groups deal in different currencies. Scientists see an enigma and want to understand it. Feminists envision a social utopia and want to engineer it. During the latter part of the twentieth century, feminist ideology infiltrated science to such an extent that it was hard to tell the difference between the objective facts of sex differences and the political ambition to erase them. But the only way to find a path to a social goal is to recognize where we currently stand. Evolutionary psychologists knew this, but they had a fight on their hands. There were three camps that dominated the psychology of gender and that vocally opposed the application of evolutionary theory: social constructionism, cognitive learning theories, and social role theory.

Since 1970, over one million studies of gender and sex differences have appeared in academic journals. The zeitgeist of the post-war years profoundly influenced the questions that researchers posed, the methods they used, and the recommendations they made. In the West, incomes rose, educational opportunity increased, and women began to discern their very unequal standing in the world of work, professional achievement, and public recognition. These forces informed a belief that society was perfectible and that we should aim to equalize the standing of women and men. Quite right too. But the political ideology that drove this laudable quest for social equality began to drive psychological theories too. The only acceptable account of sex differences was one which explicitly acknowledged the socially constructed, arbitrary, and malleable nature of sex differences. Women's studies became steeped in a politically driven rejection of essentialism (the idea that the sexes differ at a fundamental psychological level) and committed on one hand to social constructionism (there is no objective

truth "out there" only negotiable subjective representations) and on the other to extreme environmentalism (all sex differences result from factors external to the person). None of these roads took us very far toward an accurate understanding of why men and women differ.

Social constructionists effectively removed gender from the human mind and instead allowed it to float freely in an insubstantial ether as a "social construction," or an "emergent property," or an "interpretative repertoire." This is why it is possible to read statements such as the following, written in all seriousness: "Gender distinctions as dichotomous categories are perpetrated and maintained by social mechanisms and are socially constructed" (Epstein, 1997). The prevailing dogma was that the distinction between men and women is a collective and tyrannical fiction. There are no real biological or psychological differences other than ones that we construct through discourse. For these writers, questions about the causes of sex differences never rear their heads because positivistic science (with its traditional obsession with causality) is disparaged as simply another rhetoric among many—and an outdated one at that (Woolgar, 1996). Humans are the sole focus of interest and any comparison between our behavior and that of lower animals is unjustified, demeaning, and reductionist. This is because humans have language, language enables discourse, and it is through discourse that social reality, including gender, is constructed. (This is especially true of educated, middle-class Western humans judging by the disproportionate attention they receive.) The study of discourse is the study of implicit or received meaning and all meaning is subjective so there can be no single authoritative or "privileged" reading of a text. Although social constructionists recognize the implications of this observation for their own analyses, they nevertheless "deconstruct" (often in dense literary and psychoanalytic terms) the ways in which gender is created in social talk. To give a flavor of their approach to gender differences, I quote from one of the most frequently cited writers of this genre (Hollway, 1984, pp. 227–228):

> Hence recurrent day-to-day practices and meanings through which they acquire their effectivity may contribute to the maintenance of gender difference (reproduction without a hyphen) or to its modification (the production of modified meanings of gender leading to changed practices) . . . I am interested in theorising the practices and meanings which re-produce gendered subjectivity (what psychologists would call gender identity). . . . Gender differentiated meanings (and thus the positions differentially available in discourse) account for the content of gender difference.

In this article, Hollway goes on to explain how different discourses about sexuality locate women and men in different positions relative to one another. She writes of the "discourse" of the stronger male sex drive, the "discourse" of the Madonna–whore distinction, and the permissive "discourse" which

appeared to (but did not) liberate women's sexuality. Now each of these topics is of some considerable interest to evolutionary psychology, as we shall see, but in that discipline rather than locating them as discursive fictions they are taken as answerable empirical hypotheses about which evolutionary theory makes clear predictions. Men's sex drive should be stronger than women's—and it is (Baumeister, Catanese, & Vohs, 2001). Women should experience a social cost if they gain a reputation for promiscuity—and they do (Cashdan, 1996). Women should find casual sexual liaisons less satisfactory than men—and they do (Campbell, 2008a; Townsend, Kline, & Wasserman, 1995). Nor are these findings exclusive to a single culture or language community—they exist independently of so-called "constitutive" discourse. For social constructionists the key question of the origins of these discourses is strenuously avoided:

> But to assume the mechanical reproduction of discourse requires asking how it got to be like that in the first place. And that question is in danger of throwing theory back into answers according to the terms of biological, Oedipal or social and economic determinisms. (Hollway, 1984, pp. 238–239)

In short, better not to ask the question if you think you may not like the answer.

But elsewhere in the social sciences some academics were indeed resorting to "social determinism." Sex differences come from outside the child. Babies are not born wanting to play football or dress dolls. These preferences are imposed by parents and the media, and then encoded into children's cognitive frameworks, magnifying and reifying the differences between masculine and feminine behavior.

Socialization explanations of sex differences were built on the foundation of the tabula rasa infant coaxed, rewarded, and punished until it conformed to societal demands for sex-appropriate behavior. They took shape in the era of behaviorism and learning theory. The account was a simple one. Parents treat boys and girls differently, reinforcing the correct behavior in each. Boys are encouraged to fight, climb trees, and play football. Girls are forced to wear dresses, play with dolls, and share. Despite the fall from grace of radical behaviorism, nobody seriously doubts that reinforcement can shape behavior. The question was whether it was strong enough to account for the worldwide patterns of sex difference that we see. The "Baby X" paradigm was hailed as conclusive evidence of socialization differences (e.g., Will, Self, & Datan, 1976). A six-month-old baby was wrapped in a blue or a pink blanket, identified as a boy or a girl, and then handed to a woman who was asked to look after it for a few minutes. When told it was a girl, the women more often offered a doll to the infant in preference to other toys. Surely this showed that parents treat infants differently as a function of their sex? But there was a problem. Despite many attempts to replicate the effect, it seemed even weaker than it had appeared on first sight

(and recall the effect was found only for toy selection—there were no differences in social behavior toward the infant). It was certainly not strong enough to support the whole edifice of sex differences (Stern & Karraker, 1989). And even if parents give their children different toys, such a finding is trivial unless it can be shown that toys change the child's subsequent behavior.

But the real crunch came when Lytton and Romney (1991) collected 172 studies from around the world which examined the way in which parents treat their sons and daughters. Considering them all together, the evidence for differential treatment was virtually nil. Parents did not differ in the amount of interaction with the child, the warmth they showed, their tendency to encourage dependency or achievement, their restrictiveness, their use of discipline, their tendency to reason with the child, or the amount of aggression that they tolerated. There was, however, one area that showed a difference. Parents tended to give their children sex-appropriate toys. But sex-differentiated preferences for toys have been found in infants from nine months of age (Campbell, Shirley, Heywood, & Crook, 2000). Children play more with sex-appropriate toys even when their parents do not specifically encourage them to do so (Caldera, Huston, & O'Brien, 1989). It is quite likely that parents are not using toys to turn their children into gender conformists but are responding sympathetically to the child's own preferences. Anyway, if parents' behavior toward their children was guided by their desire to make them conform to traditional gender stereotypes than we would expect to find that the most sex-typed adults have the most sex-typed children. Yet studies find that there is no relationship between traditional household division of labor, parents' attitudes to sex-typing, their sex-typical activities, and their reactions to children's behavior on one hand and children's degree of sex typing on the other (Maccoby, 1998).

Following Skinnerian views came social learning theory which emphasized a hitherto neglected (but altogether central primate) capacity—imitation. No-trial learning. We can acquire a piece of behavior merely by watching it performed by others. But the trick was to co-opt this observation into an explanation of the acquisition of sex differences. This was done by proposing that children selectively imitate their same-sex parent. Laboratory studies were done in which children were exposed to adult "models" performing a variety of novel behaviors. If social learning theorists were right, then the statistical analysis would show a significant interaction between sex-of-model and sex-of-child—girls would imitate women and boys would imitate men. Dozens of such studies failed to find such an effect (Huston, 1983; Maccoby & Jacklin, 1974). Undeterred, Perry and Bussey (1979) devised a cunning experiment which avoided the pitfalls of the previous studies where children had only a one-off exposure to an adult model. They showed children a film of eight adults selecting a preferred fruit. In

one condition all four men made one choice (e.g., orange) while all four women made the other (e.g., apple). In another condition, three men and one woman chose an orange while three women and one man chose an apple. In another condition half the men chose oranges and half the women chose apples. They found that the extent to which children copied an adult's preference depended upon the proportion of their sex that made that choice. In the first condition, there was a high degree of same-sex imitation, in the second a much smaller amount, and in the third condition, there was no significant difference between the girls and boys in their choices. This meant that children were not slavishly imitating a same-sex adult but rather judging the appropriateness of a particular (in this case wholly arbitrary) preference on the basis of the proportion of male or female adults who made it. These results helped to make sense of previous work which had already shown that children tended to imitate activities that they already knew to be sex typed, regardless of the sex of the model who was currently engaged in it (Barkley, Ullman, Otto, & Brecht, 1977). What was important was the child's internal working model of gender and behavior.

Until then, the differential treatment and selective imitation views had painted a thoroughly passive view of the child. There he or she sat, slowly being filled with sex-contingent reinforcement and exposure to adult models. Some developmental psychologists rebelled. They knew that children are active participants in their own development—Piaget had shown this. Now Perry and Bussey had put the child's own understanding of gender center stage. It was the genesis of *cognitive learning theory*. Martin and Halverson (1981) argued that children have a natural tendency to think categorically. They form categories about all sorts of things from animals to sports and it would be surprising if they did not, very early in life, form categories of male and female. Once these categories are formed, all incoming information that is gender typical gets shunted into the correct binary slot and over time a stereotype is built up about what males and females look like, do, and enjoy. It is this internal model or schema, not parental training, which drives the child toward sex-appropriate behavior. It was clear that Perry and Bussey, in their search for the mechanisms of imitation, had laid bare the process of creating gender schema. At the very same time that this proposal was being offered for child development, Bem (1981) was proposing an identical schema to explain adult differences in sex typing. She argued that the degree to which we "type" information as gender relevant is an individual difference variable. Women who strongly sex type information become more stereotypically feminine than women who are less inclined to tag information with gender labels. The cognitive revolution had come to sex differences—it was not a matter of behavioral training, it was a matter of mental categorizing, organizing, and recalling.

