

Evolutionary Psychology: Its Programs, Prospects, and Pitfalls

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The emerging specialty of evolutionary psychology presents a challenge to mainstream psychology. It proposes that cognitive, not just more fundamental, traits in humans are grounded in dedicated evolutionary programs. In specific, it maintains that the common assumption in psychology—that the complexities of our psyches have been largely freed from evolutionary constraints and are instead based in a general learning capacity—is mistaken. The major premises of evolutionary psychology are examined in the light of arguments and evidence presented by both supporters and detractors. Although some of these premises are well grounded, others are questionable and limit the development of the specialty and its integration into mainstream psychology.

Beginning in the 1980's, a new specialty began to make inroads into psychology. Although there are a variety of evolutionary approaches in psychology, “evolutionary psychology” in what follows refers to this emerging and increasingly influential specialty. As its name implies, evolutionary psychology stresses the importance of understanding evolution in order to understand ourselves. Further, it promises new and better ways to achieve this understanding. This is a weighty claim, to which all psychologists need to attend. But is this claim justified? Although various authors have evaluated specific aspects of evolutionary psychology, no one to my knowledge has published a thoroughgoing evaluation. That is the purpose of what follows, which takes a look at the origins of this new specialty, what it proposes, what it offers in support of its proposals, and where it might be headed.

In particular, our discussion will focus on the perspective associated with Leda Cosmides and John Tooby, joint directors of the Center for Evolutionary Psychology at the University of California, Santa Barbara, who are commonly recognized as leading lights in the field. As Laland and Brown (2002, p 157) put it, “Evolutionary psychology as defined by Cosmides and Tooby...remains the dominant school of thought in the field.” In what follows, “EP” refers to this “core” position, and “EPs” to social scientists closely associated with this position. Not that there is total agreement even within this group; we will note some disagreements as we go along. Noted social scientists affiliated with this core group include David Buss, Martin Daly, Steven Pinker, Donald Symons, and Margo Wilson.

Since the 1980's, evolutionary psychology has expanded exponentially. Today it can boast numerous institutions offering a variety of courses and concentrations, a number of undergraduate and graduate texts, and its own journal, *Evolution and Human Behavior* (continuing what was, until 1996, titled *Ethology and Sociobiology*). But, despite its name, it would be a mistake to think that EP sees itself solely as a specialty within psychology. One of its leading lights, John Tooby, is an anthropologist, and social scientists in several disciplines have expressed interest in this emerging specialty. Even sociology, with a meager—some would say anti—biological tradition, includes some practitioners with an affinity for EP (e.g., Lopreato & Crippen, 1999; Runciman, 2000).

Although nativist approaches in psychology have sometimes been seen, especially in the first part of the last century, as marginal or ill-conceived, all psychological specialties are nativist to some degree; after all, without an evolved brain-in-a-body to begin with, there is no psychology of any kind (see Caporael, 2001; Plotkin, 2004). In fact, many eminent psychologists as far back as William James have advocated evolutionary approaches, and mainstream psychology has generally recognized the importance of our evolutionary heritage in a range of traits: sensory and

motor systems, emotions and motivations, personality characteristics, intelligence, and capacity for learning (see Degler, 1991). Even behaviorism acknowledges innate learning processes, sensory and motor systems, and (primary) reinforcers. And both psychoanalytic and humanistic psychology are nativist in proposing an innate human nature that Western society, in various ways, fails to honor. But some specialties within, or with important ties to, psychology—ethology, behavior genetics, comparative psychology, behavioral ecology, and sociobiology—have gone further in stressing the central importance of evolution and genetics (see Laland & Brown, 2002). EP is the latest and currently the most influential of these specialties. Of course, each of these specialties is distinctive in its own way, and, as we will see, EP, in particular, asserts its uniqueness.

Inasmuch as evolutionary approaches have some standing in psychology, what distinguishes EP? For one thing, EP takes a particularly principled approach to postulating evolutionary origins of psychological traits. Compared with other—including other evolutionary—paradigms, its paradigm is notably productive of coherent hypotheses (e.g., Buss, 2004, pp. 372-412; Tooby & Cosmides, 2005, pp. 26-31). For another, EP is concerned with the evolutionary roots of distinctively human experience (e.g., Buss, 2004, pp. 49-50; Tooby & Cosmides, 2005, p. 5). In particular, EP maintains that our specific cognitive traits distinguish us as a species and that these traits commonly have dedicated innate roots. As Cosmides and Tooby (1987, p. 283) put it, “Evolutionarily oriented students of human behavior have neglected what may prove to be the most important level of proximal causation: the cognitive level. *Adaptive behavior is predicated on adaptive thought.*” In reply, most psychologists probably would say that our specific cognitive traits are generally acquired rather than innate. Thus, although EP has many facets, the core of the disagreement between EPs and many mainstream psychologists comes down to the question: What role does our innate endowment play in our cognitive functioning? Tooby and Cosmides (2005, p. 20) were undoubtedly right when they declared that, “If it turns out that at least some of these [innate, cognitive] programs are specialized...then this will be a turning point in the history of the human sciences.”

EVOLUTIONARY PSYCHOLOGY PRINCIPLES

What are the basic principles of EP? EPs commonly cite the following:

1. An understanding of evolution is basic to an understanding of the human condition.
2. The legacy from our evolutionary past is chiefly adaptations, which enhanced the inclusive fitness of our ancestors. Most distinctive to us as humans, and therefore of most interest, are adaptations, embodied in dedicated cognitive modules, that enabled our ancestors to deal successfully with complex life problems.
3. Our mind is the same as our brain and is an information processor, akin to a computer.
4. Modern culture has diverged significantly from the ancestral cultures in which we evolved. The result is a mismatch between our evolved modules and the demands of our modern culture; this, in turn, underlies a wide range of psychological problems.
5. Our innate cognitive modules constitute a basic, and largely invariant, human nature that we all share; useful research strategies are based on this assumption of genetic invariance.

In competition with their perspective, EPs are quick to point out, is the viewpoint that they call the standard social science model (SSSM). EPs believe that the SSSM has assigned undue importance to a general learning capacity that, according to the SSSM viewpoint, has largely freed our distinctively human self from a dependency on genetic programming. EPs see the SSSM as the dominant theory in the social sciences as well as the one that has hindered the proper development of all of these sciences (e.g., Pinker, 2002, pp. 14-29; Tooby & Cosmides, 1992, pp.

33-43). That is, the SSSM is the legacy of not only psychologists (e.g., Skinner) but also sociologists (e.g., Emile Durkheim) and anthropologists (e.g., Franz Boas). EPs sometimes conceive of EP as a viable alternative to the SSSM as a global theory in social science (e.g., Buss, 2004, p. 373). At the least, EPs believe that an evolutionary approach is a useful perspective for understanding any psychological experience (e.g., Buss, 2004, pp. 372-412). Although it is questionable whether psychology, given its problematic dalliance with behaviorism, would benefit at this time from another single dominant paradigm (e.g., Graziano, 1995), it undoubtedly would benefit from a better understanding of the evolutionary principles that underlie any human experience.

Certainly, time seems to be on the side of evolutionary perspectives. Reports of new evidence for genetic involvement in various psychological traits appear with increasing frequency. But, while the relevance of evolution and genetics has gained support, this support does not necessarily extend to the principles advocated by EPs and enumerated above; we now discuss these principles.

IMPORTANCE OF COGNITIVE ADAPTATIONS

Overview

EP is grounded in the premise that we need to understand cognitive adaptations in order to understand the human psyche. This premise is sometimes stated in uncompromising terms; for example: “Psychological [cognitive] mechanisms are there *solely* because they evolved to promote the inclusive fitness of the individual” (Tooby, 1988, p. 69; also see Buss, 2004, p. 373; Cosmides & Tooby, 1994, p. 110). Although such statements seem to exclude nurture, EPs elsewhere maintain that our psyches are a product of nature and nurture acting jointly (e.g., Buss, 2004, pp. 404-407; Pinker, 1997, p. 32; Tooby & Cosmides, 2005, p. 18). Furthermore, EPs do not see nature and nurture as antithetical, as does—by their reckoning—the traditional SSSM view, which assumes, in the case of the distinctively human psyche, that nurture has largely replaced nature (except, of course, for an all-pervasive learning potential). In the SSSM view, the more nurture, the *less* nature. To EPs, however, these processes are best viewed as complementary; thus, the more nurture, the *more* nature (Pinker, 1997, pp. 184-186; Tooby & Cosmides, 2005, p. 17). EPs maintain that our rich psychological makeup is significantly shaped by our experience (nurture), but they also maintain that this occurs because our innate endowment (nature) promotes it in specific ways. It follows, given the complexity of our psyches, that “humans must have more ‘instincts’ than other animals” (Tooby & Cosmides, 1992, p. 93). (Obviously, “instincts” here does not mean absolutely fixed patterns.

The notion of human instincts is, of course, anathema to SSSM psychologists, who might point to skills obviously related to fitness—for example, hunting, navigating, building traps, and constructing habitats—that humans must work hard to learn but that many species perform instinctually. They might also point to apes closely related to us (chimpanzees, bonobos, and gorillas) which seem to lack an innate program for effective mating in the absence of having observed conspecifics mating. This is known from observation of apes in zoos, where “primate porn” sometimes is used to help eager but naive apes “get the picture” (S. Perry, personal communication, November, 2003). What about humans? Just ask an untutored child how humans mate...or remember the ideas you entertained as a child. (Put another way, do you think, in the absence of learning, that you would know how to mate?) And if direct genetic programming for behaviors as crucial to fitness as mating is minimal in us and our close relatives, then how much more minimal is it for attributes less crucial, including cognitive traits of interest to EP?

Adaptations and learning

To most observers, these considerations support the idea that, to a large extent, adaptations for learning have supplanted more direct genetic programming for complex traits in humans (Quartz, 2003, pp. 186-187). Certainly cognitive programs for learning have many advantages: They are more economical (they require fewer dedicated genetic and neural pathways), are more open to communication with other neural circuitry, and are more responsive to variable and changing local conditions. Further gains in genetic and neural economy surely resulted from instantiating in our culture—rather than genes—a tremendous store of information, enabled, of course, by our advanced learning capabilities. And information carried by culture is advantaged in many other ways. As an information-carrying medium and compared with genes, culture is responsive to rapidly changing conditions, is resilient in response to perturbation, is easily disseminated, is cumulative across populations, grows exponentially, and can be stored in a variety of formats. (See Donald, 1991, and Tomasello & Call, 1997, pp. 401-429, for how, in our deep ancestral past, cognitive and behavioral programming may have come to be embodied and transmitted in our culture, not just our genes.) Underlining the importance of social learning on which human society and culture depends, many innate mechanisms that enable such learning are in evidence early and for an extended period during our prolonged altricial stage of development. For example, human infants, more than infants of other species, are innately programmed to attune to, bond with, and mimic caregivers in ways that facilitate the learning of complex skills (e.g., Jaffe, Beebe, Feldstein, Crown, & Jasnow, 2001).

These considerations circumscribe but do not undermine EP's position. Most EPs seem to agree that, in humans, various adaptations for learning play an especially important role. And, short of endorsing an all-purpose learning potential, they seem to agree that learning in humans is often enabled by somewhat generic innate programs (e.g., Buss, 2004, pp. 56-57; Tooby & Cosmides, 2005, p. 28). But EPs distinguish themselves by proposing that our innate programming is often highly specific for particular cognitive proficiencies. In support of this position, EPs often point to language acquisition as a prime example of what they sometimes call a learning instinct (Pinker, 1995; Tooby & Cosmides, 2005, p. 7). And, say EPs, just as we have a specific innate capacity for learning language, we likely inherit a rich variety of specific capacities for other kinds of complex learning. But, while most psychologists would probably agree with the EP stance with respect to language, they might (in line with the SSSM) balk at the same reasoning applied to other kinds of complex learning. Then EPs might declare, is it not strange that we would have a specific innate program for learning language but not any other cognitive competency?

