Can Evolution Explain How the Mind Works?

A Review of the Evolutionary Psychology Debates

Melanie Mitchell
Santa Fe Institute

Complexity, 3 (3), 17–24, 1999.

Introduction

"Nothing in biology makes sense except in the light of evolution." It would be hard to find a biologist today who disagrees with geneticist Theodosius Dobzhansky's famous claim. Darwin's theory of evolution via natural selection has done more than any other principle to explain the biological world, and to illuminate the relationships among all current life forms and among those found in the fossil record.

If nothing in *biology* makes sense without evolution, the same should be said for the behavior and thinking patterns—the *psychology*—of biological creatures such as ourselves. The human mind has been often described as the pinnacle of evolution: the most complex organ ever "designed" by natural selection. Darwin himself believed that his principles would one day explain not only the biological world but the psychological; that due to his theory, "psychology will be placed on a new foundation" [1].

After a long period in which the two fields were largely separate, evolutionary theory has recently begun to play a significant role in psychological research, most prominently in an area called "Evolutionary Psychology." Just as evolutionary biologists attempt to explain the morphology and other explicit physical features of organisms by using evolutionary arguments, evolutionary psychologists want to explain people's thoughts, emotions, and behaviors by asking questions about their adaptive significance over evolutionary time. "Evolutionary psychology is simply psychology that is informed by the additional knowledge that evolutionary biology has to offer, in the expectation that understanding the process that designed the human mind will advance the discovery of its architecture" [2].

Such a quest sounds eminently reasonable, no? One might expect that (biblical creationists and other anti-evolutionists aside) most people would find the evolutionary psychology research program uncontroversial and admirable.

However, it turns out that evolutionary psychology has engendered deep, emotional, and rancorous debates within the scientific community, not only in dry scientific seminars and journals but also in the more free-wheeling (and mud-slinging) pages of the *New York Review of Books* and other popular periodicals. Why?

In this essay, inspired by Steven Pinker's fascinating book, *How the Mind Works* [3] and other expositions of evolutionary psychology, and by attacks on such works, I will explore, from an informed outsider's perspective, what evolutionary psychology is all about, where it came from, and what its prospects are in light of recent debates surrounding its controversial methodology and claims.

What is Evolutionary Psychology?

What is currently called "evolutionary psychology"—that is, the recent attempts at melding current evolutionary and psychological theories—has been most strongly advocated in a long essay by the anthropologist John Tooby and the psychologist Leda Cosmides, entitled "The Psychological Foundations of Culture" [4]. Tooby and Cosmides claim that evolutionary theory has, until now, been largely absent from psychology and other behavioral disciplines due to the dominance in those sciences of what they call the "Standard Social Science Model" (SSSM). According to Tooby and Cosmides, the SSSM asserts that, as far as humans are concerned, what evolution produced was a "general-purpose" mind with very little in the way of innate knowledge or predispositions. In other words, the mind is a *tabula rasa*, there is no such thing as "innate human nature", and human psychology is almost completely shaped by the culture and society in which the human grows up rather than by anything "biologically determined."

Given the charged nature of terms such as "biological determinism" or "innate human nature", it is perhaps not surprising that the dominance of the SSSM came in part from the "political correctness" that it enforces:

> ...to support the SSSM was to oppose racism and sexism and to challenge the SSSM was, intentionally or not, to lend support to racism, sexism, and, more generally..."biological determinism".... [The SSSM emphasizes] human malleability and the hope it, therefore, gave for social melioration or social revolution. [5]

Evolutionary psychology, as championed by Tooby and Cosmides, challenges the SSSM by viewing human psychology as shaped primarily not by current societies and culture, but instead by selective forces occurring over evolutionary time to produce mental mechanisms for solving problems ultimately affecting reproductive success. Tooby and Cosmides point out that modern psychology has cast strong doubt on the notion of a *tabula rasa* mind, and that both modern psychology and biology have shown that the traditional opposition (supported by the SSSM) between notions such as "innate, biological, and genetically determined" and "learned, cultural, and socially constructed" makes no sense in the light of what we now recognize as the inseparable interactions among genes, development, environment, and culture. Tooby and Cosmides rightly suggest that such oppositions "should be consigned to the dustbin of history, along with the search for a biology-free social science" [6]. The desire to break away from the outdated assumptions of the SSSM has been a primary motivator for evolutionary psychology.