But the cracks soon began to appear. Children show sex-typed behavior before they are able to label the sex of other children (Ruble & Martin, 1998). Toy choice, play styles, activity levels, and aggression are found as early as two years of age (Brooks & Lewis, 1974; Fagot, 1991; Freedman, 1974; Howes, 1988; Kohnstamm, 1989; O'Brien & Huston, 1985; Roopnarine, 1986) but children are not able to correctly sort pictures of boys and girls into piles until toward the end of their third year (Weinraub, Clements, Sockloff, Ethridge, & Myers, 1984). Although children can point to pictures of boys and girls when instructed to do so somewhat earlier at about 30 months (Etaugh, Grinnell, & Etaugh, 1989; Fagot & Leinbach, 1989), for a gender schema to operate spontaneously and successfully, children should be able to categorize without specific verbal cueing to do so. Yet children prefer sex-congruent toys before they are able to say whether the toy is more appropriate for a boy or a girl (Blakemore, LaRue, & Olejnik, 1979). They prefer to interact with members of their own sex and show sex differences in social behavior before they can label either toys or behaviors as being more common among boys or girls (Serbin, Tonick, & Sternglanz, 1977; Smetana & Letourneau, 1984). Having gender labels at the age of two does not predict sex typing either at the same age or one year later (Campbell, Shirley, & Candy, 2004). Even where a cross-sectional study finds a behavioral difference between children who can label gender and children who cannot, it is found for only some behaviors not others, or for one sex but not the other (Fagot, Leinbach & Hagan, 1986). Children do not need the ability to discriminate the sexes or an understanding of gender stereotypic behavior to show sex differences. Even in later years, as children's gender stereotypes become more crystallized and peak at about seven years of age, there is no relationship between a child's gender knowledge and how sex-stereotypic their own behavior is (Martin, 1994; Powlishta, 1995; Serbin, Moller, Gulko, Powlishta, & Colburne, 1994). As Carol Martin (1993) ruefully concluded after 20 years' immersion in the field, "Seldom are individual differences in behavior and thinking explained by differing levels of gender stereotype knowledge."

But perhaps children really recognize gender at a much earlier age than experimenters' artificial requests to point to pictures of boys and girls reveal. Perhaps they lack the verbal or cognitive skills to execute such a task before the age of three. After all, animals seem to make no mistakes about the sex of their conspecifics and they lack the sophisticated cognitive machinery that we possess. Researchers turned to infants, using an ingenuous method to uncover their ability to categorize the world. Infants, like adults, get bored when they are exposed to the same thing for too long and they turn away—a phenomenon called habituation. Fagot and Leinbach (1993) showed a group of infants, aged between nine and 12 months, a series of photographs of different men's or

women's faces. Every now and again, a face of the opposite sex would be shown. The infants would show a sudden recovery of interest when this unexpected face appeared. This suggested that infants had an implicit category of male and female for, if they did not, how could they detect the category shift when the "unusual" face appeared? This seemed to solve the cognitive problem—infants understand sex much earlier than we thought. But wait—the same type of study has also been performed in the laboratory using different categories such as animal species, rising and falling auditory tones, numbers, colors, and patterns (Bhatt & Rovee-Collier, 1996; Wagner, Winner, Cicchetti, & Gardner, 1981; Xu & Carey, 1996; Younger & Cohen, 1983). All these studies show that infants can habituate and then recover from habituation. Would we want to conclude, therefore, that six-month-old infants brought with them to the laboratory an acquired understanding of the difference between a zebra and a kangaroo? Given their limited exposure to such novel stimuli, how could they? Rather, we infer that during their time in the laboratory, infants develop (rather than reveal) categories for dividing up the perceptual world. So while infants can be experimentally primed to make a male–female distinction, this is not evidence that they have brought it with them from the outside world.

Even if they did have it, it would be of no use to them unless they knew to which sex they themselves belonged. Gender schema can only guide behavior when sex-of-self is incorporated into the schema. Children sort pictures of themselves correctly into the boy or girl pile at about the same time they sort pictures of others—around 36 months (Thompson, 1975; Weinraub et al., 1984). Indeed they do not seem to even recognize themselves in mirrors until about 20 months (Amsterdam, 1972; Campbell et al., 2004). (This is tested by surreptitiously placing a blob of rouge onto the child's nose and allowing them to view themselves in a mirror. If they try to wipe their own nose they have self-recognition. If they try to wipe the nose of the child in the mirror, they do not.) In any case, self-recognition is a necessary but far from sufficient condition for knowing which sex you belong to.

Gender schema theory was all too cognitive and the cognitive data would not fit the developmental time course. And there was the question too obvious to be asked—why do children socialize themselves to behave sex typically? Is the process one of simple social conformity? If so, is gender a special case or do children also schematize themselves in other ways (geeks, athletes) and strive to conform to these categories as much as they do to boy or girl? There lurks beneath cognitive theories a pervasive feeling that there is something special about gender, and that the engine that drives categorization and conformity is an innate propulsion—perhaps not to be aggressive or nurturing—but at least to realize oneself as a male or female.

At the heart of gender schema theory lie stereotypes. Initially crude and concrete (boys like trucks, girls like dolls), they become increasingly abstract and metaphorical with increasing age (men are more competitive, women more cooperative). We construct them from bits and pieces of observation—from the media, from watching others, from gossip and myths. And it is stereotypes that form the foundation for another explanation of sex differences—*social role theory*. According to this formulation, the division of labor in society, rather than the child's natural tendency to form categories, is the starting point for sex differences. Men occupy roles that require competitiveness, autonomy, and aggression. Women occupy roles that require nurturance, caring, and cooperation. These roles draw out of their occupants the commensurate qualities and skills. These in turn set up stereotypes that embody beliefs about the appropriateness of expected characteristics. "Expectancy confirming behaviour should be especially common when expectancies are broadly shared in a society, as is the case for the expectancies about women and men" (Eagly, 1987, p. 15). These expectancies are internalized psychologically, resulting in sex differences in both behavior and self-perception.

During the last years of the twentieth century, there was a significant change in the nature of women's labor as they moved into many arenas traditionally occupied by men. We might therefore expect to see a shift in both stereotypes and self-perceptions by men and women. No such shift occurred (Helmreich, Spence, & Gibson, 1982; Lewin & Tragos, 1987; Lueptow, 1985). Furthermore, we would expect to see a fair degree of cultural specificity with "traditional" societies showing more marked stereotypes than more egalitarian ones. We do not (Williams & Best, 1982). Social role theory supposes that sex differences follow stereotypes and hence that stereotypes should be more extreme and polarized than actual sex differences. They are not (Swim, 1994). We are left with the alternative suggestion that stereotypes are reasonably accurate assessments of the typical differences between men and women and that, rather than stereotypes causing sex differences, the reverse is the case. If this is true then we at least have a means of explaining the typical division of labor between the sexes (women prefer to spend more time than men do in parenting activities) which social role theory could not do.

Indeed its authors recognized that they must find a way to explain the origins of the sexual division of labor which, after all, formed the hinge pin of their whole theory. But there was a problem: in all cultures women assume the major burden of childcare while men (but rarely women) engage in warfare and violence. The most obvious candidate for explaining such human universals is evolutionary psychology, but this was not a route that appealed to Wood and Eagly (2002). Their radical solution was to divorce the mind from the body

and allow evolution to work only on the latter: "Our biosocial model does not assume that any sexual selection pressures that contributed to physical dimorphism between the sexes are major influences on sex-typed psychological attributes" (p. 702). They acknowledged that men have greater size, upper body strength, and speed—this fits them perfectly for their "social role" in aggression and warfare. Women are capable of giving birth and lactating—this makes them good candidates for their "social role" as mothers. But the argument that bodily differences gave rise to the sexual division of labor begged some obvious questions. Where did these morphological differences come from? If they were not created by evolutionary sexual selection pressures, what caused them? And why do we share these physical dimorphisms with so many other species? Addressing these physical sex differences inevitably plunged Wood and Eagly into recognition of hormonal effects. They accepted not only that testosterone fosters muscle development, but also that it rises and falls in men in response to competition in order to direct men's "physical and cognitive performance." How did such a useful hormonal adjustment occur, if not through evolution? But if that were true, then Wood and Eagly would have to accept that competition was of central importance to male reproductive success and that selection had therefore acted on the male brain as well as male muscle. Perhaps more importantly, how does their acknowledgement of the psychological impact of testosterone square with their argument that evolution has had no effect on "sex-typed psychological attributes"? Endocrinologists have known for many years that testosterone, aromatized to estrogen, crosses the blood–brain barrier. Their neat disjunction between body and brain is not one that hormones or biological evolution respects.