Certainly specific innate programs, or "preparedness," for learning *non-cognitive* competencies have been known for some time (Marler, 1991; McNally, 1987; Seligman & Hager, 1972). One example is the rapidity and tenaciousness of learning to avoid a food that has made us nauseous. In particular, it seems likely that learning preparedness is characteristic of traits that, in our ancestral past, fell somewhere between those, such as the breathing reflex, that were highly related to fitness and that are thus dictated directly by the genotype and those, such as artistic ability, that were neither. In this scheme, food aversions, since they impinged significantly, but somewhat indirectly, on fitness (and also needed to be sensitive to local variations in foods and toxins) were best handled by a genetic program for learning preparedness. This is an important consideration insofar as EPs are especially concerned with specific cognitive abilities, many of which impinged very indirectly on fitness and which consequently may not involve learning preparedness. Nevertheless, some cognitive aptitudes, such as language competence, may have

been sufficiently crucial to fitness that they are enabled by innate preparedness. What role learning preparedness plays in the acquisition of specific cognitive traits, then, is a central question for EP and will be addressed when we discuss specific cognitive modules proposed by EPs.

We now return to an abiding question that sets EP apart from the SSSM: Are we also endowed with generalized innate programming, as the SSSM assumes, that enables learning almost any cognitive competence? To EPs, as we have seen, this traditional assumption is suspect. And their stance underlies occasional uncompromising statements such as the following: “The concept of learning will eventually disappear as cognitive psychologists and other researchers make progress in determining the exact causal sequences by which the functional business of the mind is transacted” (Tooby & Cosmides, 1992, p. 123; also see Cosmides & Tooby, 1987, p. 291). Instead of learning processes, EPs often emphasize the process whereby different innate responses are evoked, or selected, by different environments (e.g., Buss, 2004, pp. 404-405). Gazzaniga (1992, pp. 2-3), who is closely allied with the EP movement, has carried this notion to its logical conclusion, proposing that selectionist mechanisms are all important, and that “All we do in life is discover what is already built into our brains...thus the environment *selects* from the built-in options.” In other words, what appears to be learning is really the selection, according to environmental demands, of innate programs. These viewpoints seem to stem from the belief that environmental input, if processed by a generalized learning capacity as usually conceived, is insufficient to enable learning something as complex, for example, as language; this problem is known as poverty of the stimulus. Hence, the need for innate programming that is specific and sufficient when activated by a suitable environment. (Not surprisingly, there is controversy concerning this point; e.g., see Bates & Elman, 1996; Tomasello, 1995, pp. 144-146).

Aside from statements such as these, EPs sometimes endorse alternative learning mechanisms that stop short of a generalized aptitude as conceived by the SSSM (e.g., Tooby & Cosmides, 2005, p. 18). And these alternative models (e.g., Gallistel, 2000; Gaulin & McBurney, 2001, pp. 144-152) are often, compared with traditional models, a better fit with the results of learning research as well as with evolutionary scenarios.

In several regards, then, EPs reject the SSSM postulate of an all-purpose learning capacity and favor, instead, specific enabling functions. (Note that EPs generally fail to address the innate bases of organism-environment interfaces that are crucial for the normal development of many innate cognitive potentials but that do not primarily involve learning—for example, mechanisms and needs for bonding and intimacy; see Plotkin, 1998, p. 55.)

Cognitive adaptations: A critical look.

With respect to the important issue of learning, we have seen that EP stands apart from mainstream psychology. But EPs, of course, are interested in the entire range of human cognitive adaptations, not just those that primarily enable learning. What do EPs say about cognitive adaptations taken as a whole, and what reactions has their position stirred up?

1. We have seen that, to EPs, the role of dedicated adaptations in the formation of corresponding cognitive traits is of fundamental importance. However, several considerations indicate that the role of adaptations in this regard has limits.

According to EPs, cognitive adaptations specific to humans, although they had roots in pre-human experience, generally evolved as our hominid ancestors transitioned into *Homo sapiens* and as we then dealt with the challenges of being human. It is commonly assumed that in these early stages our cultural and genetic endowment coevolved, each modulated by the other (Durham, 1991; Lewontin, 2000). Then, as the development of culture quickened and with the pace of biological evolution largely fixed and notably slow, a mismatch developed between the two

(Cosmides, Tooby, & Barkow, 1992, p. 5). Later we discuss some interesting possible consequences of this mismatch, which occupies an important place in EP's agenda. But one potential consequence, not given much notice by EPs, is relevant here. The central notion in mismatch theory is that biological evolution lags behind cultural evolution. This means that, as culture developed apace, the evolution of specific adaptations for corresponding cognitive traits that might have enabled this development could not have kept pace. Of course, various cognitive adaptations may have originally nurtured our social and cultural evolution. But these, designed for proto-cultural or early cultural conditions, probably were not sufficient to fuel, in a direct or adequate way, many of the intricacies of cultural evolution over the long haul. In fact, as we will see, few, if any, of the cognitive adaptations proposed by EPs seem to date to any time after this early period.

Undoubtedly, then, as biological evolution lagged behind, the cognitive fuel for our social and cultural developments increasingly came not from such adaptations, but from skills and innovations accumulated and passed down as a cultural legacy. And this legacy was, to an important extent, emergent (Kenrick, et al., 2002; Tooby & Cosmides, 1992, p. 122), so that aspects of society and culture not directly tied to fitness have increasingly diverged from ancestral practices. For example, how we eat or mate differs relatively little from our ancestors' experience while how we travel or communicate differs considerably and is less predictable from a knowledge of related adaptations. Without such emergent qualities and with an evolutionary base largely rooted in ancestral times, modern culture would not have come about.

In particular, while task-specific adaptations that arose in ancestral times may be of service for those tasks that are still with us, they obviously did not evolve to deal with uniquely post-ancestral challenges. Furthermore, according to Cosmides and Tooby (2002, pp. 164, 168), the "independently evolved mental programs...that govern the acquisition of a language are different from those that govern the acquisition of food aversions, and both are different from...[those] that govern the acquisition of snake phobias." And these are different from mental programs that might govern the acquisition of post-ancestral tasks such as conducting horticulture or animal husbandry or, for that matter, negotiating freeways or the Internet. In fact, evolutionary programs specific to these post-ancestral tasks are not likely to exist for the reason that evolution is a slow process; new cognitive adaptations probably have not evolved in many millennia. Which raises the question, if these latter-day tasks do not derive from dedicated adaptations, then why would tasks of interest to EPs such as choosing mates or habitats? One answer is that, for these ancestral but not latter-day tasks, there were probably long enough stretches of time over which these innate competencies could evolve. However, whether they in fact evolved is the pivotal issue we will revisit as we go along.

If latter-day tasks such as horticulture or driving on freeways, as well as thousands of others, are not enabled by dedicated adaptations, then what is their evolutionary base? It is commonly accepted that evolution has endowed us with adaptations, many of which we share with other species, for a variety of perceptual, learning, and problem solving proficiencies, ranging from very specific to very generic. And, unlike those designed for a specific task such as mate selection, these adaptations—although they surely evolved in connection with various specific tasks—can be recruited, in different combinations, to enable a tremendous variety of complex tasks. Viewing food aversions and snake phobias in this way, rather than as having "independently evolved," it is not difficult to think of adaptations (each of which has many components) that are probably common to both: adaptations for hedonic response, figure-ground discrimination, stimulus association, social learning, and many others. Of course, the way such adaptations are combined will necessarily differ for food aversion and snake phobia as well as for other mental programs.

EPs, as well as most psychologists, recognize this general mechanism of recruitment of various adaptations to construct a complex skill (e.g., Cosmides & Tooby, 2002, pp. 174-182; Tooby & Cosmides, 1995). But perhaps because a collection of such a wide variety of adaptations is difficult to envision as a distinct algorithm that orchestrates a specific corresponding behavior—and we will see that this information-processing model is central to EPs' agenda—they do not emphasize this mechanism. Instead, they propose that evolution has endowed us with cognitive adaptations that evolved in response to, and that are dedicated to, solving specific ancestral problems such as choosing mates. And such adaptations are a potential subset of our cognitive legacy, but, as we have seen, a subset with definite quantitative and qualitative limitations.

However, although we have discussed dedicated adaptations proposed by EPs as distinct from broadly recruited adaptations, surely they lie on a continuum and often complement each other. That is, the genetic underpinnings of a particular cognitive skill may consist of a mix of adaptations, from dedicated to generic, along this continuum. The sensible question, then, is: *To what extent* are various cognitive skills based in more-or-less dedicated adaptations and *to what extent* in more widely recruited adaptations? In this light, EP's bias in favor of dedicated adaptations as the evolutionary basis of cognitive skills seems narrow. We will return to this point.

2. Relative to other evolutionary mechanisms, EPs emphasize the importance of adaptations. Now it is generally accepted that adaptations, which evolved because they enhanced fitness, play an essential role in human experience. But the importance that EPs assigns to this mechanism has been questioned (e.g., Laland & Brown, 2002, pp. 186-194). EPs do grant that psychological traits may arise as a result of evolutionary mechanisms other than adaptation (e.g., Buss, 2004, pp. 38-42; Tooby & Cosmides, 1992, pp. 61-63). In the case of cognitive traits, however, they almost always emphasize adaptations, on the grounds that such finely tuned and highly functional traits were necessarily shaped by natural selection (e.g., Cosmides & Tooby, 1992, pp. 61-62).

This emphasis on adaptations and functionality has been questioned by Gould who, along with Lewontin, stressed the importance of structural constraints in the evolution of traits in general: "Pathways of development and general architecture...[are] more important in delimiting pathways of change than the selective force that may mediate change when it occurs" (Gould & Lewontin, 1979, p. 581). For example, structural constraints were likely involved in the evolution of the vertebrate eye, which, exquisite as it is, incorporates several less-than-optimal features including neural and vascular networks positioned in front of the retina and receptors that point toward the rear. Probably these features are the legacy of primitive photoreceptors that, as is common in evolution, made do with available suboptimal structures and that have evolved to be highly, but not optimally, functional (re. this scenario, see Gander, 2003, pp.107-110). And if nonfunctional, and even dysfunctional, evolutionary features are embodied in an organ as complex and as generally functional as the eye, then they may play an important role in various cognitive traits.

While possible non-functional or sub-optimal features of innate traits are acknowledged in their writings (e.g., Buss, 2004, pp. 20-21), EPs typically assume, when it comes to cognitive traits, that their job is done when they have demonstrated what they believe to be clearly functional features. Of course, demonstrating nonfunctional or dysfunctional features of otherwise functional cognitive traits is not an easy task.

3. According to EP, cognitive adaptations generally influence our experience in a direct manner and in the present moment. For example, Buss (2004, pp. 104-162) collected data indicating that, when choosing a long-term mate, men generally look for women who would be good mothers for their offspring, while women generally look for men who would be good

providers. (More on mate choice later.) According to most EPs, such findings indicate that corresponding cognitive adaptations actively guide behavior in current mate-choice situations; that is, the influence of these adaptations is direct and proximal.

However, some commentators (e.g., Wood & Eagley, 2002) have proposed that adaptations can work in an *indirect* and *distal* fashion. For example, mate preferences may be largely learned and may have arisen as cultures embodied the implications of our innate sexual dimorphism that enables women to bear and care for children and men to compete for limited resources. (Here we are assuming that cognitive programs for mate selection are not part of this innate dimorphism.) Sexual dimorphism, then, underlies a potential gender role and mate preference allocation that cultures generally recognize and embody. In this scenario, the relevant adaptation—sexual dimorphism—is largely a distal influence, with roots in the past, that acts indirectly to construct a mate-choice preference through the more proximal mechanism of social learning. The end result is that men generally favor women who would be good mothers for their children and women favor men who would be good providers. As we will see, other substantive cognitive modules also may be anchored in distal non-cognitive adaptations.

Another possibility usually overlooked by EPs is effects of adaptations that are indirect but proximal as they impinge on cognitive processes (but see Buss & Greiling, 1999, p. 226; Tooby & Cosmides, 1990, pp. 58-60). For example, a woman may favor a man who, because of his prowess (rooted in sexual dimorphism), is obviously able to provide for many of her needs. She may be guided chiefly by her own observations and inferences and not by a cognitive adaptation or cultural norm. If she has a young child, her child-protective adaptations, instantiated in her neural and hormonal makeup, may further encourage her to favor him. In other words, her preference—a cognitive bias—is based on inputs, including adaptations, that express themselves proximally but indirectly (i.e., they are not in-themselves components of a mate-choice module).

In the above scenarios, then, adaptations that are basically non-cognitive may, mediated by quasi-general learning and reasoning processes, act indirectly—proximally or distally—to construct a mate-choice preference. That is, cognitive modules that might otherwise be assumed to derive from dedicated adaptations may, insofar as they have specific evolutionary roots, derive largely from non-cognitive adaptations. This possibility is generally overlooked by EPs.