Evolutionary psychology is often compared with sociobiology, a movement of a few decades ago, made most famous by a book of the same name by the naturalist E. O. Wilson [7]. Wilson's book discussed his own work and that of other ethologists (e.g., Konrad Lorenz) on possible evolutionary explanations for animal and human social behavior—sexual and otherwise. It was highly controversial (to say the least), and some critics viewed it as condoning or at least excusing behaviors such as rape, spousal abuse, and other forms of aggression. Tooby and Cosmides, along with Pinker and other writers, try to distinguish evolutionary biology from its older, much disliked cousin; they make it clear that evolutionary psychology is not, like sociobiology, about evolutionary explanations of *social behavior*, but rather about evolutionary explanations of *mentality*. While some readers may find this distinction rather weak, evolutionary psychologists argue that there is a big difference between using evolution to explain the mental—the mind and brain structures that evolved in humans—and using it to explain the behavioral, which is linked to the mental in often indirect ways. As Cosmides, Tooby, and Barkow (carefully) put it:

> Culture is not causeless and disembodied. It is generated in rich and intricate ways by information-processing mechanisms situation in human minds. These mechanisms are, in turn, the elaborately sculpted product of the evolutionary process. Therefore, to understand the relationship between biology and culture one must first understand the architecture of our evolved psychology..... Past attempts to leapfrog the psychological—to apply biology directly to human social life—have for this reason not always been successful. Evolutionary psychology constitutes the missing causal link needed to reconcile these often warring perspectives. [8]

Specific Assumptions of Evolutionary Psychology

The term "evolutionary psychology" has been used quite generally to refer to the study of human mental activities informed by evolution, but more often it is used to refer to the more specific research methodology outlined in Tooby and Cosmides' essay and shared by many people working in that field. This methodology makes a particular set of assumptions about psychology and about human evolution. These assumptions were summarized by Pinker as the "key idea" of his book:

> The mind is a system of organs of computation, designed by natural selection to solve the kinds of problems our ancestors faced in their foraging way of life, in particular, understanding and outmaneuvering objects, animals, plants, and other people. [9]

By "organs of computation" and by "our ancestors", he means the following

> The mind is organized into modules or mental organs, each with a specialized design that makes it an expert in one arena of interaction with the world. The modules' basic logic is specified by our genetic program. Their operation was shaped by natural selection to solve the problems of the hunting and gathering life led by our ancestors in most of our evolutionary history. [10]

Here, the big assumption made about psychology is that the mind is made up of special-purpose "mental organs". The big assumptions made about evolution are that (1) each of these mental organs is an "adaptation"—that is, a trait that either directly or indirectly led to an improvement in the ability of the organism to produce fit offspring; (2) natural selection was the driving force in shaping these mental organs; and (3) it did so during the period of evolution in which our ancestors were hunter-gatherers living on the African savanna.

The rationales for these assumptions are laid out in great length by Tooby and Cosmides, and are explained in non-technical terms in Pinker's book.

The "specialized mental organ" assumption contrasts with an alternative view in psychology that the mechanisms of mind are fairly general purpose. In this view, the mind resembles a general purpose computer or "universal Turing Machine", with only a few specialized "modules" (e.g., the specialized brain area for language). This is the view that Tooby and Cosmides attribute to the SSSM, and it was a prominent position taken, for example, by cognitive scientists Allen Newell and Herbert Simon in the 1970s [11].