With the "bio" side of their biosocial model addressed, the authors turned their attention to the argument concerning its social dimension: sex differences vary in magnitude across cultures. This results, they proposed, from differences in local ecology and technology which affect social role demands and hence the rigidity or plasticity of the sexual division of labor. Evolutionary theory, as it is caricatured by Wood and Eagly, stipulates that men but not women provide food. Why then, they ask, does the contribution of women and men to subsistence vary across cultures? Evolutionary theory predicts (and data confirm) that mothers everywhere spend more time with children than fathers—but why then, they ask, does the proportion of childcare contributed by men vary? Their conclusion: evolutionary theory must be wrong. But this rests on a profound misunderstanding of evolution and facultative adjustment. Evolution depends on the degree of fit between the organism and the environment. Because ecologies vary, so must the characteristics that are best suited to it. Evolution has built the ability to adjust, creating a kind of inherited intelligence. In plants, hardly

noted for their sophisticated cognitive abilities, phototaxis causes them to orient toward the source of sunlight. In some species of teleost fish, the prevailing sex ratio causes some individuals to change sex. When we consider humans, with their unique ability to envisage hypothetical futures and to solve problems, the potential for a flexible response to the environment magnifies considerably. But I am getting ahead of myself.

Nobody can seriously doubt that environmental factors modify the expression of sex differences. The problem with socialization theories is that they ask the environment to do *all* of the work. They fail to recognize that the environment is acting on an evolved organ—the mind. Of course, forces such as reinforcement, imitation, cognitive schema, and conformity all modulate our actions. The pleasure of social approval, the ability to learn through observation, our internal representations, and the desire to be like others—these are part of human psychology everywhere. The question is whether these processes alone can explain the *origins* of the cross-cultural differences between male and female. Altering reinforcement contingencies for sex-typical behavior can temporarily change it: boys and girls will show cross-sex play where the environment is manipulated to encourage it and social approval is contingent on it. But when that intervention is removed, children revert to the same-sex preference that characterizes children everywhere (Serbin, Tonick, & Sternganz, 1977; Theokas, Ramsey, & Sweeney, 1993). Demeanor and language that used to be frowned on in young women as "masculine" is now unremarkable. But there is no link between girls' cultural approval of these new female behaviors and their level of aggression (Muncer, Campbell, Jervis, & Lewis, 2001): we have as yet seen no change in the universal tendency for men to be more violent than women. As new opportunities open to women, they eagerly accept them. Women's entry into hitherto masculine areas of achievement such as science, engineering, and entrepreneurship has been remarkable. Yet still, for the majority of women, occupational choice rests as heavily on the social as on the financial rewards and on the extent to which their work can be effectively combined with motherhood (Browne, 1995; Ceci, Williams, & Barnett, 2009; Geary, 1998).

Where we can open up new opportunities for women's self-expression, enjoyment, and achievement we should do it because it is morally right. But that is very different from saying that gender has no biological basis and that the nature of men and women is wholly constructed by society. The problem with such a position is that it fails to address the issue of why sex differences take the particular form that they do. If gender differences are arbitrary, it is a curious coincidence that they follow such a similar pattern around the world. Even if sex differences were driven by differential parental treatment, we would still want to ask why a trait is considered more desirable for one

sex than another. If they were driven by selective imitation, we would still want to ask why children might show a preferential and untutored interest in the behavior of their own sex. If driven by gender schema, we would need to ask why sex-specific conformity is so attractive to children. If driven by the division of labor, we still need to explain the preference of men and women for different social and occupational roles. Social constructionist and environmental theories explain the transmission of the gendered status quo—but without asking where it came from.

Evolutionary psychology

Evolutionary theory addresses this very question. And the Darwinian algorithm is so elegant that it can be stated in five words: random genetic variation, non-random selection. Evolutionary psychology is the application of evolutionary principles to the study of the evolution of mind (Tooby & Cosmides, 1992). Natural and sexual selection pressures which shaped species-typical aspects of our anatomy (bipedalism, cranial capacity, gestation length) are assumed to have orchestrated the architecture of the human mind which in turn drives behavior. Evolutionary psychology holds that psychological attributes that conferred significant benefits in terms of survival and reproduction upon their bearer (relative to others who did not possess such attributes) are present today in the form of evolved adaptations designed to solve such specific ancestral problems as enhancing paternal certainty (Wilson & Daly, 1992), optimizing mate selection (Buss, 1989a), speedily acquiring language (Pinker, 1994), comprehending the mental state of others (Baron-Cohen, 1997), and weighting the costs of risky encounters (Campbell, 1999).

The distinguishing features of evolutionary psychology are fourfold. First, it is ultimately concerned with *mechanisms of mind* and not simply behavior. This distinguishes it from sociobiology in which comparisons are made between animal and human behaviors and implications are drawn about a common evolutionary pathway or about convergent evolution between species under similar selection pressures. Primate behavior is often described and discussed by evolutionary psychologists (and I will be doing this too) because many human adaptations are shared with other species and emerged prior to human speciation (Foley, 1996). Such behavioral comparisons are a starting point for attempting to locate the mental mechanisms which produce it. To do this, we need to ask questions about function—what does this behavior achieve? And to answer this we need a description of the circumstances under which the behavior appears and whether or not it solves an adaptive problem. But evolutionary psychology also asks about the relevant inputs to the mental device and the range of outputs

that can appear. This is important in understanding flexibility of action—how the life stage and competencies of the organism, together with perception of the past and current environment, affect the strategy that is implemented. The same mechanisms can give rise to different manifest behaviors. Competition for resources, for example, can lead to combat, the formation of advantageous alliances, or dispersion to new ecological niches. The same mechanism can produce different manifest behaviors given different inputs; babies raised in China speak a different language from infants raised in England but that does not invalidate the existence of a universal mental device for acquiring the language heard in the local community. We are searching for the deep structure not only of language but of other universal human abilities including kin recognition, mate selection, and sexual jealousy despite the fact that their behavioral expression may vary.

Second, evolutionary psychology conceives of the *mind as an adapted organ*. Some have likened it to a Swiss army knife, equipped with many specific modules, each geared to the speedy and seemingly effortless processing and resolving of problems (Tooby & Cosmides, 1992). This view assumes that the environment of adaptation presented similar classes of problem again and again, resulting in selection of those specific mental abilities that were advantageous in solving them. The presence of a predator produces activity in the fear center of the amygdala at a pre-conscious level that triggers alertness and evasion even before we have consciously registered exactly what the threat is. (The path to the sensory cortex is slower and more roundabout than the direct pathway to the amygdala.) Fast-approaching objects on a collision course with us were a sufficient danger in our evolutionary past that infants today will fall backward when an object is made to "loom" (by simply increasing its size) on a screen in front of them. This reflex was sufficiently useful as an adaptation that it is now hardwired. The mind is a collection of modules that reliably develop in a wide range of environments. Some are simple reflexes, but many more are not. Humans have a tendency to commit various cognitive "errors" that have been successful rules of thumb in our evolutionary past. One is the availability heuristic—we judge the likelihood of events in terms of the ease with which we can recall instances of their occurrence. When asked whether accidents or cardiovascular disease accounts for more deaths in the United States, most people reply that accidents do. In fact, accidents account for 5 percent of deaths annually compared to 50 percent from heart attacks and strokes. Accidents are more vivid and memorable and their prominence in our memory misleads us (Tversky & Kahneman, 1974). In ancestral communities, only about half of infants survived to adulthood and many of these deaths would have been traumatic. The ability to attend to and recall such lethal threats (and consequently to

overestimate their frequency) had advantages. For evolutionary psychologists, many human psychological abilities (controversially, some would say all) are hardwired and encapsulated mental modules—theory of mind; spatial orientation; numeracy; kin detection, face recognition, and a range of emotional systems including fear, disgust, and jealousy (Barrett & Kurzban, 2006).

The argument for this modular view of mind rests on three main points. The first is that specialized modules work faster and more efficiently than a general-purpose problem solver—they accept only certain kinds of input and are equipped with an algorithm that speedily generates a solution. Speed is of the essence in many situations of life and death, and these are the very situations on which natural selection operates most potently. A second point is what has become known as the frame problem. At any given moment in our lives our brains are assaulted by billions of bits of information. If an immediate decision is required (Shall I run from this tiger or finish eating this apple?), a general-purpose mind would first have to identify which of thousands of perceptual factors might be relevant to answering the question. (Is the sky blue? Is the species of tiger relevant? Is the ripeness of the fruit important? . . .) The reason these options sound ridiculous is precisely because our evolved mind is already furnished with a module that has solved the frame problem for us—it has automatically sifted out these factors as irrelevant. This computational efficiency is nowhere better exemplified than in language acquisition (Pinker, 1994, 1997). Babies acquire their native language in a couple of years. Yet to work out the rules underlying the grammatical structure of language in this period of time is impossible. The baby seems to arrive equipped with a program that directs it to correct linguistic constructions and allows meaning to be mapped to them. Finally, other bodily organs are not all-purpose designs: evolution appears to select for specific function so that hearts pump blood, kidneys maintain water balance, and so on.

Yet the massive modularity idea has proved controversial. It is relatively easy to accept that some lower-level brain functions are modular in the sense that they are sensitive to only certain inputs, encapsulated from other psychological processes, operate below conscious awareness, and automatically generate certain outputs (Fodor, 1983). Vision is a classic example. We have conscious access only to the products of the visual system, not to its processes. We see the world effortlessly and automatically. The modularity of the system makes it resistant to conscious interference—look around you now and try *not* to see your surroundings in three dimensions or in color. Emotional reactions have this same quality: when asked to eat a piece of fudge shaped to resemble feces, most people refuse because it is difficult to consciously override the automatic disgust module that has been so adaptive in our evolutionary past (Rozin,

Millman, & Nemeroff, 1986). But when we reach higher levels of cognition, can modularity still work? Cosmides (1989) believes that even something as apparently cognitively demanding as the ability to detect cheating on a social contract is a modular system. She asked subjects to choose which (out of four) pieces of information would be required to establish if a social rule was being broken (underage drinking). The speed and success rate was much higher than when the same task was framed as a decision that could be solved only by the application of formal logic.