In all, the disagreement between EPs and many mainstream psychologists may hinge less on whether we are products of evolution and more on what kinds of adaptations are critical and on how to trace their trajectories. Obviously, whether the roots of a cognitive module are proximal or distal, direct or indirect, and possibly non-cognitive, would be important to determine. However, EPs seldom address these distinctions. This may stem, in part, from EPs' commitment to an information processing model of the mind (more on this later). For example, perhaps they hesitate to postulate that important innate origins of mate choice, insofar as they are specific, may lie in adaptations as non-cognitive, and as irrelevant to information processing, as sexual dimorphism.

ROLE OF COGNITIVE MODULES

Overview

It is widely accepted, by EPs and others, that psychological functions, including those derived from specific adaptations, are embodied in modules instantiated in the brain. Thus, EPs' understanding of the innate basis of experience is vested in their understanding not only of adaptations but also of modules. Fodor (1983) is generally given credit for fostering the recent interest in mental modules. EPs have molded this notion for their own purposes (Cosmides & Tooby, 2002, pp. 174-182; Pinker, 1997, pp. 27-31; Tooby & Cosmides, 1995, pp. xiii-xiv):

Substantive cognitive modules are, to some extent, domain-specific and informationally-encapsulated, and because we have faced innumerable substantive tasks in our evolutionary history, we have a very large number of cognitive modules with a corresponding innate basis; Tooby & Cosmides speculate that there are hundreds or thousands.

To EPs, advantages of cognitive modules with these properties include the following (Cosmides & Tooby, 1994; Tooby & Cosmides, 1998, p. 200): (a) Because their operations are prespecified to deal with particular tasks, speed and efficiency of reaction are enhanced; (b) because individual modules deal with limited amounts of information, they are not swamped by excessive demands for information processing (which EPs call combinatorial explosion); (c) because they are somewhat encapsulated, modules are less likely to interfere with each other's functions; and (d) because they are not totally encapsulated, they can, individually or in combination with other modules, accomplish tasks with both narrow and wide-ranging demands. EP uses the metaphor of a Swiss army knife to illustrate these features of modules: It comes with a large collection of individual tools, each handy and specific for one or several tasks, and, as needed, several can be used for a given job.

Cognitive modules: A critical look.

EPs' use of the module concept has stirred up interest from several perspectives. (In what follows, *innate module* refers to a somewhat domain-specific module with a dedicated evolutionary basis. More specifically, *innate* refers to "reliably developing species-typical properties of the organism" [Cosmides & Tooby, 1995, p. 48], so that "innate equipment interacting with environmental factors" constructs our human nature [Tooby & Cosmides, 2005, p. 18.]

1. EPs sometimes discuss modules as if they were stand-alone preprogrammed mechanisms, based in adaptations that evolved to deal with specific problems (see Odling-Smee, Laland, & Feldman, 2003). On the other hand, EPs grant that the properties of cognitive modules are determined not just by genetics, but jointly by genetics and environment—from cellular to cultural (e.g., Tooby & Cosmides, 2005, pp. 16-18). Certainly EP's aspirations to the status of a metaperspective in psychology involves promoting a workable synthesis of "nature" and "nurture" (see Bjorklund & Pellegrini, 2002; Elman, et al., 1996; Tomasello, 1999). Necessary to this synthesis is the proposition that, as EP's grant, emergent properties of culture—that is, properties only loosely related to adaptations—mold cognitive modules in important ways (e.g., Tooby & Cosmides, 1992, p. 122). As Karmiloff-Smith (1992, p. 5) put it, "gradual modularization rather than prespecified modules." is the operative mechanism (also see Buller & Hardcastle, 2000). EPs sometimes explore experiential processes in depth (e.g., Pinker, 1996), but this, of course, is a difficult task. The difficulty of this task may contribute to EPs' sometimes cursory treatment of these processes in the formation of modules that they postulate.

Furthermore, the degree to which cognitive modules are, in fact, shaped by the environment—that is, the degree to which they are malleable—is an important issue. It seems reasonable that relative malleability (plasticity) was selected for in the case of some modules, but not others. For example, some phenotypic variation in mate preference, arising from plasticity, might have had its evolutionary uses, whereas variation in the use of grammar might have been selected against. Taking a broader view, inherited traits such as reflexes, that are directly related to fitness, are undoubtedly not very malleable (Lewontin, 2000, p. 125), while cognitive traits, in which EPs are most interested, are relatively malleable because they are less directly tied to fitness. For example, failure of the breathing reflex invariably affects fitness, whereas failure to evaluate mates according to common practice may nevertheless succeed as an alternative

approach. Unlike a reflex, the ability of a cognitive function to mold itself to fit variable (notably cultural) constraints is undoubtedly an asset. However, despite its importance to understanding the development of modules, EPs seldom address the issue of relative malleability.

In sum, and as EPs recognize, cognitive modules cannot be understood solely as products of evolution. EPs could help foster an integrated psychology by expanding their efforts to articulate the workings of environmental, along with evolutionary, inputs in the formation of cognitive modules.

2. We have seen that, to EPs, innate cognitive modules are, to some extent, domain-specific and encapsulated. After all, to the degree that they are not, the distance lessens between EP's position and the SSSM's assumption of a generalized cognitive faculty. However, some commentators (e.g., Buss, 2004, pp. 56-57; Fodor, 1983, pp. 101-102; Mithen, 2001, p. 212) have pointed out that, while basic sensory and motor systems (e.g., vision pathways, reflex pathways) are likely grounded in relatively encapsulated modules, cognitive modules—which need to communicate with other mental processes as well as be flexible to deal with local and changing conditions—must be open to a range of inputs and outputs. After all, although areas of the brain related to sensory and motor functions are relatively specific, areas related to cognitive functioning are generally somewhat diffuse.

But would an open or generic cognitive faculty experience excessive processing demands (i.e., combinatorial explosion) as it attempts to deal with varied input and output and as EPs predict? Not necessarily. Experiential inputs during development may modularize functions, initially somewhat open or generic, gradually and as needed, thus avoiding combinatorial explosion. A good illustration of this process is the development of latter-day cognitive skills (e.g., learning to read or to play chess) that are not notably accompanied by combinatorial explosion. Obviously, these latter-day skills are enabled solely by faculties that, to the extent they are innate, are open to recruitment or are somewhat generic. The specificity needed to enable such skills, then, is learned, not innate, and this specificity typically develops in an incremental, not a quantal, fashion. And this same scenario must have characterized the development of many cognitive modules in ancestral as well as modern times (see Elman, et al., 1996).

But would learned proficiencies that are enabled by initially open or somewhat generic innate programs suffer from imprecision and slow response times as EPs would predict, at least compared with more narrowly-focused innate proficiencies? Not necessarily. The speed and efficiency of cognitive skills that are well-learned should not constitute a handicap; after all, your response to “What is 2+2?” is almost as fast and precise as a reflex.

EPs often grant that modules likely differ in their degree of specificity (e.g., Buss, 2004, pp. 56-57; Tooby & Cosmides, 2005, p. 28). That is, probably some modules express themselves in a wider range of experiences than others. However, EPs seldom specify what conditions in the ancestral environment might favor the evolution of cognitive modules of various degrees of specificity. Where various modules lie on the specificity-generality continuum, then, is unclear, which leaves open the possibility, for modules that are somewhat generic, that somewhere in the middle the EP and SSSM perspectives might approach each other.

Several considerations, then, indicate that the innate bases of cognitive modules of interest are often more diffuse or generic than EPs sometimes assume and that needed specificity is often facilitated by somewhat generic learning faculties. This calls into question EPs' common assumption that the innate bases of their proposed modules are notably specific to a particular cognitive task.

3. Some commentators have noted that EP's conception of modules implies a certain neurological substrate. In fact, EPs typically say little about this substrate; given our relative ignorance concerning relevant brain mechanisms, this is not surprising. Nevertheless, EPs

sometimes imply that neurological lesions, or areas highlighted by brain imaging, that relate to cognitive functions point to a neurological basis for an innate module (e.g., Stone, Cosmides, Tooby, Kroll, & Knight, 2002). At most, of course, the brain area identified represents only a necessary, but not sufficient, element of a larger system required for a psychological function, a system that, furthermore, may subserve many other functions. And this larger system may have a largely developmental basis in learning or other experience and, therefore, have little relationship to innate modules of interest to EP (Elman, et al., 1996, p. 242).

Some commentators (e.g., Bechtel, 2003) have questioned EP's tendency to discuss a cognitive module, and by implication its neurological substrate, as if it had a one-to-one relationship with a task to be done. EPs do grant that what appears to be a unitary module often involves a large number of somewhat distinct innate programs (e.g., Cosmides & Tooby, 2002, pp. 174-182), but they sometimes gloss over some implications of this view. One implication relates to the underlying neural architecture. Rather than a separate neural program for every cognitive task, which would entail a huge number of dedicated and somewhat redundant circuits, it is more economical for a task to marshal a collection of circuits which, in various other groupings, are also recruited for a range of other tasks (e.g., Elman, et al., 1996, p. 40; Laland & Brown, 2002, p. 183). Neural economy further predicts that these circuits share components as required, while unshared components differentiate them. This arrangement also facilitates communication between processes when this is advantageous. Such a perspective could inform the search for neurological underpinnings of cognitive skills as well as guide predictions about the psychological makeup of traits of interest.

For example, as we discuss later, EPs tend to assume that innate fears of animals involve a cognitive assessment of the characteristics of, for example, poisonous snakes. Actually, such fears may be grounded in reflexive responses to certain properties—for example, quick, unpredictable movements—common to a wide range of feared objects such as snakes, bats, and large flying insects (Bennett-Levy & Marteau, 1984). If this is so, the seeming one-to-one correspondence between the feared object conceived of as a whole (e.g., a snake) and the fear is deceptive; that is, it may not mirror the related neurological underpinning. In the case of innate fears provoked by animals, the underpinning might involve circuits that are sensitive to properties of objects such as size, distance, and rate and eccentricity of movement and that are variously recruited for a wide range of experiences. This general principle, that apparent complexity may have relatively elemental roots, might account for the neurological basis of many seemingly cognitive modules. To the extent this is so, a productive research strategy might involve decomposing complex tasks into more basic elements that may, as our understanding of the brain develops, be more easily related to their neurological underpinning (as this concerns theory of mind, see Baron-Cohen, 1995; Chisholm, 2003).

In sum, there is reason to think that the neurological basis of what is described as a unitary cognitive module commonly involves a particular assemblage of circuits, many or most of which are also recruited in various combinations for other psychological functions. The seemingly unitary nature of a cognitive competence can be misleading inasmuch as it might be decomposed into more elemental roots, often non-cognitive, that may bear little resemblance to the competence as usually conceived.

Some cognitive modules proposed by EPs

Shortly some modules representative of those postulated by EP will be discussed. First, however, two themes that inform these discussions should be mentioned. The first theme concerns the scope of modules considered cognitive by EPs. Note that behaviors related to most

of the proposed modules below can be found in species fairly low on the phylogenetic scale. Commonly, therefore, these behaviors—for example, selection of habitat—do not involve sophisticated cognitive functions. One implication is that, whether or not these behaviors are homologous with similar ones in humans, a sophisticated innate module for many of these functions may not be necessary even in humans. In fact, as we discuss many of these proposed modules, we will see that elemental, non-cognitive adaptations may significantly enable these experiences in humans. Of course, even the involvement of elemental adaptations provides support for an evolutionary perspective. However, EPs seldom address this possibility, perhaps because of their dedication to cognitive adaptations.

Interestingly, however, sometimes EPs define a wide range of adaptations—including emotions and motivations—as cognitive (e.g., Tooby & Cosmides, 1992, p. 65). However, given that these adaptations characterize many non-human species, such a broad definition erodes EP's selective focus on the cognitive status of humans. And, to the extent that EP focuses on such elemental adaptations, its distinctiveness fades inasmuch as these are nothing new to mainstream psychology. Also, defining emotions and motivations as cognitions conflicts with common conceptualizations of these functions.

For these reasons, narrowly-defined cognitive modules remain central to EP's agenda, and failure to demonstrate dedicated innate bases for such modules would weaken EP's claim to offer an innovative perspective. Consequently, in our discussion of the proposed modules below, we will pay particular attention to the narrowly-defined cognitive utility in each case, including evidence that it is innate, this being the distinctive claim of EP.

The second theme concerning these modules is that alternative scenarios (e.g., generalized learning programs or assemblages of broadly recruited innate programs) may account for much of what EP ascribes to dedicated innate modules. Of course, any role played by these alternative processes does not discount the involvement of such modules. That is, dedicated innate modules, including those for learning preparedness, may enable a number of the cognitive functions discussed below, whether or not other processes are also involved.