The "specialized mental organ" view says instead that the mind (and, by implication, the brain) consists of a large number of relatively independent "specialists"—roughly, computer programs

that compute only one particular thing about the world. For example, one hypothesized module specialized for detecting "cheating". I will return to this shortly.

The "natural selection" assumption is that these mental organs were formed via the (presumably slow) accumulation of genetic variations, each of which contributed to the reproductive success of the individual. Unlikely as it may seem, selection on random processes of genetic variation appears to have produced very complex adaptations in organisms. Most evolutionists (including evolutionary psychologists) assume that there is no other explanation for the creation of complex adaptations. "Evolution by natural selection is the only presently validated explanation for the accumulation of functional design features across generations" [12].

The third assumption is that the processes that formed our specialized mental organs occurred during the Pleistocene epoch—the period one to two million years ago in which our ancestors were hunter-gatherers in the African savanna and during which significant brain expansion took place. Thus human psychology may not make sense in our current society and culture, and may even be detrimental to us, but was adaptive back in the Pleistocene. This, as Pinker asserts, could explain some of the paradoxes of modern psychology:

> People hold many beliefs that are at odds with their experience but were true in the environment in which we evolved, and they pursue goals that subvert their own well-being but were adaptive in that environment. [13]

Methodology of Evolutionary Psychology

These three assumptions led Tooby and Cosmides to specify a methodology for work in evolutionary psychology. The goal is to understand and explain the structure of particular mental phenomena. To illustrate, let's take a famous example from evolutionary psychology research: the notion of "cheater detector". (At one point I heard a British colleague speak about this issue; knowing little of the field myself, I initially misheard him as saying "cheetah detector", which seemed like an equally useful adaptation for the African savanna.)

The notion that humans have a special-purpose detector for cheating comes in part from Cosmides' interpretation of a puzzling result in psychology [14]. The psychologist Peter Wason, in testing humans' abilities to falsify hypotheses, created four cards. Each card had a letter on one side and a number on the other. The human subjects were shown one side of each card:

card 1: D
card 2: F
card 3: 3
card 4: 7

They were then asked which card or cards they needed to turn over in order to verify or falsify the hypothesis "If a card has a D on one side, it has a 3 on the other."

The right answer is that you need to turn over cards 1 and 4. If the "F" card has a 3 on the other side, that tells you nothing about the hypothesis, which doesn't say that only D cards have 3s on the other side. Likewise, whether or not the "3" card has a D on the other side is immaterial, since the hypothesis doesn't say that cards with 3s on one side have to have Ds on the other. But clearly for the hypothesis to be true the "D" card has to have a 3 on the other side, and the "7" card can't have a D on the other side.

However compelling this logic, when this experiment was done on human subjects, the subjects most often answered that they would need to turn over either only card 1, or card 1 and card 3. This was puzzling to the psychologists. As Pinker recounted, "Dire implications were seen. John Q. Public was irrational, unscientific, prone to confirming his prejudices rather than seeking evidence that could falsify them" [15].

However, later experiments showed that when certain real-world objects and events were used instead of abstract letters and numbers, people would get the right answer. For example, subjects were told "You are a bartender, and you need to enforce the rule 'If a person is drinking beer, he must be eighteen or older'." They were then given cards which listed a beverage order on one side and an age on the other:

card 1: beer
card 2: coke
card 3: age 25
card 4: age 16

The subjects were then asked, "Which cards do you have to turn over to make sure the drinking-age rule is being enforced"? Interestingly, while this task is logically isomorphic to the letters and numbers task described above, most subjects performed perfectly on this task, whereas most failed on the abstract version.