Others are more skeptical. They go under the banner of dual-process theorists (Evans, 2008; MacDonald, 2008; Stanovich, 2004). They argue for two evolved systems. The reflexive system (sometimes more neutrally called System 1) is modular. It is unconscious, automatic, fast, requires little effort, and has a high capacity to process information. It is universal and does not depend on intelligence. Many evolutionary psychologists believe that this is an ancient system and one that we share with other species. The reflective system (System 2) is uniquely human, although elements of it can be seen in other primates. It is conscious, controlled, requires high effort, and has low capacity to process information. It is analytic, logical, and linked to language. The performance of this system is affected by individual differences in intelligence and working memory capacity. It is this system that allows us to play chess, and solve algebra problems—activities that are evolutionarily novel and hence for which we have no specific modular adaptation. It provides the cognitive "imagination" that allows us to envision the future and to engage in conditional and hypothetical thinking. This reflective system has an inhibitory role also: it suppresses the "automatic" behavioral tendencies generated by the reflexive system. We restrain the reflexive tendency to lash out when angry, to yawn during a conversation, or to laugh when we see a friend's pratfall. When evolutionary psychology first opened its doors, "massive modularity" was specified as an essential requirement of an evolutionary approach (Tooby & Cosmides, 1992). This is no longer the case. But whether the evolution of the human mind culminated in a set of discrete modules or whether these were complemented by a high-level general problem solver, evolutionary psychologists do not doubt the human mind is an evolved organ.

Third, evolutionary psychology *does not conceive of the mind as a conscious fitness maximizing device*. To appreciate this, the distinction between ultimate and proximate causes is crucial (Tinbergen, 1963). When we pose a "Why?" question about the causes of a behavior, there are at least two answers—both of them correct but in different ways. Why does a baby cry? At a proximate level, it cries to attract the attention of its caregiver. At an ultimate level it cries to increase its chances of survival and its future reproductive success. The ultimate

causes of behavior are evolutionary and the proximate causes are the immediate mechanisms by which this larger goal is achieved. These mechanisms are adaptations that evolved incrementally over evolutionary time because individuals who possessed them (a baby who cried when hungry or endangered) survived more often than those who did not. These adaptations mean that animals, including ourselves, do not need to be conscious of the grand evolutionary picture because lower-level adaptations will automatically keep our actions on the right evolutionary path. Hunger makes us want to eat. Pain makes us avoid its source. Physical attraction makes us want sex. We have emotional responses that trigger evolutionarily appropriate tendencies to approach and avoid stimuli. Understanding the function of these adaptations and how they work is the focus of much evolutionary psychology.

It is also what distinguishes evolutionary psychology from its sister discipline of behavioral ecology, sometimes called Darwinian anthropology (Smith, Borgerhoff Mulder, & Hill, 2001; Tooby & Cosmides, 1990a). Behavioral ecologists focus on the way in which contemporary human communities optimize their interaction with others and their environment. Their subjects are usually peoples whose way of life corresponds to earlier human subsistence patterns; hunter gatherers, pastoralists, and agriculturalists. For example, optimal foraging theory is concerned with the net gain or loss in calories that are contingent on different organization of foraging. Their measure of fitness of a community's strategy is the extent to which it corresponds to statistical models of the most efficient means of calorie replenishment. Behavioral ecologists have been characterized as "baby counters" (Betzig, 1998). They examine which modes of kin and community organizations result in the highest yield of surviving children. The assumption is that humans do whatever they can to maximize their survival and success, and this entails the usually unspoken presumption that the mind is an all-purpose fitness maximizing device designed to operate adaptively in any environment in which it finds itself.

This focus on the optimization of current behavior is one way in which behavioral ecology differs from evolutionary psychology. Evolutionary psychology argues that much present behavior is a function of the *past* adaptive success of genetically encoded mental modules. Adaptiveness is a property of the past because that is where selection occurred. To know if a current behavior is adaptive we would have to return in several hundred thousand years, find what traits had gone to fixation, and trace the reproductive success of humans who had the necessary rudimentary adaptation compared to those who did not. Because the current environment differs from the one in which we evolved, it is quite possible that an adaptation is not currently adaptive. Men's fascination (some might say obsession) with sex stood them in good stead to take advantage of

unexpected mating opportunities in ancestral times. Recently this adaptation has been exploited by 24-hour Internet pornography which not only threatens to undermine work productivity but may be creating a new form of behavioral addiction (Robinson, 2011). Our preference for fat and sugar was useful at a time when meat and berries were nutritious and rare. They are currently responsible for obesity and heart disease in an environment where sources are too plentiful. Indeed our appetite for sugar is so strong that, rather than simply refusing it, we go to extraordinary lengths to develop chemicals that mimic the taste while removing the calories. The question for any putative adaptation is "What did it do for us back then?" Although we can (and do) surmise on the apparent mismatches between evolved adaptations and current environments (Crawford, 1998), we cannot meaningfully speak of adaptations-in-the-making until the unknown future environment has a chance to make its genetic selection.

But the rise of dual-process theory brings evolutionary psychology and behavioral ecology much closer. As evolutionary psychologists recognize the evolution of the higher order and very human process of problem solving, they approach the territory of behavioral ecologists. The advantage of our creative intelligence is that it allows online adaptation to short-term fluctuations in our environment. We can imagine the different futures to which our current actions might lead and we adjust our behavior accordingly. We have become what Daniel Dennett (1997) calls "Popperian creatures" (in honor of the philosopher Karl Popper) because foresight means that our hypotheses can die in our stead. If a woman must make a decision as to the best foraging strategy, she can formulate the problem (food located at a minimum of two kilometers away), generate a number of possible solutions (the net utilities of various permutations of traveling alone, carrying the baby, leaving an older child at camp, traveling early before the sun gets hot, relying on leftovers from relatives), and select the most successful strategy. Now the chief difference between evolutionary psychologists and behavioral ecologists is reduced to the difference between explanations of individual minds and descriptions of group-level behavior. Evolutionary psychologists want to explain what mental processes are needed for decision-making and how such mechanisms evolved. Behavioral ecologists gather descriptive data from the field about how the ecology or social environment affects birth spacing, or longevity, or patrilocality. There is more and more scope for close cooperation between the two approaches.

Lastly, evolutionary psychology is chiefly concerned with *species-typical adaptations*. It seeks to explain the emotions, algorithms, and strategies that are common and central to all human experience (even though their behavioral manifestation may vary from one culture to the next and though they may only be activated given appropriate environmental input). This sets it apart from

behavior genetics. Behavioral geneticists are engaged in a statistical attempt to explain differences between people in a population with respect to a given psychological trait. Using adoption and twin studies, they attempt to fit mathematical models that distribute the variance in a trait to environmental and genetic sources. The whole enterprise depends essentially on the presence of variance. But for species-typical traits, no variance exists. Because we have all evolved to have one heart and two lungs, there is no variability on this attribute (genetic abnormality aside). The trait has gone to fixation and falls out of the purview of behavior genetics. The very existence of a heritable component for any trait tells us that it has not reached fixation and is not possessed uniformly by every human being. Evolutionary psychologists are not uninterested in variability (and in Chapter 8 I shall have more to say on this) but to see the big picture of evolution we must dwell not on the noise but on the signal—those traits that were acted upon by selection to the point that they came to characterize the whole species.

We need a crucial caveat, however, when we talk of universality. Humans come in two distinct morphs—women and men—differentiated by the size of the gametes that they contribute to sexual reproduction. The bulk of selection pressures—disease, predators, famine—affected both sexes equally and no sex differences are expected in psychological mechanisms that allow us to cope with these threats. The majority of traits that were advantageous are passed on by sexual recombination to both daughters and sons regardless of whether they were contributed by the mother or the father. (Later in the book this statement will have to be complicated by the discussion of genomic imprinting—a process by which the expression of some traits depends upon the parent that contributed them.) Where the sexes differ, it is the result of sexual rather than natural selection. The strategies that enhanced reproductive success in women were not identical to those that enhanced it in men. Through sex linkage and sex limitation evolution has coupled genetically encoded adaptive strategies to the sex of the individual receiving them.

What evolutionary psychology offers is the hope of integration in the understanding of human behavior. Using the most powerful theoretical development of the last hundred years, we are finally able to address the "Why?" question and to ask it together with other disciplines that have long ago accepted the premise of adaptation. Psychologists must work with and depend on other disciplines if the enterprise is to be successful. We need primatology to help us understand the common and unique paths of adaptation in the anthropoid line. We need paleoanthropology to track the evolving size and shape of the brain. We need archaeologists to describe the man-made tools and art that were part of the early emergence of *Homo sapiens*. We need anthropology to describe and

document the varieties of human solutions to ecological and social problems. We need geneticists to map the genome and tie complex psychological traits to their even more complex interacting genetic loci. We need biologists to identify the mutual paths between genes, hormones, and environment. We need developmentalists to document the trajectory and constraints on the successful emergence of human capabilities. We need neuroscientists to identify the evolution and modification of structures that govern specific human emotions and actions. We need pharmacologists to help us understand the actions of neurotransmitters and their relationship to subjective experience. As psychologists, our contribution is to identify the characteristics and parameters of the mental mechanisms that drive behavior. It will be a long and cooperative undertaking if it is to be finally successful.

The meteoric rise of evolutionary psychology has been impressive—but it has not gone unchallenged. Its birth in the 1990s was greeted with disapproving howls as feminists attacked its politics and its scientific status—and sometimes both simultaneously.

Bad politics?