Now to some cognitive modules as proposed by EPs. EP's postulate of dedicated, innate bases of substantive cognitive modules is, of all their postulates, the most pivotal; it certainly sets EP off from the rival SSSM postulate of a general-purpose cognitive faculty. It is also subject to empirical arbitration. As we discuss these proposed modules, we will note especially the evidence offered that they have dedicated innate origins, which is the central EP claim.

Language acquisition. Sometimes called the language acquisition device (LAD), this module was the first to challenge the SSSM, and among psychologists it probably enjoys the widest acceptance of any cognitive module. Noam Chomsky, who proposed the LAD in pre-EP times, is the most cited advocate of the view that “The brain has a component—call it ‘the language faculty’—that is dedicated to language and its use. For each individual, the language faculty has an initial state, determined by biological endowment” (Chomsky, 2000, p. 77). Many other linguists have supported this general view (e.g., Pinker, 1995; Stromswold, 2000). A wide range of research is cited in support of a language faculty, including studies of emergence of language in language-impooverished environments as well as studies linking particular genetic deficits to certain language disabilities. However, there is much controversy surrounding this research (e.g., Gopnick & Crago, 1991; Ridley, 1999, pp. 97-102; Tomasello, 2003, pp. 282-290).

On the other side of the debate are linguists (e.g., Bates, Devescovi, & Wulfeck, 2001; Lieberman, 2000, pp. 157-167; Tomasello, 2003) who have questioned how specific our programming for language is and have proposed that language acquisition is related to more open or generalized functions. For example, compared to other species, human infants are unique in their ability to attend to, and to mimic, conspecific adults who, of course, spend much of their time

using language, more than they spend on any other sophisticated skill. This degree of language exposure and practice may be sufficient, given capable and recruitable cognitive and learning faculties, to account for language learning.

Advocates of an innate language module, in turn, maintain that, even given such processes, language exposure per se could not account for learning the (especially grammatical) intricacies of language; innate enabling mechanisms dedicated to language acquisition must be involved. The debate continues. At this point, the existence of an innate language acquisition potential, with many of the characteristics EP ascribes to modules, appears a strong possibility.

Familial violence. Probably the most notable research on this topic was conducted by Martin Daly and Margo Wilson. Focusing on stepfamilies and looking at figures from several Western countries, their conclusion was that stepparents kill their stepchildren at a much higher rate than they kill their biological children (e.g., Daly & Wilson, 1988; Daly & Wilson, 1999b). A common explanation among EPs is that stepparents have few fitness interests in common with a stepchild and, consequently, that they often see the child as a liability that detracts from their own fitness. These fitness costs include economic as well as time and effort expenditures. Further, these expenditures are especially costly in disrupted stepfamily environments. The consequence is that parents are more likely to be violent toward stepchildren than toward biological children. However, as we see below, the controversial issue is not whether fitness interests play a role (few would dispute this) but, rather, what mechanism enables this role.

Of course, EPs grant that such fitness concerns may be eased by situational factors. For example, adopted children are probably not especially at risk for parental abuse (Daly & Wilson, 1999b, pp. 45-46) although, even more than stepchildren, they are genetic outsiders—that is, related to no one in the family—and, as such, should be even more prone to abuse. However, adoptive parents are usually carefully screened and therefore, compared with stepparents and on average, have the resources, stability, and motivation to care for their adopted child.

Certainly parents' solicitude toward their children embodies (inclusive) fitness concerns. But, then, so do most behaviors. These concerns are expressed through our hedonic system, which evolved to steer us toward fitness-beneficial and not fitness-costly behaviors. But this system, along with its evolutionary origins in enabling fitness, is well-known to mainstream psychologists, though they tend to view these linkages as givens rather than pay them serious attention. At any rate, these considerations are not new revelations on the part of EPs. But the primitive hedonic system is not designed for processing information relative to fitness considerations. Here is where the EP perspective offers a new possibility, namely that evolution has constructed a dedicated cognitive module that can evaluate these considerations. As Daly and Wilson (1988, p. 73) put it, "A's love of B will tend to be a positive function of B's expected contribution to A's fitness." And such an innate utility might indeed be required if there were no other possibilities for the construction of such a module. But there are at least two such possibilities.

First, the importance of the family to inclusive fitness is expressed in adaptations of bonding within the family. And these bonding experiences involve protective attitudes toward children with whom we have bonded. Stepparents, however, are generally not part of the stepfamily during their stepchild's infancy, and this is the time when this emotional bond typically forms. This bond, then, may not be in place to protect stepchildren from parental abuse in disrupted stepfamily environments. However, as we indicated above, EPs tend to assume that bonding is dependent on a prior cognitive assessment, based in innate programming, of fitness implications. But such assessments may instead develop from the bonding experience itself, and this reverses the causal arrow. That is, parents probably learn to evaluate child-protective options on the basis of their sense of bonding, or lack of bonding, with their children. Here a largely non-

cognitive adaptation, in this case bonding, likely underpins the development of a cognitive module by means of a generic learning utility.

Second, all societies recognize that the family is the social unit that, when it is cohesive and stable, bears and cares for the children who maintain and perpetuate the society, including biological kin. Because of its central importance, norms have developed to protect the family from serious disruption. It follows that these norms are generally strongest for cases of abuse of immediate biological family, weaker for more distant relatives and non-relatives, and weakest of all for strangers. Stepchildren, being outsiders relative to biological children, may thus be less protected by these norms. This may account, at least in part, for stepchildrens' greater vulnerability to abuse. In this scenario, norms with ancient cultural roots modulate our behavior through the more proximal mechanism of social learning. Even though norms that encourage intact biological families thus have roots in the evolutionary, procreative importance of the family, these roots, although they support the argument from "nature," are largely non-cognitive and are therefore not of much interest to most EPs.

Everything considered, fitness concerns surely enter into stepparents' feelings and actions toward their stepchildren. The pivotal question is: Are these concerns mediated by an innate cognitive module that is dedicated to evaluating them, as fits the EP perspective? As we have seen, such a module may not be needed. Certainly we acquire, from cultural and personal experiences and by means of generic learning utilities, relevant guidelines that express fitness concerns. These guidelines and resultant treatment of children thus have evolutionary roots, but the significant trajectories may differ in important respects from the EP model.

Social exchange reasoning. Before we review research on this topic in humans, let us look at studies involving monkeys and chimpanzees that provide a tantalizing glimpse of what may be an innate social exchange module. In these studies (Brosnan & de Waal, 2003; Brosnan, Schiff, & de Waal, 2005), capuchin monkeys and chimpanzees, performing a task for a reward, often would not perform the task if their reward was inferior to that of a fellow worker. If further research shows that such a module in monkeys and chimpanzees does not derive principally from their prior experience with social exchange, and inasmuch as these primates are close relatives of ours, this would lend support to the hypothesis that humans have a similar innate module that performs this clearly cognitive function.

Starting with Leda Cosmides (e.g., 1989), EPs have conducted considerable research on social exchange reasoning in humans. Cosmides and Tooby (1992, p. 189) proposed that "humans have [innate] rules of inference that are specialized for cheater detection." This conclusion is based largely on research, using what is known as the Wason test, that asks subjects to solve certain problems in logic. One condition asks them what information they need to determine whether someone (a cheater) is taking unfair advantage of them. Then a comparison/control condition asks them, framing the question in the same logical structure, what information they need to determine, for example, how to reach a destination on public transportation. In these studies, subjects are reported to do better at detecting a cheater; this, to EPs, indicates the presence of an innate module that does this calculation.

This research can be, and has been, questioned (e.g., Cheng & Holyoak, 1989; Fodor, 2000, pp. 101-104; Gray, Heaney, & Fairhall, 2003; Sperber & Girotto, 2003). Commentators (e.g., Badcock, 2000, pp. 107-110; Davies, Fetzer, & Foster, 1995) have specifically questioned the logic used to formulate problems presented to subjects as well as the comparability of the control condition—which, in the above example, poses a transportation, not a social, problem. According to these commentators, such factors, rather than the operation of an innate module, make the social exchange problem more salient or otherwise easier to solve.

To support the idea of an innate social exchange module, EPs sometimes refer to the case of someone with a brain lesion who was impaired in his ability to reason about social exchange (Duchaine, Cosmides, & Tooby, 2001). This was assumed to constitute support for an innate module that was disabled by the lesion (see Stone, et al., 2002). However, even if this deficit were specific to social exchange judgments, the impaired skill may have been acquired principally through general learning mechanisms (Elman, et al., 1996, p. 242).

That our social exchange reasoning skills may be enabled largely by generic learning mechanisms is an important consideration (Lloyd, 1999). Certainly our individual fitness interests might sensitize us to the relative fairness of social exchanges in particular. After all, many social exchanges involve, at least indirectly, fitness-related outcomes such as food. And, as fitness interests have social ramifications, they are also embodied in social norms that we acquire as young children (“Now, be good and share with your friends. If you’re nice to them, they’ll be nice to you.”). With practice, then, we become notably good performers when dealing with the calculus of social exchange. Given this scenario, a dedicated cognitive module may not be necessary as the evolutionary basis of our well developed social-exchange reasoning skills. Rather, non-cognitive fitness imperatives that enable these skills by means of generic learning utilities may be sufficient. But, although this scenario embodies evolutionary/fitness considerations, it is rarely proposed by EPs, perhaps because it does not postulate an innate cognitive module specific to the task. In fact, it is difficult to imagine that this generic learning scenario does *not* construct a finely-tuned social exchange module. The question then becomes: Is this scenario sufficient to account for the sensitivity of this module? To my knowledge, the research to date is not sufficiently sensitive to answer this question.

Barrett, Dunbar, and Lycett (2002, p. 288) summarized the state of the research on social exchange reasoning in humans as follows: “Taken together, these results suggest that a dedicated [innate] social exchange module is highly unlikely to be operating.”

Mate choice. The most thorough research on mate-choice, it is generally agreed, was conducted by David Buss (2004, pp. 104-162). According to Buss, his, and others’, research indicates that, in a wide variety of cultures, men usually look for long-term mates who would be good child-bearers and care-givers while women look for mates who would be good providers. Men and women, then, judge potential mates using criteria—of experience, social status, age, etc.—assessed somewhat differently. Recent research (e.g., Miller, Putcha-Bhagavatula, & Pedersen, 2002), with some elaborations and refinements, has generally supported Buss’s work, though sometimes finding more moderate gender differences.

How should we interpret this research? To most EPs, the differences between men’s and women’s mate preferences reflect differences in fitness imperatives and corresponding modules that, as proximal influences, orchestrate mate choices in relevant situations. However, as we saw earlier, mate preference may reflect cultural recognition and embodiment, since early times, of the implications of innate sexual dimorphism. That is, women are equipped to bear and care for children while men are equipped to compete for limited resources, and mate choice reflects these distinctions. In this scenario, sexual dimorphism, as a distal influence, acts through more proximal social learning processes (see Eagly & Wood, 1999). And Buss is quite willing to concede that social learning plays a role in mate choice.

Aside from cultural norms, our interest in mates and mating is surely guided by non-cognitive adaptations embodied, for example, in our motivational/hormonal system. Then, as we saw earlier, using the kind of information and logic that is generic to many situations, we may choose mates based on our idiosyncratic evaluation of the implications of sexual dimorphism to our relative fitness, as in, “Hey, big guy...I could sure use your talents around my place!”

Given these possibilities, a mate-choice cognitive module may develop from a mix of non-

cognitive adaptations and generic learning utilities expressed in both cultural and personal experience; a dedicated, innate mate-choice module may not be involved. But these possibilities do not fit the dedicated, innate module scenario and are seldom suggested by EPs.

Fears and phobias. According to EP, we innately fear, or easily develop fears of, events that constituted dangers in our ancestral environment. We have already mentioned our seeming innate preparedness to acquire food aversions, so genetic priming for acquiring other aversions, or even phobias, is not a strange notion. Innate fears related to animals are the ones most cited by EPs, and relevant research was summarized by Gaulin and McBurney (2001, p. 304) as follows: “The things we develop phobias about tend to be things that were genuine dangers in the EEA [environment of evolutionary adaptedness]....we easily develop fear of spiders, snakes, [and] fierce creatures.”