Here, then, is a mental phenomenon to be explained. Further experiments showed that it wasn't just a matter of having real-world versus abstract entities on the cards. Cosmides suggested that the crux of the phenomenon is that people get it right whenever the task involves spotting cheaters (e.g., underage beer drinkers). Previous work in evolutionary psychology had reasoned that a species, like our own, in which reciprocal altruism occurs must have a way to remember who received favors and who returned them, for otherwise reciprocal altruism would not have been able to evolve—it would have been vulnerable to cheaters. Therefore, the reasoning goes, evolutionary arguments point to the strong possibility of a mental organ for detecting cheating in conspecifics. Cosmides believed that the results of the card experiments were evidence for just such a mental organ [16].

This reasoning is a classic example of the methodology of evolutionary psychology: when faced with a psychological phenomenon that is hypothesized to be the result of some kind of adaptation, figure out what good it would have done our hunter-gatherer ancestors (not necessarily what good it does us today), and analyze it in terms of selective pressure on those ancestors. Tooby and Cosmides explain optimistically how this is done as a form of "reverse engineering":

> Evolutionary biology and hunter-gatherer studies supply definitions of the recurrent adaptive problems humans faced during their evolution, and cognitive psychology describes the information-processing mechanisms that evolved to solve them. By combining insights from these two fields, the functional organization of the mind can be brought into sharp relief. [17]

Pinker seconds this approach and finds it quite general: "There is no reason that reverse-engineering guided by evolutionary theory should not bring insight about the rest of the mind" [18].

In his book, *How the Mind Works*, Pinker gives several examples of his own and other people's

evolutionary hypotheses about mental phenomena. For example, he hypothesizes about the origin of present-day phobias:

> The other common fears are of heights, storms, large carnivores, darkness.... The common thread is obvious. These are the situations that put our evolutionary ancestors in danger. Spiders and snakes are often venomous, especially in Africa, and most of the others are obvious hazards to a forager's health.... Fear is the emotion that motivated our ancestors to cope with the dangers they were likely to face...when Chicago schoolchildren were asked what they were most afraid of, they cited lions, tigers, and snakes, unlikely hazards in the Windy City. [19]

Pinker also has a very nice analogy to explain some aspects of emotions, in terms of the notion of "doomsday machine". This image comes from the movie "Dr. Strangelove", in which Dr. Strangelove, played by Peter Sellers, explained the point of having a doomsday machine (a triggering network for a nation's nuclear arsenal) which would destroy everyone, including the device's builders and, once set off, could not be stopped. It's clearly pointless once it goes off, he explains, but if its existence is advertised, it can act as a powerful deterrent. Pinker hypothesizes that a analogous notion might explain the seeming separation between passion and reason:

> The intellect is designed to relinquish control to the passions so that they may serve as guarantors of its offers, promises, and threats against suspicions that they are lowballs, double-crosses, and bluffs. The apparent firewall between passion and reason is not an ineluctable part of the architecture of the brain; it has been programmed in deliberately, because only if the passions are in control can they be credible guarantors. [20]

In another example, Pinker analyzes "parent-offspring conflict"—not the familiar kind all parents consciously endure but the unconscious kind that is claimed to be a holdover from those earlier days. Pinker points out that since a parent shares 50% of his or her genes with each offspring, in evolutionary terms the investment in each should be equal (all other things being equal). But if I am one of those offspring, I share only 50% of my genes with each sibling, but 100% of my genes with myself, so it is in my best interest to suppress parental investment in my siblings and to promote parental investment in myself. Pinker hypothesizes that this may lead to a child's behavior that, indirectly, helps prevent or delay the parents having another child:

> In all cultures, young children are sometimes possessive of their mothers and cool to the mother's consort. Parent-offspring conflict offers a straightforward explanation. Daddy's interest in Mommy takes her attention away from me—and, even worse, threatens to create a baby brother or sister. Children may well have evolved tactics for delaying that sad day by diminishing their mothers' interest in sex and keeping their fathers away from her. It would be a straightforward extension of weaning conflict. [21]

Of course, the claim here is not that children do this consciously, but rather that evolution has created mental modules that produce unconscious behavior with the desired effects.