> Sociobiology functions as a political theory and program. (Bleier, 1984, p. 46)
>
> Evolutionary psychology is not only a new science, it is a vision of morality and social order, a guide to moral behaviour and policy agendas. (Nelkin, 2000, p. 20)
>
> . . . the biological accounts of male-female difference and male dominance that have emerged since the mid-nineteenth century have merely used the language of science, rather than the language of religion, to rationalise and legitimise the status quo. (Bem, 1993, p. 6)
>
> Nevertheless, the social construction of the categories "woman" and "man" has been historically justified by reference to biological differences, and the modern tendency to provide essentialist and reductionist explanations which include the effects of genes and hormones can be viewed as a contemporary manifestation of this long-standing tradition. (Muldoon & Reilly, 1998, p. 63)
>
> Sociobiologists are . . . constructing a framework of ideas about what is natural and what is not. Women who enter professions that are typical of men are therefore seen as unnatural and going against their biology; so too are men who take up professions using abilities considered typical of women. These "unnatural" women and men are considered to threaten the fabric of society, as seen and maintained by those (scientists, politicians, business leaders and the general public) who see genes as paramount in causing sex differences in behavior. (Rogers, 1999, p. 49)
>
> Ought science to be seen as truth-telling, or as politics by other means, or can it be both things at the same time? (Fausto-Sterling, 1992, p. 58)

As these quotes show, one line of attack has come from those who are more concerned with the political implications of evolutionary psychology than with its truth value. As they see it, any attempt to identify a universal human nature

and to posit a biological basis is equivalent to abandoning all hope of social progress. For them, evolutionary psychology is about the maintenance of the status quo and the rejection of a liberal agenda. Some go further, viewing evolutionary psychology as a right-wing conspiracy (see Segerstrale, 2000), despite the fact that evolutionary psychologists share the same left-of-center views as other branches of psychology and are considerably less conservative than average Americans (Tybur, Miller, & Gangestad, 2007). Many of the most vehement objections come from feminists who have been particularly offended by the proposal that universal sex differences may have a biological basis. But let's unpack their arguments and take them one at a time.

Charge 1: Evolutionary theory is biological determinism. Evolutionary theory is certainly biological. It argues from the premise that the genes associated with phenotypic characteristics that increase survival and reproductive success will increase over generations. For feminists, the real issue is whether there are other biological differences between males and females aside from the somatic changes that are triggered by the 23rd chromosome pair. In short, are some psychological traits sex linked (carried on one of the sex-determining chromosomes) or sex limited (carried on autosomes and triggered by the presence of male or female hormones)?

Most feminists agree that there are two sexes possessing different reproductive organs and that the two sexes also differ on average in height, strength, and fat distribution (Lewontin, 1994). However, some writers do not even concede these facts—Muldoon and Reilly (1998, p. 55) believe that "the objectivity of 'hard science' in this area can be questioned, so much so that the biological definition of sex itself becomes untenable." They suggest that there is no biological basis for our belief in male and female as "dichotomous, mutually exclusive categories" (see also Bem, 1993). Notwithstanding these authors' uncertainty, most feminists broadly agree that there are two discriminable sexes. Indeed most feminists are even willing to acknowledge that biological differences are the result of evolution—provided that biology stops at the neck (Bem, 1993; Wood & Eagly, 2002). Even though the brain is the most expensive organ in the human body in terms of calorie consumption, and even though feminists accept that hominid brain size itself was a result of natural selection, feminists reject the notion that evolution could have had an impact on the minds of men and women. Though successful reproduction is the reason for our existence today and though the sexes play vital and different roles in that process, feminists reject any notion that their minds may have been sculpted by millions of years of evolution to pursue different strategies.

Most five-year-old children also agree that people are either male or female. They will also tell you that boys are rougher and fight more than girls do. They

are correct. The sex difference in physical aggression is evident in naturalistic studies of playgrounds, in experimental studies of undergraduates, in psychometric inventories, and in criminal justice statistics (Eagly, 1987; Hyde, 1986; Kruttschnitt, 1994). This sex difference is cross-cultural and trans-historical (Daly & Wilson, 1988). There are no human societies in which women commit more violent crime than men. We also know that in animal species like our own, in which females provide the bulk of parental investment, the same sex difference exists (Geary, 2000). We have seen too that children show sex differences in aggression before the age at which they can correctly label the sex of others or sort photographs correctly by sex. Together these facts strongly suggest a very fundamental difference between the sexes in aggression and one that, however biologically mediated, may be traced back ultimately to differential evolutionary pressures on the two sexes. It is important to bear in mind that evolutionary theory predicts sex differences in only a few psychological domains—those that are relevant to male and female roles in sexual reproduction. There would be no evolutionary reason to suppose that men and women should differ on average with regard to sociability, intelligence, sense of humor, or openness to experience (to name but a few) and they do not. There is every reason to think that they should differ in nurturance, hostility, and assertiveness and they do (Feingold, 1994).

The "determinism issue" relates to the erroneous belief that genes alone direct development and behavior. Patently, this is not the case—although it is a straw man that is frequently used to bait evolutionists. Take three examples culled from many dozen similar pronouncements:

> Sociobiologists argue that these strategies are given by biology and thus imply that they are eternally fixed features of human sexual relations. (Sayers, 1982, p. 60)
>
> By reducing human behaviour and complex social phenomenon to genes and to inherited and programmed mechanisms of neuronal firing, the message of the new Wilsonian Sociobiology becomes rapidly clear: we had better resign ourselves to the fact that the more unsavoury aspects of human behavior, like wars, racism, and class struggle, are inevitable results of evolutionary adaptations based in our genes. (Bleier, 1984, p. 15)
>
> [Genes] are therefore seen as the source of human behaviour, including sex differences in monogamy and polygamy, aggression and the perception of beauty. This is clearly a reductionist position. Of course, genes have a part to play in the development of sex differences and other behaviours, but it need not be any more important than other influences from both inside and outside the body and the part played by genes may not be separable from these other influences. (Rogers, 1999, p. 44)

Where are these evolutionary psychologists who allege that genes operate without reference to hormones, experience, or environment? Wherever they

are, I have not been able to locate them. Rather it is environmentalists who set up mythical distinctions between nature and nurture in order to maintain a clear line between the politically correct and incorrect. As Margo Wilson and her co-workers (1997, p. 433) explained:

> "Biology" is the study of the attributes of living things, and only living things can be "social". So whence this idea of antithesis? . . . The irony is that developmentally, experientially and circumstantially contingent variation is precisely what evolution-minded theories of social phenomenon . . . are all about.

Surely it is evident that the ultimate success of a given individual in evolutionary terms depends upon manifest behavior which in turn derives from a particular gene–environment complex. Smuts (1995) provides a good example of this. Cooper and Zubek (1958) took strains of maze-bright and maze-dull rats that had been so successfully bred that there was no overlap in their maze performance. They then reared a new generation under normal, enriched, or impoverished conditions. All of the rats who were raised in the enriched environment performed as well as the maze bright rats that were reared normally. All the rats raised under impoverished conditions performed as poorly as maze dull rats reared normally. Behavior depends upon the confluence of genetic disposition and environmental influences.

The environment interacts with genetic predispositions in a variety of ways (Buss, Haselton, Shackelford, Bleske, & Wakefield, 1998). Some environmental parameters are necessary for the emergence of adaptations—absence of contact with a language-using community can severely disrupt the development of language and early close contact with a reliable caretaker seems to be important for later social and emotional functioning. Early developmental events may channel individuals into different pathways by setting different expectations about the environment. Father-absent children are more inclined to pursue short-term mating patterns with the expectation that paternal investment is a statistically rare event. Families and communities characterized by high levels of competition and hostility set children on a more aggressive life course than those whose early interactions are more stable and cooperative. Other genetic tendencies are expressed only if the environment provides the necessary trigger—nicotine addiction has a high genetic component but whether it is activated depends upon environmental (and sometimes chance) factors such as exposure to peers who smoke. Environmental experiences can alter the expression of adaptations—sexual jealousy seems to be activated only when people experience a deep and exclusive attachment to a romantic and sexual partner. The emergence of one strategy rather than another depends upon a variety of contemporaneous factors such as the life stage of the individual, the prevailing sex ratio, the number of alternative avenues of action, and her behavioral

and psychological competencies. Humans are characterized by facultative responses to the demands of their environment. Differences between societies and between individuals are seen by evolutionary psychologists as environmentally induced variation in the expression of similar genotypes.

In evolutionary theory, genetic predispositions orchestrate universal trends in human psychology and behavior and thus create what is often called human nature. It also directs particular male and female natures in some psychological modalities. However, superimposed upon these, we must take into account the impact of the environment in both development (nutrition, education, opportunities congenial to the development of particular abilities) and facultative adaptation (the particular environmental input that inform decisions about behavioral strategies).

Charge 2: Evolutionary theory is simplistic and reductionist. Evolution is the process of selection which causes differential survival and reproduction of individuals as a function of their performance in a particular ecological niche. I can think of few other theories that can be expressed so succinctly. Yet pejorative accusations of "simplistic" notwithstanding, it is apparently not simple enough to escape misunderstanding. Fausto-Sterling (1992), a biologist and vocal critic of evolutionary psychology, correctly explains the evolutionary premise that the sex which makes the lower parental investment (typically males) tends to display greater promiscuity in its mating habits. She then points to female promiscuity in phalaropes (sea snipes) exclaiming "You name your animal species and make your political point." The non-political point which she completely misses is that in the phalarope it is the male not the female that makes the greater parental investment. Hence this example is entirely consistent with evolutionary theory and merely demonstrates what the theory has always argued—it is parental investment not sex per se that drives mating strategy.

The truly remarkable thing about evolution is that, although the theory itself is simple, it leads to highly varied and often counter-intuitive hypotheses. An evolutionary analysis of incest developed by Edvard Westermarck argued that people develop an aversion to sexual contact with individuals with whom they spent their infancy and childhood years (normally siblings). One counter-intuitive prediction was that children raised in kibbutzim should avoid marriage with their kindergarten peers despite their non-relatedness. This prediction turned out to be true (Shepher, 1983). A different strand of evolutionary thought has been concerned with homogamy (the tendency for like to mate with like). Together these two pieces of work can explain reports that siblings separated at birth and then reunited in adulthood tend (often to their distress) to find one another sexually attractive. This seems to me to be simplicity at its best—a simple theory that is able to explain apparently unrelated and unexpected findings in the real

world. There was a time when simplicity used to be called elegance and constituted one of the criteria for explanatory quality—if the data equally support two theories then the simpler one is the better one.