In fact, there may be an important relationship between our ancestral experience and our fears and phobias regarding animals. On what, however, is this relationship based? Are we endowed with an innate cognitive module that evaluates these dangers? Or, as we have already noted, might these fears relate to more elemental reflexive responses (Bennett-Levy & Marteau, 1984)? After all, the animals named above often move in quick, unpredictable ways, and it is well known that our nervous system responds reflexively, with a startle reaction and some degree of fear, to almost any such stimulus. Likely this response is rooted in experiences with animal threats going back to deep evolutionary times.

How can we appraise these two hypotheses: reflexive response vs. cognitive module? One way is to note examples that the hypotheses do not explain—in particular, response errors. We know that many people are afraid of bats and large flying insects, though they are not harmful. And we know that fear of snakes is usually misplaced; that is, this fear typically encompasses all snakes, not just poisonous ones. The reflexive response hypothesis, which postulates responses that are rather indiscriminant, would predict errors of this kind. The cognitive module hypothesis, however, postulates sophisticated discriminations that surely could note the differences between snakes, bats, and large insects as well as the unique properties (e.g., coloration patterns) of poisonous snakes. In other words, the cognitive module hypothesis would not predict these response errors. In addition, sophisticated discriminations might be time-consuming and—because time is of the essence when faced with a speedy and unpredictable animal—might detract from fitness. On the other hand, certainly we learn from our own reflexive responses, as well as from our culture’s teachings about them, to make cognitive appraisals of potential threats. And these appraisals, in turn, likely influence our response to these threats. In this way and as we have seen before, cognitive processes surely are constructed from more elemental innate responses.

In sum, that we have specific fears with innate roots is generally accepted by mainstream psychologists. What is controversial is EP’s suggestion that such fears entail an innate cognitive component that evaluates a collection of features of, say, an animal. Inasmuch as reflexive fears triggered by fast-moving, unpredictable threats likely trace back to deep evolutionary times and seem to function effectively in a wide range of species, there seems little reason for layers of additional cognitive complexity to have evolved to deal with particular threatening animals. After all, evolution, as do natural systems in general, probably favors designs that embody the least possible complexity (as Ockham might say).

Habitat preferences. Many EPs believe that, as a place to live, we tend to prefer the environment in which, generally speaking, our ancestors evolved—namely the savanna (e.g., Buss, 2004, pp. 88-90; Orians & Heerwagen, 1992; but see Calvin, 2002; Laland & Brown, 2002, pp. 177-182, for an alternative view that our ancestors faced varied and changing Pleistocene environments, rather than an enduring savanna, and that these, moreover, stimulated human cognitive development). But the often-cited research (Balling & Falk, 1982) that tested people’s

preferences for various landscapes included these choices besides savanna: forests (tropical, deciduous, and coniferous) and desert. Strangely, it failed to include temperate and Mediterranean landscapes with a mix of fields, woods, and water. And it did not include the landscape that is almost synonymous with paradise, a tropical island landscape (trees heavy with fruit, warm beaches, water rich with sea life).

Given a broad selection of landscapes, then, a temperate, Mediterranean, or tropical island landscape might be preferred over a savanna. But, regardless of the outcome, on what landscape features might such a preference be based? My guess is that these features would include ready access to food and potable water, a comfortable range of temperature and moisture, places of safe haven and protection from the elements, vantage points, and other amenities we might easily agree on. These preferences seem to be reasonable predictions based on a knowledge of largely innate human needs for food, water, safety, a certain temperature range, etc. Furthermore, these preferences likely construct, by means of a generic learning utility, a derivative cognitive module that can evaluate features of various landscapes. And, over time, cultural norms, tempered by historical contingencies, would also reflect these needs and preferences and contribute to the formation of such a module. That such elemental needs are based on adaptations emphasizes the relevance of an evolutionary perspective. Once again, EP's assumption that the related cognitive preference itself is innate, rather than acquired in the service of more elemental needs, seems to add a layer of unnecessary complexity.

Conceptualization of the natural world. EPs postulate innate modules (embodying what they call intuitive, folk, or naïve physics, biology, and psychology) for conceptualizing the natural world. Because of its importance, we have already discussed a postulated module for judging social exchanges, which EPs consider an example of intuitive psychology. Here we discuss some other proposed modules underlying our concepts of the natural world.

One consideration concerns how we group things into categories such as living vs. non-living, plants vs. animals, and so on. People almost universally show a notable consistency in at least basic kinds of categorizations (e.g., Atran, 1990; Keil, 1989). But does this mean that dedicated cognitive adaptations are involved? Common classification schemes may, to the contrary, reflect the fact that humans everywhere are confronted by a somewhat similar array of objects, themselves similar and dissimilar to one other in various ways. It is hardly surprising that, to deal with this multiplicity, people tend to categorize objects in consistent ways that reflect universal invariants—in accordance with the relevance of such classifications to their way of life. As Berlin (1978, p. 24) put it, "Folk biological classification is based on a recognition of natural discontinuities in the biological world." Of course, our sensory and perception systems are innately programmed to note particular discontinuities (e.g., movement vs. non-movement, transition vs. continuity), but such innate programs are relatively elemental and are well recognized in psychology. Certainly many classification systems seem to be the product largely of generic learning programs. As Restak (1994, p. 70) remarked, "While living versus nonliving distinctions are appealing..., what [evolutionary] use is the distinction between musical instruments [or games or works of art] and other man-made objects?" And if some universal classification systems are largely learned, perhaps most of them are.

In regard to folk physics, EPs are interested, for one thing, in how people react to the ways objects interact with one other. For example, they cite research that indicates that infants show surprise when solid objects appear to do impossible things, such as pass through one another (e.g., Spelke, 1991). This, to EPs, points to an adaptive module. However, this and similar research tested infants who were several months old and who thus might have learned, with the help of a generic program, the particular characteristics of solid objects. On the other hand, newborns do show innate perceptual biases—for example, they preferentially attune to the features of faces

(Johnson & Morton, 1991). We certainly come into the world able to make many perceptual discriminations, but perhaps not with the sophisticated knowledge that EP postulates.

Whether or not we have an innate sense of the behavior of objects, perhaps we have an innate preparedness for *learning* about how objects behave. If we do, it seems only marginally effective. Most adults, when asked to articulate, or demonstrate with drawings, how moving objects behave, commit systematic errors. After all, for hundreds of years the great thinkers of the Western world perpetuated Aristotle's mistaken notions about physics (in particular, mechanics). However, when adults are asked to hit an object with a projectile, their performance improves. That is, the principles guiding their actions differ from the principles they are able to express explicitly (see Bertamini & Hecht, 2003). Of course, good aim was certainly important to our ancestors as they hunted animals and may have a specific genetic basis—though this, to my knowledge, has not been demonstrated. On the other hand, viewed solely as an acquired skill, the difference between motor and cognitive processes, as shown in this research, is an example of the differences between procedural and declarative learning, with declarative learning being less informed by the practice of a physical skill. In sum, it is difficult to see how the concept of an innate, cognitive understanding of the physical world would account either for this kind of cognitive deficit or for the procedural-declarative discrepancy.

The research on our basic notions of the natural world was summed up by Geary and Huffman (2002, p. 687) as follows: “There is no consensus regarding the meaning of this research...that is, whether it is best understood in terms of inherent modular constraints or as the result of general-learning mechanisms.”

In all, we have examined evidence offered by EPs in support of seven proposed innate cognitive modules that are fairly representative of those in the EP literature and that, according to EPs, act in a direct, proximal manner: language acquisition, familial violence, social exchange reasoning, mate choice, fears and phobias, habitat preferences, and conceptualization of the natural world. We have seen that, in most cases, innate processes that are non-cognitive, and/or cognitive but open or generic (including generic learning programs), and that act indirectly or distally, could account for what EP ascribes to innate cognitive modules that act proximally and are specific to each task. Given that EP's agenda consists, to a large extent, of demonstrating the existence of such modules, this is an important conclusion. However, as we have said, this does not mean that these modules do not exist. It is certainly possible that dedicated innate programs, including those that prime for learning, enable these various tasks. But these programs have yet to be demonstrated in a rigorous fashion. The problem is that demonstrating the existence of these innate programs may be difficult given the constraints of EP's research agenda (more on this later).

Having looked at the central role of adaptations and modules in the EP program, we now look at some other basic EP principles.

OUR MINDS AS INFORMATION PROCESSORS

To EPs, “The brain is a machine designed to process information.... [And] the mind is what the brain does” (Cosmides & Tooby, 2000, p. 27). To enable cognition, which consists of information processing, “the human mind contains...[innate] content-specific algorithms” (Cosmides & Tooby, 1992, p. 208). Taken together, these characteristics of the mind are akin to those of a computer (Tooby & Cosmides, 1995, pp. xiii-xiv). Thus, to EPs, the mind = the brain = a quasi-computer—that is, an information processor that uses algorithms (Pinker, 2002, pp. 31-34; Tooby & Cosmides, 2005, pp. 5-6).

What are the implications of this information processing model? Given that computers are prototypical, and easily conceptualized, information processors, some implications will be clear if we review certain differences between minds and computers as presently understood. Though bear in mind that EPs differ in their commitment to a hard mind-as-information-processor model.

1. Unlike computers, minds are constructed and function only within an environment in which they experience reciprocity of action (Neisser, 1993); in fact, the mind-in-environment is an irreducible unit for many functions viewed as information processing. And the most salient environment is social. That is, minds are immeshed in a community of minds that is necessary for the construction and elaboration of cognitive functions; as someone said, “A lone mind is no mind.” This is true of computers only in relatively trivial ways. Although EPs sometimes acknowledge the importance of the community of minds (Tooby & Cosmides, 1992, p. 119), they often discuss minds as if they were stand-alone units (e.g., Cosmides & Tooby, 1997, para. 13). Obviously, this perspective marginalizes topics such as social processes, which are so important to the development and embodiment of cognitive functions and which constitute “a single [distributed] processing system that dwarfs all others” (Dennett, 1996, p. 381; also see Donald, 2001, pp. 149-164). In fact, the notion that what is true for a solitary mind is also true for a network of minds evokes the fallacy of composition. As Mithen (2001) put it, “The notion of the ‘extended mind’... detracts from arguments that there is an equivalence between the mind and the brain” (p. 208).

2. Computers do not have motivations or emotions as humans do. Inasmuch as EPs see emotions as closely tied, and sometimes even as identical, to cognitive functions, let us explore emotions further. As Buller (1999, p. 104) said, “An organism with information but no motivation has nowhere to go.” The same could be said of emotions, which are closely linked to motivations (“I love Susie; I want to be with her!”). And Tooby and Cosmides (2005, p. 39) concur in this function of emotions: “An emotion is a superordinate program whose function is to direct the activities and interactions of many subprograms.”

On what basis do emotions direct other mental functions? In particular, do the distinctive and compelling qualia of our emotions—the fury of anger, the agitation of fear, the exhilaration of joy—contribute to this function? For the moment, assume that qualia, in fact, contribute to the regulation of our psychological—including cognitive—functioning and are not just epiphenomena. Then, following the logic of the mind-as-information-processor model, an appropriate algorithmic program running in a non-organic substrate would have to create the qualia of, for example, anger, fear, and joy as it generates mental phenomena. But this strains credulity. To avoid this quandary, qualia might be considered epiphenomena. But as epiphenomena, emotional qualia would contribute nothing to our psychological functioning, and that also strains credulity. Furthermore, as epiphenomena, by definition not subject to evolutionary processes as ordinarily understood, how did qualia come into being? And if qualia did not evolve, what other human traits are likewise unaccounted for by evolution? In a number of respects, then, the information processing model strains to accommodate emotions with their qualia (or qualia of any kind).

Perhaps because emotions, with their compelling qualia, seem to transcend the information processing model, they are usually not given much attention in discussions by EPs of particular cognitive modules (see Badcock, 2000, pp. 121-129; but see Buss, 2000). Although EPs recognize the regulatory importance of emotions, to my knowledge they have not proposed to capture the seeming motive power of emotions—their qualia—in information processing terms.

3. Let us take a further look at the possibility of duplicating organic mental phenomena in inorganic computers inasmuch as this is often considered the eventual and ultimate acid test of the mind-as-information-processor hypothesis (W. Rowe, personal communication, January, 2005).

First, a computational program that was said to represent information processing operations of a brain would have to incorporate all processing levels, not just interneuronal (i.e., neural networks, which, probably because these nicely fit our image of a computer, are the idealized image). It would have to simulate extraneuronal components (e.g., glial cells and hormonal factors) as well as intraneuronal components (e.g., organelles, vesicles, and microtubules). Unlike a computer whose logic circuitry is well insulated from ambient influences, all of these levels and associated processes are potentially involved in whatever information processing goes on in the brain. In all, it may be unrealistic to think that a non-biological substrate could simulate in real time—time constraints being a necessary element—brain processes that involve billions of components (some are mentioned above) many of which, along with billions upon billions of mediators (molecules, atoms, ions), can change state within microseconds.