A good part of Pinker's book consists of hypothesized evolutionary explanations for many other human psychological phenomena, including differences between men and women in response to pornography, in courtship behavior, with regard to polygamy, and in aggression and war. At

this point, critical comparisons with the claims of 1970s sociobiology are not surprising; that field attempted to explain many of the same phenomena. Evolutionary psychologists assert, however, that their new attempts are based on a more rigorous foundation and are, in some cases, more testable.

Critiques of Evolutionary Psychology

Evolutionary psychology, like sociobiology before it, has engendered critiques from many parts of the academic spectrum, some of them rather emotional and angry. In some of the more extreme critiques, evolutionary psychology has been variously described as "simplistic dogmatism" [22], "the authority of modern science pressed into the service of speculative fictions" [23], "biology as ideology" [24], and criticized as having a "penchant for narrow, and often barren, speculation" [25]. Many of the strongest barbs have come from articles by the eminent evolutionist Stephen Jay Gould in the *New York Review of Books* (a entertaining periodical whose contents can often be described as a kind of Championship Wrestling for the intelligensia). The attacks in the other direction have been severe as well; for example, Gould is described by another eminent evolutionist as "a man whose ideas are so confused as to be hardly worth bothering with" [26].

What exactly are these people fighting about? In my reading of the literature of this debate, each side has mischaracterized the claims and beliefs of the other, much to the detriment of the public's understanding of complex and important scientific issues. Here I will try to summarize what I feel are the more valid critiques of evolutionary psychology, and show where they lead for defining the open questions in both evolution and psychology.

The major critiques of evolutionary psychology center around its three main assumptions: that the mind is a collection of special-purpose modules; that those mental modules are adaptations, formed via natural selection; and that the Pleistocene era was the period in which these modules evolved.

The claim that the mind consists of special-purpose independent modules is supported by some evidence, both psychological and neurological, but it is far from being generally accepted in cognitive science. I won't describe this debate here, but will instead focus on the evolutionary issues in the second and third assumptions.

How Do We Identify a Complex Adaptive Trait?

It is far from straightforward to determine what complex traits (physical or mental) are adaptations. Evolutionists define "adaptive trait" as one that directly or indirectly promotes reproduction (or at least did when it originated). Most believe that natural selection is the mechanism for "designing" adaptive traits.

However, all evolutionists would agree that not all traits are adaptive. Some are presumably accidental—the product of random mutations that give no selective advantage—and some are products of other mechanisms that shape organisms, such as physical constraints on developmental processes, side effects of adaptations, and so on.

While natural selection clearly does occur (this has been demonstrated in innumerable experiments with many types of organisms), there is no general detailed theory of what kinds of *complex* adaptations it can produce and how to distinguish them from non-adaptive traits, particularly if

they appear in only a small number of related species (e.g., primates). The eye—the classic example in evolution that worried Darwin because it was *too well designed*—seems clearly adaptive because we understand its structure and function so well in so many different species (though it is possible that some of its structure and function may have arisen via the non-selective processes mentioned above, or via selective processes in the service of adaptive traits other than vision). However, it gets harder to be so sure when we're talking about the less well-understood mental traits that are the subject of evolutionary psychology (e.g., human emotions). This difficulty is at the crux of the common accusation that evolutionary psychologists spend their time telling "just-so stories".

Taken from Rudyard Kipling's book by that name (including stories about "how the leopard got its spots" and so on), the term "just-so story" here refers to hypothesized explanations of supposed adaptive function of a particular trait that may or may not be true, but are impossible to test. Pinker's hypotheses about the adaptive function of passion, unconscious parent-offspring conflict, and other psychological traits, while plausible and even elegant, are difficult to test since we don't understand what brain structures implement these traits, and even if we did, we don't know the extent to which selection can shape such brain structures, or precisely what brain structures shaped by selection should look like. They may be adaptations, but there are other plausible explanations, and the less well-understood the trait, the harder it is to devise definitive tests to distinguish between rival hypotheses.