The charge of reductionism comes in two forms. The first objects to the "reduction" of complex human behavior to the action of genes and we have already discussed the fact that no serious evolutionary psychologist believes that genes can operate independently of the environment (although many feminists apparently fear that they may). The second highlights a failure to include the full range of variables that are needed to account for a given behavior. No scientist really wants this contrived simplicity, any more than her critics do. We would all love to offer complete theories that account for the full range and diversity of human behavior. But reductionism is a necessary evil. It is a stepping stone that allows us to work toward the truth by first decomposing the explanation into its constituent elements. If (as many feminists prescribe) we reject reductionism and take on the full complexity of a phenomenon as it appears in the real world, we are faced with an insurmountable problem. Every event is determined by multiple causes and no event is ever exactly repeated. So without "reductionism" (the identification of causal factors and their interaction) we can offer only a description and nothing more. We cannot generalize beyond the historical moment and the actors involved. Feminists, like Gestalt psychologists, argue that the whole is more than the sum of the parts. So if as scientists we remove or introduce variables to observe their effect, we have "committed reductionism" by accepting the decomposability of what we study. Many feminists are happy to reject scientific method. But in making that choice, they become historians (not psychologists) describing (but not explaining) non-generalizable and unique events by the use of a subjective interpretation (that is itself the product of a particular moment in history, geography, and culture).

Charge 3: There are no human universals and hence no such thing as human nature. If something is universal, it may reflect a fundamental human nature and, if such a thing exists at a biological level, then attempts to ameliorate the status quo are doomed. This is the shaky reasoning that underpins the enormous kudos given to anthropologists who return from their travels with reports of novel and bizarre behavior in exotic locations. Obvious hoaxes such as Carlos Castenada's dissertation on Don Juan or the discovery of the Tasaday (who were inventions of the Marcos government) were eagerly and, for many years, uncritically embraced by cultural anthropologists. Especially welcomed was Margaret Mead's (1935) challenge to the traditional equations of masculinity with aggression, and femininity with gentleness. She conveniently found, within a hundred-mile area, three tribes in which these equations broke down; the Arapesh (both sexes gentle), Mundugumor (both sexes aggressive), and the Tschambuli (sex role

reversed). Since that time, her claims have been discredited by other researchers and these have been carefully documented by Freeman (1983). Her determination to demonstrate the existence of these three anomalous permutations of sex and temperament lead her to some strange interpretations of her observations. Though she argued that among the Mundugumor both sexes are violent, the men express it through murder, rape, and head-hunting raids, while the women express it by serving tastier dishes than their co-wives. Among the allegedly gentle Arapesh, young men were not initiated into adulthood until they had committed homicide. Among the sex-role reversed Tschambuli, the make-up worn by men celebrates their killing of an enemy and the "aggressive" women were frequently beaten by their "gentle" husbands. Anthropologists vocally encouraged reports of cultural difference rather than cultural similarity (Geerz, 1984) and this no doubt affected the way in which field workers interpreted the behavior that they had witnessed.

Critics often seem confused about just what is meant by human nature. Consider the following quote from Sandra Bem (1993, pp. 21–22): "As a biological species, human beings do not have wings, which meant that it was part of human nature to be unable to fly. But now human beings have invented airplanes, which means that it is no longer part of universal human nature to be unable to fly." Now the idea that sitting in flying machine 30,000 feet above the ground constitutes an alteration of "human nature" is an odd distortion of the concept. The evolution of wings might indeed have led to a radical alteration of human nature but we have not evolved them. Has air travel in any way lead to an alteration in our physical morphology? Do we seriously suppose that airplane passengers show a different psychology or physiology to those who have not flown?

It is equally hard to know what to make of Fausto-Sterling's (1992, p. 199) claim that "there is no single undisputed claim about universal human behavior (sexual or otherwise)." Presumably even the most ardent cultural relativist would accept that everywhere; people live in societies; they eat, sleep, and make love; and that women give birth and men do not. The arguments seem to arise when we move from basic universals to their specific behavioral expression. Though everywhere women are the principal caretakers of children, the fact that there may be variation in how that task is fulfilled leads some anthropologists to conclude that mothering is not universal. This is analogous to arguing that because people eat different food in different parts of the world, eating is not universal. Evolutionary psychologists do not argue for cultural invariance in the expression of evolved adaptations. As Tooby and Cosmides (1992, p. 45) put it, "manifest expressions may differ between individuals when different environmental inputs are operated on by the same procedures to produce

different manifest outputs." At a behavioral level, the expression of the mechanism may vary but that does not question the universality of the generative mechanism itself.

Fortunately Donald Brown (1991), trained in the standard ethnographic tradition, has documented the extent of human universals. The list is astoundingly long but here is a taste of the hundreds that he finds: gossip, lying, verbal humor, storytelling, metaphor, distinction between mother and father, kinship categories, logical relations, interpreting intention from behavior and recognition of six basic emotions. Of special interest to the study of gender we find: binary distinctions between men and women, division of labor by sex, more child care by women, more aggression and violence by men, acknowledgement of differences between male and female natures, and domination by men in the public political sphere.

Now this last observation (that men predominate in positions of power) provides a nice example of the extreme reluctance of cultural anthropologists to acknowledge universals. In 1973, Steven Goldberg wrote a book documenting the universality of patriarchy. He was inundated with letters informing him that he was wrong and pointing out counter-examples. (Other feminists were more willing to accept his premise, see Bem, 1993; Millett, 1969; Rich, 1976.) Over the next 20 years, he carefully examined the available ethnographic documentation for each putative counter-example and in 1993 authored a second book in which he was emphatic that no society had yet been found that violated his rule. There are societies that are matrilineal and matrilocal and where women are accorded veneration and respect—but there are no societies which violate the universality of patriarchy defined as "a system of organisation . . . in which the overwhelming number of upper positions in hierarchies are occupied by males" (Goldberg, 1993, p. 14). Such a state of affairs is deplorable but mere denial of the facts will do nothing to alter it—women's engagement in the political arena will.

Charge 4: Evolutionary psychology is used to naturalize and legitimize the status quo. Evolutionary psychology has considered a number of highly charged and socially relevant issues including infanticide, sociopathy, wife abuse, and rape. In these areas, feminists (e.g., Fausto-Sterling, 1992) have objected that such work opens the door to frivolous exonerating pleas in the criminal justice system ("I beat my wife because it is in men's nature to experience extreme sexual jealousy due to internal fertilization and concealed ovulation"). The misuse of scientific research by defense attorneys is doubtless widespread but it is certainly not confined to evolutionary theory. Indeed, environmental factors are far more commonly implicated. Parental abuse and neglect, inadequate educational opportunities, and drug addiction are all used to mitigate criminal

guilt and reduce sentences. The issue here is not evolutionary theory but the prevailing legal philosophy of responsibility and free will.

This objection also charges that an evolutionary explanation of, for example, patriarchy will allow policymakers to view it as "natural" and therefore benign. It is deeply ironic that evolutionary psychologists have been the ones to argue most forcibly against the naturalistic fallacy—the belief that what is natural is morally right or desirable. This is not a post hoc attempt to make their position politically correct but flows from the very nature of the theory itself. Natural selection operates as a sieve allowing some genetic variants to pass through and others to die. This sieve knows nothing of good or bad, kind or cruel, desirable or unacceptable. It does not result in progress in the form of the survival of "better" species or individuals. Humans have proliferated exceedingly successfully and one feature which we possess is a large brain relative to our body size. That does not make a species with high intelligence better than one with low intelligence, although it did make it a useful adaptation for *Homo sapiens* trying to survive in a particular ecology several hundred thousand years ago. If intelligence was "naturally" good, then ants and spiders would have developed an enormous cortex or would have become extinct—neither of which has occurred. It is vital to make a distinction between what we as humans hold to be morally desirable and what natural selection has retained as an adaptation. Malaria, tuberculosis, and death in childbirth are "natural" but we hardly regard them as good. Indeed we have poured enormous (positivist) scientific effort into their eradication with considerable success. Our vision of a more perfect world cannot be found in evolutionary theory which tells us only about the selection pressures of the past, not about our moral aspirations for the future.

Charge 5: Culture and technology have so changed the environment that we are freed from natural selection. Evolutionary psychologists hold that evolution has provided us with "fitness tokens"—desires, pleasures, aversions, and goals that mold our preferences and behavior. Teenagers do not attend discos in order to increase their share of the future gene pool—they go there because browsing the potential mate pool exerts an untutored fascination for teenagers everywhere. A teenage couple who have sex after such an event are not seeking to increase their reproductive success—if they were, they would not employ contraception. Consensual sexual contact is inherently pleasurable (evolution has seen to that) and they are simply enjoying that evolved pleasure. Natural selection worked to make sexual contact enjoyable because in ancestral environments contraception was not available, so sex eventually led to pregnancy and increased reproductive success. The principal aim of evolutionary psychology is to understand the origins and the parameters of these mental adaptations. Such adaptations

have not magically disappeared with the advent of new technology or social institutions in the past one hundred years.

But, some argue, the world today looks nothing like the environment of evolutionary adaptation (EEA). Population density is greater. Social and political structures are more complex. We live in parts of the world that would have been uninhabitable then. International conflicts, air pollution, and multinational companies dominate the world. At first glance, there is an enormous gulf between the hunter-gatherer societies in which humans spent 99 percent of their existence and the contemporary societies we now inhabit. But these changes have been wrought by the human mind and this mind was adapted in the EEA. As Crawford (1998, p. 291) points out, we have not created a world "designed for individuals who can fly, who choose mates indiscriminately, who have litters of offspring, who have fur to protect them from the cold, who make little investment in infants once they are born, who do not mind being cheated in a social contract, who do not value close relatives and so on." Cultures everywhere value altruism, reciprocity, fairness, and in-group solidarity. Cultures devalue selfishness, cheating, theft, and in-group violence. Cultures which endorsed mass suicide or abstinence from sex would not last long.