Second, this processing (sometimes called syntax) would, in addition, actually have to process psychological experience (sometimes called semantics). But we should not expect psychological experience (consciousness, qualia) to emerge from inorganic simulations of the mind (Chalmers, 1996, notwithstanding) any more than we should expect a storm when we run an appropriate weather simulation. That is, the subjectivity of the mind is likely a property of certain organic, but not inorganic, substrates. As John Searle (1997, p. 163) put the case, “The brain is a biological organ like any other, and consciousness is as much a biological process as digestion or photosynthesis.”

Third, a brain is, to an important extent, self-organizing with emergent properties; a computer is not (Thelen & Smith, 1994). Even if a computer program, complete with a self-organizing potential, were developed to represent a brain’s informational state, brain and computer systems would quickly diverge as butterfly effects in the different substrates accumulated.

4. Computers operate according to known algorithms programmed into, or extractable from, them. In contrast, we are not privy to the properties of any algorithms in the mind. Postulating mental algorithms can be a handy conceptual tool, but needs to be seen as such. And researchers will usually admit that their models (algorithms) of cognitive functioning are just that, models. Usually alternative models can be fitted to the data. This is an important consideration to keep in mind if and when EPs offer algorithms that are said to represent innate cognitive modules.

5. Not all cognitive attributes are computational or algorithmic, at least as these terms are ordinarily defined. And EPs tend to neglect attributes that don’t fit the algorithmic model. For example, our social cognitive skills may have evolved to deal with human populations of a limited size (i.e., in the hundreds) in our ancestral past. Brains, as do computers, necessarily have input, storage, processing, and output limitations. And algorithms, which specify *procedures* for solving *problems*, are not used for representing such limitations. (Re. this particular limitation and apropos mismatch theory, we might expect to experience overload and stress when confronted, in contemporary times, by local populations in the thousands.)

So the common view in EP is that the mind/brain is a quasi-computer that can be understood in terms of its internal algorithms. In this regard, EP is part of a trend in psychology that defines an increasingly wide range of mental processes as cognitive and, consequently, sees mental life as information processing. As long as this correspondence is seen as resemblance and not equivalence, the assumption of mind-as-information-processor can be productive. However, just because we can develop algorithms that help us understand human behavior (and inferred mental operations) does not mean that the mind-brain itself computes such algorithms anymore than the fact that physicists can develop algorithms that help us understand the behavior of objects means that objects themselves compute these algorithms. To the extent that EPs flirt with such an equivalence, or functionalist, position—and they sometimes do—they are vulnerable (see Mundale, 2003). After all, the model is not the mind, and believing that it is evokes the fallacy of

misplaced concreteness. In practical terms, this functionalist stance may underlie, in part, EPs' sometimes casual approach to relating cognitive modules to brain mechanisms; perhaps they assume that the essence of modules, at least ideally, is reproducible, as well as more easily studied, in a non-organic information processor. And, as we have seen, this stance may have distanced EPs from certain traditional areas of interest in psychology—for example, emotions and social processes—that are difficult to conceptualize in information processing terms.

Finally, to the extent that EPs are committed to a functionalist/equivalence mind-as-information-processor view, they must appeal, in the absence of an empirical justification, to a rationalistic justification for their position, and, for this reason alone, this is not a strong position. Interestingly, EPs' mind-as-information-processor assumption seems to make little difference to their everyday work with modules; for example, for no module (to my knowledge) has an algorithm been worked out. In all, EPs' assumption, at least in its extreme form, seems to bestow few benefits at the same time it works against their desire to be relevant to all of psychology.

MISMATCH BETWEEN OUR PSYCHOLOGICAL MAKEUP AND MODERN CULTURES

The mismatch hypothesis, which predates EP (see Bowlby, 1969, p. 59) and which EP has incorporated, maintains that we still carry the psychological makeup that evolved to deal with the cultural conditions of our ancestors' time. But modern conditions are much different. There is, then, some degree of mismatch between our innate psychological makeup and our culture (e.g., Buss, 2004, p. 401; Pinker, 1997, p. 42; Tooby & Cosmides, 2005, p. 6). Although, as EPs grant, the demands of modern culture shape innate modules, the degree of shaping undoubtedly is limited, which, in turn, underlies this mismatch. This postulated mismatch between adaptations and (emergent) culture implies, of course, that properties of culture are emergent and not reducible to properties of adaptations (Tooby & Cosmides, 1992, p. 122); after all, if culture were merely an embodiment of adaptations, there would be no mismatch. However, in spite of the importance that mismatch theory assigns to culture, EPs tend to view adaptations as primary movers in human experience and culture as secondary (e.g., Tooby & Cosmides, 1992).

The mismatch between our innate psychological makeup and our culture results in a wide range of psychological and psycho-social disorders given that, as Daly and Wilson (1999a, p. 512) put it, “A world with...effective oral contraceptives, telephones,...televised violence, personal computers, internet pornography and exogenous opiates...must be importantly different from that to which an evolved human nature is adapted.” For example, it is likely that many modern-age disorders relate to the increasingly fragile nature of relationships (Gilbert & Bailey, 2000) as well as to related difficulties in the transmission and maintenance of coherent cultural norms. As we confront such modern-day conditions with our ancestral mentality, then, we experience stress.

The mismatch perspective has given rise to a variety of writings exploring the clinical implications of this mismatch (e.g., Gilbert & Bailey, 2000; Glantz & Pearce, 1989; McGuire & Troisi, 1998). However, some disagree with this perspective (e.g., Crawford, 1998, pp. 285, 291; Laland & Brown, 2002, pp. 144, 190-191), and the fields of sociobiology and behavioral ecology, in particular, have generally assumed—contrary to the mismatch hypothesis—that adaptations can be expected to contribute to fitness in current environments. Of course, fitness is not necessarily highly related to psychological well-being. In all, the mismatch hypothesis has a great deal of appeal, though some questions arise about how it is used in EP.

One question concerns how EPs account for the decoupling between our psychological makeup and our culture. It is widely assumed that human genetic endowment and culture co-evolved until around 50,000 years ago. That is, culture (e.g., tool economies) developed in

concert with genetic traits that allowed for them, and, reciprocally, genetic traits (e.g., the capacity to make tools) that fit cultural demands were selected for. But, around 50,000 years ago, it appears that a decoupling began between the two, with culture outpacing biological evolution. Since our genetic endowment seems not to have changed significantly from that time to this, the common assumption is that this decoupling resulted chiefly from the escalating development of culture, facilitated by language, which has continued at an increasing rate up to modern times. This decoupling, then, underlies the current mismatch between the demands of modern culture and our genetic endowment. But EPs make little attempt to account for the decoupling, which is so important to the mismatch hypothesis, perhaps because such accounts assign a decisive role to culture and a minimal role to evolution, and this conflicts with EP's tendency to focus on evolution.

Another question concerns how EP conceives of the psychological impact of this mismatch. Some of the distress caused by this mismatch may result from ancestral cognitive programs gone awry in contemporary society. However, probably most of this distress results from innate needs—for example, for intimacy—gone unmet. Inasmuch as these needs are neither algorithmic nor cognitive, the impact of the gene-culture mismatch involves psychological mechanisms (innate needs and associated emotions) that are only marginally related to EP's view of humans as distinctly cognitive beings.

But, everything considered and in spite of some unsettled issues for EPs, the mismatch hypothesis has proved useful in generating insights into psychological, as well as social, disorders.

OUR UNIFORM HUMAN NATURE

According to Cosmides and Tooby (1987, p. 284), the generally acknowledged leaders of the EP movement: “The [evolutionary] cognitive programs of different individuals...[are] essentially the same.” (However, they acknowledge differences associated with gender and age. For similar statements re. genetic uniformity, see Pinker, 1997, pp. 48-49; Tooby & Cosmides, 2005, pp. 23-24; but see Tooby & Cosmides, 1990, p. 37.) But, to EPs, genetic invariance commonly means qualitative, not quantitative, uniformity (e.g., Buss, 2004, pp. 394-399; Pinker, 2002, p. 143). For example, almost everyone inherits an innate capacity for language (qualitative uniformity), but this capacity can differ in various ways from person to person (quantitative variation). Most psychologists would probably agree with this. However—and this is the sticking point—EPs sometimes endorse quantitative, not just qualitative, genetic uniformity in cognitive traits; in this view, innate capacity for language does not vary. As Tooby and Cosmides (1990, p. 38) put it, “Those interested in studying complex psychological adaptations should be most interested in design features that are inherited, but not heritable [i.e., not genetically variable]” (also see Tooby & Cosmides, 2005, p. 25). As we will see, this position is difficult to support (see Wilson, 1994). For these reasons, we now look at the rationale for the assumption of quantitative uniformity in innate cognitive endowment and some of the reasons this assumption enjoys little currency outside of EP.

To a large extent, the assumption of genetic uniformity in cognitive processes rests on the belief that variation in the innate components of a complex system such as cognition would, after being shuffled during sexual reproduction, come together in jumbled combinations that work inefficiently (e.g., Tooby & Cosmides, 2005, pp. 23-24). Of course, the same could be said about body structure: How could body parts of miscellaneous sizes, thrown together during the process of reproduction, possibly work together in an effective way? But, of course, they usually do. Very likely, both cognitive programs and body parts are structured, and self-organized, epigenetically as conditions dictate (see Clark, 1997; Thelen & Smith, 1994). For example,

canalization may help channel a mixed genotype into a functional phenotype (Waddington, 1959). Of course, evidence relevant to this question is difficult to obtain in humans. But a possibly relevant observation comes from studies of canids. According to Alice Moon-Fanelli (personal communication, November, 2001), dogs from a cross-species coyote-beagle mating showed no confusion or inefficiency in their gape-threat display, which differs significantly in the two species. In fact, the hybrid vigor principle would predict that offspring of genetically diverse parents, far from being handicapped by genes at odds with one another, may have certain adaptive advantages.

A number of additional problems are associated with the assumption of genetic uniformity underlying our cognitive traits:

1. It reverses the common and generally accepted inverse relationship between phenotypic complexity and genotypic uniformity. After all, if greater complexity generally entailed more uniform genetic programming, then playing chess or reading maps would have more uniform innate roots than reflexes, and that is unlikely. Because non-cognitive traits—for example, reflexes—are generally more closely tied to fitness, genetic variation might be costly; thus they typically have very uniform genetic roots (Lewontin, 2000, p. 125). By the same reasoning, innate programming for cognitive traits is probably somewhat free to vary.

2. It requires an unsubstantiated uniformity in neural structure. To bolster the notion that our human essence is grounded in a uniform genetic program, Tooby and Cosmides (1992, p. 38) stated that, “any given page out of *Gray’s Anatomy* describes in precise anatomical detail individual humans from around the world.” It is true that humans are very similar on a macro scale (four limbs, one brain, etc.) but, in fact, we differ in the “precise anatomical detail” where Tooby and Cosmides claim uniformity (Wilson, 1994). Contrary to Tooby and Cosmides’ claim, *Gray’s Anatomy* depicts typical, not universal, anatomical details. For example, Williams (1956) documented the wide range of variation in organ and biochemical systems of the human body, including, of course, those of the nervous system. (Also see Edelman, 1987, pp. 57-59; Gazzaniga, 1992, p. 102.) And these variations, more than can be accounted for by prenatal influences, exist in very young humans, so they do not result solely from environmental effects. Because, to Tooby and Cosmides, the mind is the same as the brain, these variations implicate variation in innate cognitive functions.

3. It necessitates a recent evolutionary trend in favor of genetic uniformity in cognitive traits. Taking a long view of our evolutionary history, it is clear that cognitive adaptations are products of notable changes wrought by evolution. Thus, there must have been considerable underlying genetic variability to enable these changes. It is difficult to understand, then, how such variability would have been effectively eliminated, as Tooby and Cosmides evidently maintain, in the time since our basic makeup was established (perhaps around 50,000 years ago). In fact, as Pennington (2002, p. 494) put it, “Since much of human evolution has involved rapid brain evolution, we should expect the genes expressed in the brain [and thus the mind] to be more polymorphic than those expressed in evolutionarily older organs.”