Pinker would argue with this, saying that complex, "improbable" organs must be adaptations. For example, Pinker asserts that:

> A sane person can believe that a complex organ is an adaptation, that is, a product of natural selection, while also believing that features of an organism that are *not* complex organs are a product of drift or a by-product of some other adaptation. [27]

and

> Selection is not invoked to explain mere usefulness; it's invoked to explain *improbable* usefulness. [28]

One problem here is that "complex organ" is not yet well-defined—how do we know one once we see it? Is "language" a complex organ and thus an adaptation? Pinker would say yes (and wrote a book arguing this point) [29] but later, in *How the Mind Works*, he allows that other mental traits, such as our taste for music and art (presumably the results of complex mental organs), might well be by-products of adaptations rather than adaptations themselves: "some of the activities we consider most profound are nonadaptive by-products" [30].

Another problem is that we don't yet know enough about what selection can do (and how it interacts with other mechanisms that shape organisms) to say what constitutes *improbable* usefulness, especially when we're talking about mental traits that themselves are not well-understood.

How Do We Know When a Mental Trait Evolved?

Related to the question of how to spot an adaptation is the question of how long a particular adaptation takes to evolve via natural selection. A fundamental assumption of evolutionary psychology is that the mental traits of interest evolved during the Pleistocene, the era one to two million years ago during which the most significant expansion of the human brain occurred.

> Our ancestors spent the last two million years as Pleistocene hunter- gatherers, and, of course, several hundred million years before that as one kind of forager or another. These relative spans are important because they establish which set of environments and conditions defined the adaptive problems the mind was shaped to cope with: Pleistocene conditions, rather than modern conditions. [31]

It is almost certainly correct that recent history (e.g., the past several hundred thousand years) was not enough time for complex mental organs to evolve, and that many interesting changes happened in the brain as it expanded during the Pleistocene epoch. However, just as we don't yet have a good theory about how to tell, in general, if a given trait is an adaptation, we don't have a good general theory about what traits natural selection *can* produce, how quickly it can produce them, and how stable or unstable an environment has to be for this to happen. This is especially true for more complex traits such as the psychological ones discussed by Tooby and Cosmides, Pinker, and others. Pinker asserts that "most of our evolution took place" on the African savanna [32]. By "our evolution" he means that of our most human-like ancestors—those with brains similar to ours. But, as Ahouse and Berwick point out, it would be equally true to say that "over 99 percent of our evolutionary history was spent in (and most of our genes arose in) a warm, salty sea" [33]. Our sea ancestors also had nervous systems, ancestral to our own. Would it not be plausible to speculate that some of the structures important to human psychology arose, at least in part, during that time and were originally adapted for those conditions? And could this have had as much of an effect on their ultimate structure and function as the time spent in the Pleistocene? It is hard to say for sure.

The Pleistocene savanna hunter-gatherer assumption is based on fossils and archaeological relics, which indeed help in making sense of the time scale and stages of human evolution, including at what times certain types of mental traits most likely first appeared, at least in their modern forms. However, the fossil and archaeological records are notoriously sketchy, none of the mental traits evolutionary psychologists study are captured directly in fossils, and the archaeological evidence is often hard to interpret, particularly in forming hypotheses about the origins of language, emotions, and other mental traits. Natural selection quite probably did contribute strongly to these things, but in order for these hypotheses to become compelling theories rather than speculation, more must be known about the details of both the mental structures and the evolutionary process.

My view is not shared by all evolutionists; for example, Tooby and Cosmides have a much more generous view of what the field of evolutionary biology can tell us in its current state:

> Just as the fields of electrical and mechanical engineering summarize our knowledge of principles that govern the design of human-built machines, the field of evolutionary biology summarizes our knowledge of the engineering principles that govern the design of organisms, which can be thought of as machines built by the evolutionary process.... Modern evolutionary biology constitutes, in effect, an "organism design theory". [34]

I would characterize this view as overly generous, given all that is not known about how genes vary, how they map to physical and mental traits, and the entire process of development during which bodies and minds are formed. In short, today's evolutionary biology is far from a well-worked-out design theory of organisms.