However, it is true that adaptations now engage with a range of environments that are richer and more diverse than those they evolved to deal with. Activity in the dopaminergic reward pathways of the brain feels pleasurable and supports our appetite for important adaptive behaviors such as sex and food. But these same dopamine receptors can be directly stimulated by illegal and addictive drugs. Today, some ancient adaptations have been recruited in the service of leisure activities: the pleasure that soccer brings to millions may derive from our natural fascination with inter-group conflict, with male–male competition and with the demonstration of young male strength and agility. The universal enjoyment of gossip is exploited in soap operas. Despite knowing that we are watching miniature representations of human beings (as pixels on an electronic machine) who are pretending to be people they are not, we still find our emotions engaged in the drama of these people's lives even though they are so artificially presented.

The mind and body that we have today exist in their current form because we come from a long line of individuals who survived past puberty and successfully reproduced. Many did not. We are fortunate to live in cultures where medical advances have enhanced the survival of severely premature infants and have brought cures for diseases that would have been lethal in the EEA. We have seen significant increases in longevity in the past decade. Infertility treatment has become widely available, as has contraception. When medical and technological advances can be used to give and take life, we have created the

instruments of our own selection. We would do well to keep a watchful eye on those who exercise that judgment on our behalf.

Bad science?

Another set of objections has come from those who question the scientific status of evolutionary psychology. We begin with the most radical critiques from those who regard the scientific enterprise in general as androcentric and who accuse those women who engage in it as "sleeping with the enemy." Their wrath is not specifically directed at evolutionary psychology per se but at any use of the hypothetico-deductive method.

Charge 6: Evolutionary theory, as part of traditional science, fails to recognize that there can be no objective truth. Many feminists have objected that the very questions posed by scientists are laden with tacit political agendas and that the scientific method itself can never be value-free (Fausto-Sterling, 1992; Harding, 1991; Hubbard, 1990; Keller, 1992). The solution they offer is for researchers to announce their politics at the same time as their results so the reader is made aware of possible bias in their data collection, analysis, or interpretation. Of course, this has the side effect of allowing readers to pick and choose articles in terms of the author's politics and to be prejudicially positive to articles that gel with their own ideological agendas. Fausto-Sterling (1992, p. 212), for example, writes of the difficulty that she has in distinguishing between "science well done and science that is feminist." She is also surprisingly honest about the double standard that she employs in evaluating data which is not congenial to her ideological position: "I demand the highest standards of proof, for example, on claims about biological inequality, my high standards stemming from my philosophical and political beliefs in equality" (Fausto-Sterling, 1992, pp. 11–12). Theories that are not consistent with a feminist viewpoint often fail to achieve this high standard. Feminists are keen to promote high-quality research—but this aim is compromised by their inability to distinguish between feminist science and good science. Many feminist journals will refuse to publish data that are unacceptable to their ideological position. This state of affairs has already inhibited open expression of ideas by those who fear incurring feminist wrath and, if it continues, will seriously jeopardize academic debate.

There is a more liberal possibility. Traditional scientific method is a cyclical loop joining theory and data via hypotheses. It is a system that requires explicit and coherent reasoning at the level of theory building, and honesty and clarity about the method and results of data collection (but not about the ideological position of the authors). It also crucially depends upon the endeavors of many scientists working separately and together. The scientific system allows freedom

of politics to individuals, is self-correcting (unsupported hypotheses are modified or abandoned), and open (replications can be undertaken by detractors as well as supporters). Though hypotheses, or even whole theories, may be laden with tacit ideology, the data that they require for falsification are collected from ordinary people who have no axe to grind. Scientific method can be the antidote to hidden agendas.

Charge 7: Evolutionary theory does not resonate with women's experience. Two strands of contemporary thinking have come together to create a new criterion for the acceptability of an explanation: it must reflect women's lived experience—it must "feel" subjectively true. The first strand (which I wholeheartedly endorse) is the feminist demand that researchers should address women's experiences, recognizing them to be potentially different from those of men. The second strand is the post-modern rejection of grand theory (feminist theory excepted, of course) which prioritizes qualitative description of experiences and discourses that are contextually and historically bound. This effectively replaces theory with subjectively interpreted description. Since there are multiple possible descriptions of any event and no objective criterion for deciding amongst them, the best one is the one that resonates with the feminist reader's own experience and intuition. (Parenthetically, it should be noted that the rejection of any objective set of truths necessarily excludes men's oppression of women as a historical truth.) This emphasis upon personal resonance has been endorsed by feminists who encourage women to "transcend" positivist empirical method and seek alternative ways of knowing that are true to their own life experiences (Belensky et al., 1986). But this personalized approach to knowledge places resonance with the reader above the truth, generality, or coherence of the argument.

For many women, evolutionary psychology does not resonate with their own experience. They do not "feel" that parental investment impacts upon their emotions or behavior. It does not "feel right" that differences in gamete size could create differences between men and women's behavior or interests. But intuition is not a reliable guide to the quality of an explanation. Children do not "feel" as if their bodies are composed of 65 percent water. People do not "feel" that solid matter is made of atoms. "Feeling right" is equally controversial with regard to psychological truth. Psychotherapists can persuade clients that they are secretly in love with their father. Palm readers can persuade clients that they are destined for greatness. In an influential article, Nisbett and Wilson (1977) demonstrated that participants in psychology experiments perform no better than chance in guessing the causes of their behavior when these are manipulated in experiments. Although we have conscious access to the products of lower-order processes (recalling our mother's name or the ability to speak in

grammatical sentences), we do not have access to the processes themselves (we do not know how our memory or language production systems work) except by the formal knowledge gleaned by psychological science. Evolutionary theory is concerned with how the mind was shaped in the environment of evolutionary adaptation approximately 150,000 years ago. We cannot have any "feel" for what the selection processes were or even what it felt to be an early human at that time. What are available to us are the psychological products of evolution. We like the taste of sugar, feel sick in the first trimester of pregnancy, experience fear when we look out from a tall building, see three-dimensional images in stereograms, enjoy sexual contact, and feel anger when our child is threatened. Evolutionary explanations have been offered for all these experiences.

There are many feminists working in the evolutionary sciences. They have misgivings about the way in which women have been systematically excluded in their discipline both as objects of study and as collaborators (see Hager, 1997). However, few evolutionary feminists want to see the abandonment of empirical techniques. Instead, they seek to identify the evolutionary problems faced by women but ignored by male researchers such as patriarchy (Hrdy, 1997; Smuts, 1995) or male infanticide of infants (Hrdy, 1981). Others highlight the selection pressures that operated specifically upon women such as the care of slow-maturing, altricial young (Lancaster, 1991) or the infant's greater dependence on maternal rather than paternal survival (Campbell, 1999). They believe that their work is important because it can illuminate the evolutionary basis of sexual inequality and, in so doing, complement mainstream feminist work to inform a more solidly grounded agenda for change. Evolutionary feminist research on wife abuse and male proprietary jealousy; on brutal techniques for increasing male paternal certainty (such as clitoridectomy, infibulation, and claustration); on polygyny and the gendered inheritance of wealth are a few examples of how evolutionary theory and feminism can work together to improve the status of women.

Other critics of evolutionary theory, far from wishing to see the abandonment of scientific method, argue that evolutionary psychology is not scientific enough.

Charge 8: Evolutionary theory is tautological. In principle, this objection can be leveled at any functional explanation in the social or natural sciences. Some radical feminists argue that (male-dominated) governments allow the production of pornography in order to objectify women and to keep them in a state of fear about the possibility of rape. This is a functional explanation. It seeks to explain why the status quo is the way it is. The simple question "What is this for?" is the driving force of most scientific enquiry that goes beyond mere description or classification. When directed at evolutionary theory, the objection takes the

form of allegations of the Just-So Story: the invention of plausible but unverifiable stories about how an adaptation occurred (Bleier, 1984).

In fact the methods of evolutionary psychology have been clearly explicated by Tooby and Cosmides (1992) and others (Andrews, Gangestad, & Matthews, 2002; Halcomb, 1998; Sherman & Reeve, 1997). Broadly, evolutionary psychology proceeds by: (1) identifying an adaptive problem that proto-humans would have faced in the environment of evolutionary adaptation; (2) developing a description of the module that is suggested to have evolved in response to this problem, including the range of inputs that would have activated it and the impact of its outputs in terms of differential survival and reproductive success; (3) formulating a description of the current environment and a map of correspondence between the ancestral and present conditions that allows specific hypotheses to be generated about the current activating inputs; and (4) undertaking tests of these hypotheses which, where appropriate, allow comparison with alternative (evolutionary and non-evolutionary) accounts.

An adaptation is identifiable by evidence of special design such as complexity, economy, efficiency, reliability, precision, and functionality (Williams, 1966). The eye, for example, is so manifestly and complexly suited to the function of tracking the environment and allowing an animal to orient itself that nobody could seriously doubt that it evolved to serve that function (Dawkins, 1986). The ability to interpret the mental states of others also evidences special design—it is fast, accurate, automatic, follows complex rules, rarely makes errors, and bestows obvious advantages on its bearers. Language also has these trademark features. But to make the techniques of determining an adaptation more concrete, let us take a different example. Let us posit for a moment that individuals everywhere prefer to avoid, rather than seek out, situations in which they are cheated or exploited. Universality is taken to suggest (but not prove) that the trait may have an evolutionary basis. The next step is to ask what purpose it might have served in the EEA about 300,000 years ago. The fossil record provides information about where we were living (on the savannah plains of sub-Saharan Africa) and roughly how (in small hunter-gatherer bands). We were highly social and our survival depended as much on regulating social relationships as on ecological pressures. We can posit that it would have been important to detect social cheaters—those who failed to repay altruistic acts. If we could not do so, we would find our generosity exploited in the service of someone else's reproductive success. Let us hypothesize that one module of the evolving mind might have been devoted to detecting cheats.