4. It overlooks basic mechanisms for maintaining genetic variability. New genetic material, of course, is created solely by mutation. Successful mutations are then propagated and assorted by processes that result in a nearly endless variety of genetic combinations and resultant traits. In sexual reproduction, these processes include: recombination, mate choice, and the joining of a particular egg and sperm during fertilization. At the level of populations, a partial list includes: multiple adaptive peaks, frequency-dependent selection, and heterosis. These mechanisms maintain significant genetic variation in the face of natural selection, which favors the most functional variants (Bailey, 1998, pp. 220-221). Resultant genetic variation in humans, while less than that in chimpanzees (Brown, 2001, p. 42) and many other species, is nevertheless significant.

For example, one survey (Cavalli-Sforza, Manozzi, & Piazza, 1994, p. 141) found, in humans, that 30 percent of a wide-ranging sample of genes demonstrated heterozygosity (i.e., more than one allele per single gene). This suggests that significant genetic variation underlies complex psychological traits.

5. It ignores research on genetic variation underlying cognitive traits. Pennington (2002, p. 495) summarized this research as follows: “Behavioral geneticists have documented moderate heritability [and thus genetic variation] for most human cognitive... traits” (also see Miller, 2000, p. 69). Most of the cognitive traits for which genetic variation has been demonstrated—for example, intelligence—have a long history of acceptance in mainstream psychology. But, in addition, there is either demonstrated or likely genetic variation in some traits of particular interest to EP, such as grammatical ability (Pinker & Bloom, 1992, p. 476) and theory of mind (Hughes & Plomin, 2001).

Taken together, these considerations make it difficult to accept the notion that, in our cognitive traits, we are genetically basically the same.

One practical effect of the assumption of genetic uniformity has been that EPs sometimes see a number of traditional specialties and areas of interest in psychology as peripheral. According to Tooby and Cosmides (1997, para. 12), “The thousands of interesting psychological phenomena (of interest to psychopharmacologists, psychiatrists, behavior geneticists, personality psychologists, etc.) are not adaptations, but are byproducts of adaptations, negative mutations, or are the results of... neutral genetic variants.” Because the traits of interest to these specialties are non-adaptational variants, they are not genetically uniform and therefore (remember) not cognitive; everything considered, they are not part of our distinctively human nature and therefore not of particular interest to EPs. In a nutshell, “Evolutionary psychologists are usually less interested in human characteristics that vary due to genetic differences, because they recognize that these are unlikely to be evolved adaptations central to human nature” (Tooby & Cosmides, 2005, p. 25).

To EPs, these genetically variable and therefore only marginally interesting traits are generally considered non-cognitive: personality traits, emotions, etc. (e.g., Tooby & Cosmides, 1990). However, as we have seen, it is likely that cognitive traits also vary genetically. If this is so, then EPs who claim that genetically variable traits are not part of our basic human nature are faced with advocating a human nature that excludes cognitive as well as more elemental traits and is therefore quite impoverished (De Jong & Van Der Steen, 1998, p. 200).

In addition, EPs seldom address intelligence, at least as traditionally conceived, perhaps because it is commonly assumed, contrary to EPs’ perspective, to be genetically variable as well as a generic aptitude that is not specifically algorithmic. Or EPs may think that, in light of their study of innate cognitive modules, traditional studies of intelligence are outmoded. Perhaps for similar reasons and as we have discussed, EPs give little attention to traditional learning research. EP’s reluctance to incorporate traditional work on intelligence and learning is unfortunate. Of any extant body of work, some of this traditional work is certainly robust as well as strongly indicative of the innate roots of cognition. EPs would surely benefit from incorporating, and re-conceptualizing as needed, select portions of this important legacy, relevant as it is to the issue of innate cognitive functions.

In these ways, EP’s questionable assumption that our human nature is genetically uniform has marginalized significant portions of the psyche as traditionally conceived. This, in turn, has impeded the development of EP and distanced EP unnecessarily from some traditional areas of psychology. This uniformity assumption also has steered EPs away from quantitative genetic research designs, which assume genetic variation (Tooby & Cosmides, 2005, p. 25). As we will see, this seriously limits the kinds of evidence EPs can offer in support of their claims.

The principles discussed to this point—cognitive adaptations and resultant modules, the mind as information processor, mismatch theory, and genetic uniformity—form the foundation of the EP edifice. This discussion has positioned us to consider the EP research program.

EP RESEARCH PROGRAM: AN EVALUATION

Current EP research strategies

We have seen that EPs use a number of research strategies to search out dedicated evolutionary bases of corresponding human cognitive traits, this being their chief research goal. What can we say about the utility of these various strategies? (See Buss, 2004, pp. 58-67, for an extended summary.)

Demonstrate the existence of a cognitive trait predicted from ancestral conditions. In the approach favored by EPs, as we have seen in the examples of proposed modules above, a cognitive trait is predicted from postulated conditions of the ancestral environment (known as the environment of evolutionary adaptiveness, or EEA; Bowlby, 1969; Symons, 1990), and its substantiation is then the subject of research. This strategy is known as reverse engineering because it looks into the past to reconstruct our cognitive features from the conditions our ancestors had to contend with (Tooby & Cosmides, 2005, pp. 12-13), and it has proved very useful in generating hypotheses about these features. However, it has definite limitations when it comes to testing those hypotheses:

1. Often alternative scenarios could link psychological traits and postulated ancestral conditions. As Dennett (1996, p 245) put it, “Since *some story or other* must be true, we must not conclude we have found *the* story just because we have come up with *a* story that seems to fit the facts.” For example, if men preferred 28 year-old, rather than 18 year-old, women, “will it not then ‘make excellent adaptive sense’ that these older women were better bets in the ancestral environment? They had more skills in foraging, or more resource holding power within the band, or had already proven their fertility by bearing a child” (Griffiths, 1997, p. 110).

Given the difficulties of relating cognitive traits to ancestral conditions, we might expect that predictions EPs make about traits would occasionally not be supported. This seems to happen rarely. This raises the possibility that EPs, at least sometimes, finalize the details of hypothesized links between ancestral conditions and cognitive traits with some knowledge about the direction the data might take (Laland & Brown, 2002, p. 189). If this were the case, EP’s claim—that finding the predicted characteristics of a cognitive trait (demonstrating what is called “special” or “good” design; e.g., Tooby & Cosmides, 2005, pp. 14-15) constitutes support for the evolutionary basis of the trait—would be called into question.

Thus it seems probable that EP-proposed links between cognitive traits and possible evolutionary origins are, at least sometimes, tenuous and questionably indicative of the evolutionary basis of these traits.

2. EP’s strategy, of postulating modules on the basis of ancestral conditions, imposes few limits on the modules that can be envisioned. Remember that Tooby and Cosmides (1995, pp. xiii-xiv) proposed that we have hundreds or thousands of innate cognitive modules, and this global outlook offers few guidelines for identifying false positives. As the sage said: A theory that predicts everything predicts nothing. We might ask, is there an innate module for every cognitive task related to fitness that our ancestors dealt with successfully? For example, certainly our ancestors had to cross rivers or gullies filled with running water. So an innate module for recognizing, or for learning to recognize, fords might have contributed to fitness. If I propose such a module and then find that people are skillful at recognizing fords, can I claim to have

demonstrated an innate module? The same could be said for recognizing materials suitable for making tools, or places suitable for taking shelter, or clouds that portend a storm, or ground surfaces (e.g., dangerously slippery or littered with sharp rocks) to avoid when walking. And so on.

This, in fact, mirrors the research strategy favored by EPs (e.g., Tooby & Cosmides, 2005, pp. 14-15). Clearly this strategy, which is useful for forming hypotheses concerning innate modules, is inadequate for testing them.

3. EP's appeal to the argument from "special design"—that innate cognitive modules "make sense" as solutions to specific ancestral challenges—deserves a closer look. While this argument has utility for non-human species, it may not for cognitive traits in humans. As we saw in our discussions of many EP-proposed modules, the special design argument also can support the case that the same cognitive functions "make sense" if they are constructed by generic learning utilities drawing on innate but non-cognitive or innate cognitive but open or generic processes. In other words, predictions based on these different models are commonly isomorphic with one another, possibly because, to an important extent, they all embody fitness considerations. The problem is that EP's favored research strategy assumes that predictions based on their preferred scenario—that specific cognitive modules have dedicated innate bases—best satisfy the requirements of special design. Consequently, demonstrating the existence of these modules is taken as support for this scenario. However, because these modules are also predictable from reasonable alternative scenarios, this favored EP strategy fails as a definitive research approach. Later we suggest some alternative research designs that might provide more definitive and apportioned support for these different hypotheses.

In all, it is apparent that the research strategy favored by EPs, while a fruitful source of hypotheses, does not provide an adequate test of those hypotheses.

Demonstrate that a cognitive skill is present in infancy. A valuable principle is that a cognitive skill manifested early enough probably has a corresponding genetic basis. The crucial question is: How young must infants be for us to say with confidence that they could not have learned the skill of interest (by means of domain-general learning programs) and that therefore the skill has corresponding genetic roots? This, of course, depends on the trait and is, to a large extent, a matter of guesswork.

Relate specific genetic deficits to cognitive deficits. Researchers sometimes attempt to relate specific genetic deficits to cognitive deficits. In principle, this is a very useful approach. In practice, clearly defined genetic deficits are sufficiently rare that this approach has very limited application. Also, it can be difficult to demonstrate that the cognitive deficit involves just the trait of interest and not a broader range of traits.

Relate brain areas identified by lesions or brain scans to cognitive functioning.

Although approaches that use lesions or brain scans to relate neurological structures to cognitive functions are useful, they cannot usually be used to demonstrate the innateness of the function. The brain area identified is likely a necessary but not sufficient part of a larger network which may, furthermore, embody a function that developed almost solely as a result of experience (Elman, et al., 1996, p. 242)

Determine whether a cognitive trait is universal across cultures. To some extent, the EP research program has assumed that universality of a trait across cultures implies a specific genetic basis. That is, if a trait is robust in any and all environments, a common genetic base that is insensitive to environmental differences is a reasonable hypothesis (e.g., Pinker, 2002, p. 101). But there are other reasonable hypotheses, including acquired accommodations to environments, physical and cultural, that vary in many respects but that share some common features. For example, vagaries of weather characterize all natural environments. That all cultures have learned

to provide for shelter and protection follows logically, without the need to postulate a dedicated adaptation. In fact, there are many universal traits that developed in ancestral times and that are importantly cognitive—making tools, hunting, navigating, and using fire, to name a few—for which evidence for a dedicated genetic basis, including learning preparedness, is meager; nowhere in the world do people demonstrate these skills without a somewhat specific and extensive course of learning. Viewed another way, these skills are generally as difficult to learn as latter-day cognitive skills such as interpreting maps, taking buses, negotiating shopping malls, and using computers. Given that these latter-day skills are obviously not enabled by a dedicated genetic program, then perhaps neither are these ancestral skills. And if universal cognitive traits as relevant to fitness as these ancestral skills do not have dedicated innate bases, then many other universal traits may not. In sum, it seems that universality can be suggestive, but not demonstrative, of the dedicated innateness of a trait (see Levy, 2004).

In this review of EP research strategies, we have seen that the one favored by EPs—which involves demonstrating the existence of innate cognitive traits predicted from ancestral conditions—though useful in forming hypotheses, is, in the end, inconclusive for determining the genetic bases of these traits. Of all these strategies, that of relating genetic deficits to cognitive deficits is probably the most definitive, but, as we saw, it has limited application. The limitations of research approaches favored by EPs may account, in large part, for the lack of general acceptance of EP claims, which are seen as inconclusive by many psychologists. As Panksepp and Panksepp (2001, p. 7) put it, “There is essentially no evidence *yet* that modularized, sociobiological cognitive adaptations have emerged in the neocortex since our neocortical divergence from ‘chimp-brained’ anthropoids some two million years ago.” So the question arises, are there research strategies that EPs could use that would broaden their evidentiary base and provide more convincing outcomes?

Suggested research strategies

Probably the chief constraint on EPs’ research strategies is their occasionally expressed but highly questionable assumption that cognitive traits have a quantitatively uniform genetic base (e.g., Tooby & Cosmides, 2005, p. 25). In this view, there is no genetic variation to link with phenotypic variation. Unfortunately this rules out tried and true (experimental and correlational) research designs that are used to study relationships between *variables*. Certainly most psychological traits have been shown to be genetically variable, and research approaches that are designed to measure genetic variants are generally more sensitive than approaches that assume genetic invariance; after all, it is easier to detect a signal if the source varies.