Cosmides and Tooby (1992) made such an assumption and tested it on the Wason card task which goes like this: A person is presented with four cards; on one side is a number and on the other is a letter. The upturned cards read

D F 3 7. They are then given the proposition "If a card has D on one side, it has 3 on the other," and the person is asked which cards they need to turn over in order to determine whether this proposition is correct. This is a standard philosophical P-not-Q problem. They ought to turn over card D (to verify the conditional) and then a second card bearing a number that is not 3 (to disconfirm the consequent). Most people find this task quite difficult. But then Cosmides changed the task slightly. The subject is presented with a cheater detection problem. They are told that they are a barman and that they must ensure that nobody under the age of 18 is unlawfully drinking alcohol. They have four cards before them: One side of the card tells them the customer's age (26 or 16) and the other side what they are drinking (beer or cola). As before they are asked which cards they need to turn over. Most people rightly realize that if the person is 26 years old it does not matter what they are drinking and ignore this card. They also rightly realize that if a person is drinking cola, it also does not matter what age they are. Correctly, they turn two cards: Age 16 and Drinking Beer. The identical problem when translated into cheat detection becomes easy. And it is not just the fact that the problem was made social rather than abstract. The cheater problem also seems to be activated only when a rule of exchange has been broken. If we alter the situation to "If a person eats chili peppers then they drink beer" people seem as flummoxed as they were before because although the problem is still social, no rule violation is involved.

The environment of evolutionary adaptation has become a particular source of concern to some. We have no time machine so we cannot visit it and we must rely on archaeological and paleoanthropological reconstruction. Because we believe that savannah living was the lifestyle that shaped our species, there is a tendency to caricature the EEA as something akin to an African hunter-gatherer community. This is can be misleading if we fail to recall that evolution is deployed over vast stretches of time and that different characteristics evolved during different time periods and conceivably in different ecologies. For example, humans' tendency to live in kin groups can be traced back over 25 million years to a common ancestor shared with other anthropoids. Meat-eating may have evolved about two million years ago. The evolution of language is traced to a mere 300,000 to 100,000 years ago (Foley, 1996). There were a variety of adaptively relevant environments. And every adaptation comes from a statistical aggregate of selection pressures spread over time—the environment presented the same problems over and over again with sufficient regularity to make a problem-solving adaptation a distinct advantage. The uncertainty that must surround the details of life at the time of each adaptation does not preclude the generating and testing of adaptational hypothesis. If adaptations evolved, they are part of human nature and will manifest themselves today over a wide range of cultures given the appropriate environmental inputs. Some have

argued that the study of contemporary human adaptations will help to build a more accurate picture of the EEA (Tooby & Cosmides, 1990a). Even if it does not, the status of current adaptations is not dependent on a complete account of their genesis. It is dependent on their ability to offer elegant and empirically supported explanations of contemporary human behavior. Adaptations exist as part of our nature—from the infant's Moro reflex to our fear of heights—and a psychology that denies the available evidence in favor of a wishful world where humans are formless clay waiting to be molded by cultural practices may serve politics but not truth.

However, tests of evolutionary predictions will never satisfy critics if they insist on moving the evidentiary goal posts. The standards of proof that are required from evolutionary theory are far higher than those demanded for social environmental theories. The interpretative constructionism espoused by many feminists is subject to the single standard of "plausibility." Ironically this is the very standard that feminists reluctantly agree that evolutionary psychology meets. Fausto-Sterling (1992, p. 187) admits that "At one level it all seems quite plausible" and Bem (1993, p. 30) acknowledges " . . . the consistent pattern of sexual difference and dominance that not only appears to exist across time and place but that a theory like sociobiology appears to so elegantly explain."

Charge 9: Evolutionary theory is riddled with disagreements. The "modern synthesis" brought together Darwin's nineteenth-century insights about natural selection with our twentieth-century understanding of genetic transmission. Together they have inspired an ever-increasing body of empirical work that seeks to test and refine these ideas. In so doing, the modern synthesis has brought together biologists, anthropologists, geneticists, developmental and social psychologists, and neuroscientists who, for the first time, have a common language with which to communicate. Notwithstanding this remarkable integration, Fausto-Sterling (1992, p. 169) asserts that "arguments continue to rage" within evolutionary theory. The arguments to which she refers are the objections offered by Steven Jay Gould, an ardent Darwinian, which have been greeted with delight by many critics of evolutionary theory. His critiques are not rejections of adaptationist thinking but proposed modifications and cautionary admonishments to his fellow Darwinians (Sterelny, 2001).

First a possible modification—Gould believes that the trajectory of evolution is discontinuous rather than smooth (see Eldredge & Gould, 1972). He believes that the normal equilibrium of evolving life is punctuated by dramatic events that select for new macromutations before the pace slows again. His claim is far from radical—there is no reason why evolution should proceed at a constant pace and periods of stasis when species were freed from dramatic

environmental change were probably commonplace (Dawkins, 1986; Dennett, 1995). Failure to find evidence of intermediate forms of life that evolved and were extinguished in a matter of a few hundred thousand years is not especially surprising. For a species to be identified as a unitary entity some degree of stasis has to be involved—we would not even entertain the idea of a species, whether alive or extinct, unless all of its members shared common attributes over some space of geological time. Whether the emergence of new life forms happens "momentarily", as Gould proposes, largely depends upon one's definition of a moment. The punctuated equilibrium argument depends upon the scale on which one draws evolutionary change. Gould himself appears to recognize this and agrees that "Our theory entails no new or violent mechanism, but only represents the proper scaling of ordinary events into the vastness of geological time" (Gould, 1992a, p. 12). In this matter, he hardly seems to part company from Darwin himself who wrote "the long periods, during which species have undergone modification, though long as measured by years, have been short in comparison with the periods during which they retain the same form" (see Dennett, 1995, p. 290). So, for many evolutionists, Gould's thesis hardly constitutes a major threat to Darwinian ideas.

Gould also argues that chance can be an important component of evolution—and again this is far from heretical. It is universally acknowledged that evolution (defined as a change in the relative frequency of genotypes over time) can be the result of things other than natural or sexual selection (Majerus, Amos, & Hurst, 1996). However, only these latter forces can produce adaptations—by which we mean a feature of design that becomes common by the differential success of phenotypic variants in previous generations. Mutation, migration, and differential mortality due to chance events can all change the gene pool—but not adaptively. Although random catastrophic events may cause the extinction of a whole species (for example, dinosaurs from a meteor strike) they do not cause systematic changes in the gene pool of an existing species. This is because such events, by their definition and nature, are random. Every year people die as a result of being struck by lightning. The people who die take their genes with them. But the genes that are eliminated are a random selection from the human gene pool. Chance does not systematically retain and reject different variants. Some critics appear to believe that the mere existence of such chance events is a serious challenge to the whole theory. For example, Fausto-Sterling offers a hypothetical example of an island of birds, composed of blue and speckled variants, in which the speckled variants are blown onto a neighboring deserted island. She points out that this is an example of evolution by "a chance natural event, not natural selection" (Fausto-Sterling, 1992, p. 172). But the example is flawed because the probability of the wind carrying only one color of bird by

chance is vanishingly small. A chance event would be unselective about what color of birds it affected. When a natural event (wind) selectively affects one variant (speckled birds) while not affecting the other (blue birds) then it is most likely for a reason—perhaps the speckled birds weighed less than the blue ones. This made them more likely to be blown away and would constitute a clear case of natural selection. To give another example, imagine a community of people who vary genetically in their tendency to store fat. A famine occurs and those with low fat reserves perish before the rains come. The genes for low fat reserves will be selectively culled. Although the famine was a chance event, its effect was systematic selection. Chance events that do not distinguish their targets can have evolutionary effects, notably the extinction of whole communities and species, but only chance events that have systematic effects on different variants can generate adaptations.

Gould and Lewontin (1979) coined the term "spandrel" to describe epiphenomenal aspects of natural selection. They borrowed the term from architecture. In cathedrals, notably the Basilica di San Marco in Venice, spandrels are ornately decorated and give the appearance of having been put there specifically for this aesthetic purpose. But as Gould and Lewontin note, they are simply a by-product of the design—they had to exist as soon as the architect decided to join two rounded arches at right angles and thereby created a tapered triangular space. Gould's point was that we must not assume everything in nature to be a functional adaptation. Some apparent design features are merely side effects of selection for something quite different. Bones are white and we might be tempted to pose the question "What is the evolutionary advantage of the whiteness of bones?" if it were not for the fact that bones just happen to be made out of calcium which happens to be white in color. Blue or purple bones could do the job just as well and the color is of no evolutionary significance (although bones themselves are). Because most genes are pleiotropic (they have multiple effects), some natural phenomena are simply side effects that have survived because they tagged on to an adaptive gene complex and were not so detrimental as to outweigh the beneficial impact of the other phenotypic effects. As Dennett notes, daisies float in water but no sensible person would ask what the adaptive significance of their buoyancy is.

> The thesis that every property of every feature of everything in the living world is an adaptation is not a thesis anybody has ever taken seriously, or implied by what anybody has taken seriously, so far as I know. If I am wrong, there are some serious loonies out there, but Gould has never shown us one. (Dennett, 1995, p. 276)

Gould (1991) has also introduced another term—the exaptation—to describe "any organ not evolved under natural selection for its current use—either because it performed a different function in ancestors (classical preadaptation) or