If EPs discarded the assumption of genetic uniformity, their research could be informed by a number of known sources of genetic variation. For example, it is possible that, in a given population and especially with some assortative mating, different genetic mixes might be adaptive (this is called multiple adaptive peaks). Also, game theory would predict that genetic mixes underlying different strategies (e.g., for evaluating potential mates) could co-exist in certain relative proportions (a result of frequency-dependent selection). It is also possible that minimal expression of certain alleles (e.g., in the heterozygous state) is adaptive, even though maximal expression (e.g., in the homozygous state) is not. That there are more heterozygous than homozygous carriers can result in the perpetuation of alleles that are sometimes maladaptive. (This mechanism is called heterosis.)

These are some of the ways in which attention to the possibility of various sources of genetic variation might help in the principled design of research to explore these variations. In addition to useful knowledge gained regarding polymorphisms, the payoff to EP is that

demonstrating genetic variation in a cognitive module is tantamount to demonstrating the innateness of the module, which is EP's principle research goal.

Although EPs sometimes grant such polymorphisms (see Buss, 2004, pp. 394-399; Tooby & Cosmides, 2005, p. 26), they seldom look for them in their research. But most genetic variation in cognitive traits undoubtedly involves garden-variety distributions around central values (i.e., quantitative variation, about which EPs fail to agree). With this in mind, let us look at strategies for studying genetic inputs to traits with such distributions and see if these strategies might help EPs marshal evidence for their claims.

The measures described below can be used to determine to what extent heredity, relative to environment, contributes to variation around a central value. Variation in a trait, of course, reflects only two inputs, genetic and environmental. A comparison of the derived variances, then, not only indicates whether there is a specific genetic contribution to a trait, which is of primary interest to EPs, but also provides, at least for a given population and environment, information about the contribution of genetic variants relative to environmental variants. How are these measures derived? A prototypical, and idealized, correlational design relates input that varies (in this case, degree of genetic relationship) to output that varies (the psychological trait of interest). Since causation here is unidirectional (genes shape traits, not vice versa), by holding other variables as constant as feasible, if necessary with statistical controls, such a design approximates experimental conditions. For example, regarding development of language skills, such designs might be used to determine to what extent differences in children's selective attunement to utterances, or mimicking of language, or facility with grammar reflects differences in genetic programming. The determination, using heritability measures, of the contribution of genetic variants to specific phenotypic differences is a specialty of quantitative, or behavior, genetics.

But note that if genetic input is essentially uniform (as in the case of four limbs in quadrupeds), heritability (which is a measure of the relative contribution of genetic *variants* compared with environmental variants) will be vanishingly small. That is, variation in number of limbs is almost always a result of environmental insults, not genetic variants. But, although *heritability* is insignificant, heredity is obviously the major determinant of number of limbs. Since EPs often assume significant but uniform genetic programming for cognitive traits of interest, they typically avoid the use of heritability, which, if their assumption of uniformity is correct, would always indicate an insignificant genetic contribution to these traits (e.g., Pinker, 2002, pp. 373-378; Tooby & Cosmides, 2005, p. 25). However, we have seen that EPs' assumption of genetic uniformity in cognitive traits is just that, an assumption; the evidence is not in its favor. What would favorable evidence consist of? One kind of evidence would involve determining the variation in the cognitive trait of interest. Minimal variation means that neither genetic nor environmental variants impact it significantly, and this would constitute a *prima facie* case for genetic uniformity. In the absence of such evidence, and EPs seldom provide it, we can reasonably assume genetic variation.

It seems that EPs would benefit from the use of heritability (Mealey, 2001; Scarr, 1995; Segal & Hill, 2005). After all, it is widely applicable as well as informative. What might be the outcome if they did? On the one hand, they might find significant heritability in traits of interest to them; this would indicate a significant, as well as variable, genetic basis for these traits. In this case, although (at least some) EPs would lose the battle (i.e., cognitive traits of interest are not genetically uniform, after all), they would win the war (i.e., these traits do have a dedicated genetic base). On the other hand, if heritability turned out to be low, this would indicate an inconsequential corresponding genetic base, a relatively uniform one, and/or a high degree of malleability. In the case of low heritability, then, EPs could employ alternative research designs. Whatever the outcomes using heritability measures, they are potentially more informative, with

regard to the role of innate modules, than the outcomes of research paradigms currently favored by EP. Of course, EP may also shun heritability measures because, in their view, they are based on flawed research designs (see Ehrlich & Feldman, 2003, pp. 89-92; Laland & Brown, 2002, pp. 269-271; Schiff & Lewontin, 1986). But, although EPs occasionally mention limitations on the use of behavior genetics (e.g., Pinker, 2002, p. 377), they usually dismiss the approach without any mention of intrinsic flaws (e.g., Tooby & Cosmides, 2005, p. 25).

In sum, the use of research paradigms that are sensitive to genetic variants would be a helpful addition to EPs' research program; this would facilitate their determination of the importance of dedicated innate inputs in the development of corresponding cognitive traits. After all, this is the principle goal of their research, but a goal that has been difficult to attain given the limitations of their research program. This does not mean that this research should supplant other EP research approaches. In most fields of study, testing and substantiation of hypotheses advance with the convergence of results from a variety of research approaches. My subjective sense is that an augmented research strategy might provide convincing support for various EP-proposed modules, as well as others. We need to stay tuned.

CONCLUSION

An overview of relatively new specialties in psychology would show that EP is not only the biggest new kid on the block but also the most contentious. In particular, EP is adamant that we need to understand evolution in order to understand ourselves and that the reigning orientation in psychology, what it calls the SSSM (Standard Social Science Model), hinders this perspective. At the same time EP is rattling psychology's cage, it is experiencing its own growing pains, which are evident in inconsistencies that have not been resolved. More importantly, we have examined specific premises of EP and noted their fine points and strengths and weaknesses. As we summarize these, we will suggest modifications in EP's program that would help advance both its own program and its integration into mainstream psychology. Fortunately, there are identifiable currents of interest in EP in support of each of these.

1. EP holds that our substantive cognitive traits, which distinguish us as humans, commonly have dedicated evolutionary roots. This focus on the cognitive is in line with a general trend in psychology and is not especially controversial. However, it does detract from EP's relevance to non-cognitive specialties in psychology as well as from EP's potential status as a general advocate for the importance of evolutionary principles. What is controversial is EP's premise that, in addition to our capacity for language, our substantive and specific cognitive traits are commonly based in dedicated adaptations (embodied in modules), while most psychologists would probably say (in line with the SSSM) that our innate cognitive endowment consists primarily of a generic capacity to learn an immeasurable variety of skills. This premise, more than any other, sets EP apart from mainstream psychology.

Although EP-proposed adaptations are a distinct possibility, we have seen that, for several reasons, they may be in the minority relative to adaptations that are neither all-purpose as fits the SSSM nor dedicated—each to a specific life challenge—as fits the EP model, but that can, in various combinations, enable a tremendous variety of cognitive tasks. In addition, such adaptations have currency in mainstream psychology. Enhanced attention by EPs to such adaptations—which, after all, they generally acknowledge—might constitute a productive strategy and also enhance EPs' credibility in the psychology community without negating their justifiable interest in dedicated cognitive adaptations. That the distinction between EP's dedicated adaptations on the one hand and broadly recruited adaptations on the other hand is one of degree, not of kind, should make such a transition easier.

2. According to EPs, the more nurture, the more nature. This conflicts with the common assumption, embodied in the SSSM, that we are extraordinarily dependent on nurture because we have been largely *freed* from specific evolutionary programming, or nature. In contrast, EPs hold that nature and nurture are best understood as complementary. For example, as infants we are—by nature—primed to attune, to bond, and to respond, to conspecifics, and these mechanisms facilitate the development—by nurture—of many incipient cognitive modules. Furthermore, as part of the developmental process and as EPs postulate, innate programs may prime for specific kinds of cognitive learning. Certainly priming for language learning is the most-cited example, and priming for other kinds of complex learning is a definite possibility.

Of course, to the degree innate priming is important (i.e., to the degree that, as EP maintains, specific genetic programming enables corresponding experiential programming), the SSSM assumption that, in humans, nurture has largely replaced nature is untenable. This EP perspective, then, is an important correction to the nature *versus* nurture dichotomy so common in the social sciences. Notwithstanding this theoretical stance and not surprisingly, in practice EPs typically attend to the nature side rather than examine the intricacies of the nurture side of this relationship.

3. EPs assume that our specific cognitive modules are rooted in dedicated adaptations and express themselves directly and proximally—that is, in the present moment. However, there are good reasons to think that many such modules, contrary to the EP model, are rooted in a variety of adaptations, often non-cognitive, whose influence is not direct and proximal, but rather indirect or distal. Furthermore, EPs typically discuss these modules as if they evolved as dedicated solutions to specific ancestral challenges whereas, to the contrary and as we have seen, they are likely often enabled by generic or open learning and problem-solving adaptations.

EP would surely benefit from a broader view that, in accounting for cognitive functions, encompassed a range of evolutionary and experiential inputs acting jointly. Such a view would also appeal to psychologists with broad interests in the bases, however distant in time or varied in mechanism, of cognitive experience. We have seen that EPs sometimes venture into territory beyond their favored dedicated-innate-cognitive-module scenario; perhaps this is a precedent for even more productive exploration.

4. In line with the development of cognitive science, EPs commonly use information processing and computer metaphors for the mind. But the postulate that minds are equivalent to information processors entails significant difficulties, not the least of which is that it has not been, and may never be, substantiated. In practical terms, seeing minds in this way sanctions seeing them as stand-alone units, unrelated to other minds, and information processors to the exclusion of other processes, and this marginalizes important areas of concern such as social processes and emotions.

EPs would do well to see minds as more than isolated information processing units; otherwise the computer model may limit unnecessarily the future course of EP. This could be done without serious changes to the rest of EP's program. Inasmuch as most EPs are probably not mind-as-information-processor hard-liners, their realization of the limitations imposed by a hard-line position might help broaden EP's scope to encompass sometimes-neglected issues.

5. EPs maintain that innate components of our psychological makeup evolved in the context of, and are adaptations suited for, ancestral, and not necessarily contemporary, conditions. This, then, underlies some degree of mismatch between our genetic endowment and the current demands of our culture, which fosters psychological stress. This viewpoint, although it entails some unsettled issues as used by EPs, is reasonable and has enlarged the scope of our understanding of psychological and psycho-social disorders.

6. EPs sometimes assume that substantive cognitive modules have a quantitatively-uniform

genetic base and favor research strategies that reflect this assumption. Unfortunately, this assumption, which is not supported by the evidence, has steered EP researchers away from research approaches that might identify relevant genetic variants underlying modules of interest to them. The utility of these approaches, as used in quantitative and behavior genetics, is widely recognized outside of EP. Currently, EP's favored research approach is to attempt to demonstrate the existence of cognitive modules predicted from ancestral conditions and thus assumed to be innate. However, this approach, while useful for generating hypotheses, is not adequate for testing them inasmuch as predictions based on these hypotheses are commonly isomorphic with predictions based on competing hypotheses that emphasize alternative innate and experiential scenarios. For this reason, confirmation of their predictions constitutes weak support at best for EPs' hypotheses.

EPs would benefit from adding, to their research repertoire, strategies designed to identify relevant genetic variants underlying cognitive modules of interest to them. These strategies could provide more definitive measures of the role of evolution in the formation of cognitive modules, this being EPs' chief research goal. Inasmuch as most EPs seem open to the likelihood of quantitative variability underlying evolutionary cognitive traits, these strategies might be incorporated relatively easily.

What does the future hold? As the chief bearer of the banner of nativism in psychology and other social sciences, EP's influence has grown, and for some time probably will continue to grow, remarkably. In important ways, principles of EP have proved useful and have been worthwhile corrections to the widespread assumption, in psychology and social science, that evolution has largely freed us from the constraints of our evolutionary past. In particular, to the extent that EP marshals evidence for its contention that our specific cognitive traits are based in dedicated innate programs, it will make an original and impressive contribution to psychology. At the same time, EP's influence will be more far-reaching and enduring if, and as, it revises certain of its premises that are questionable and that limit its future development. In fact, one measure of EP's progress as a science will be how its premises change to accommodate new insights and findings. As EP grows into a mature specialty, it holds promise of re-shaping psychology as a whole to be more congenial to the relevance of evolutionary mechanisms. For EP and for psychology, this would be a memorable legacy.

Notes

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