What Evolutionary Mechanisms Are Relevant In Explanations Of Traits?

Every serious biologist believes that natural selection has been a central mechanism of evolutionary change: Darwin and many after him have given compelling and testable explanations for many traits in terms of natural selection [35].

However, it is not the only mechanism; accounts focusing solely on natural selection are only part of the story. Darwin himself said "I am convinced that natural selection has been the main but not the exclusive means of modification." [36] Most evolutionists today agree with this statement. Steven Jay Gould, Niles Eldredge, Richard Lewontin, Stuart Kauffman, and Brian Goodwin are names often cited as the strongest proponents for taking into account alternative causes of evolutionary change. These people and others (including Darwin himself) have proposed candidates for important mechanisms other than natural selection that result in modifications of organisms. Some candidates that have been proposed are neutral evolution (in which organisms change in a neutral, non-adaptive way), constraints and influences of development, historical accidents, genetic drift, genetic hitchhiking, and, more generally (and vaguely) "self-organization".

In spite of misleading name-calling on various sides of the evolutionary psychology debates (evolutionary psychologists have been called "ultra-Darwinists" [37] and have been accused of hawking "vulgar adaptationism" [38]; their opponents have been labeled "anti-selectionist" [39] and "Darwin-doubters" [40]), all the participants (and almost all evolutionists) would agree that all of these mechanisms come into play to some extent and that for a full understanding of where traits came from and how they are structured, we need to take them all into account. For example, human language might have had a different structure if some of those mechanisms were different, or if some historical accidents had gone the other way. It's hard to say, since we only have one example of evolved human language.

The main disagreements are about the relative importance of each of these mechanisms on shaping particular traits, and how we identify which mechanisms played which roles. For example, while Pinker and Tooby and Cosmides argue that the complex mental modules of the mind could only have been shaped by natural selection, Gould speculates that

> Natural selection made the human brain big, but most of our mental properties and potentials may be spandrels—that is, nonadaptive side consequences of building a device with such structural complexity. [41]

Kauffman argues that as the entities undergoing evolution become more complex (and mental traits are certainly among the most complex), then the principles of self-organization play an increasingly constraining role [42].

Pinker finds such arguments unconvincing: "It is the bald claim that a feature is a lucky product of drift or of some poorly understood dynamic that is untestable and post hoc" [43].

In some sense he's quite right to say this. Gould and Lewontin convincingly used the notion of "spandrel" (non-adaptive by-product) to explain aspects of the morphology of one species of snail [44], but that's a far cry from explaining anything about the human brain in those terms, and Gould has no evidence for his conjectures on this front. Likewise, Kauffman has shown that particular kinds of interconnected networks exhibit some form of self-organization, but again that's a far cry from a theory explaining how self-organization might shape particular mental traits. In short, while these candidates for alternative evolutionary mechanisms have been proposed as important sources

of change, none of their proponents have yet proposed explanations of particular psychological phenomena or other similarly complex traits based on any of them.

However, the other side could equally well argue that it is just as much a "bald claim" to simply assert that a complex mental organ such as language, or a little-understood psychological or cultural phenomena such as the inclination to go to war are the products of natural selection, when we have so little understanding of the underpinnings of such traits in terms of brain structures or genes, and so little understanding of how natural selection might work on such complex traits. In other words, as yet neither side has well-worked out theories of evolutionary mechanisms that can explain psychological phenomena in a satisfying way.

It might be said that the grandest open problem in evolutionary theory is to develop a unified theory of evolutionary mechanisms that could help settle these disputes.

Final Words

In this short essay I have attempted to illuminate the main issues of evolutionary psychology and to review some of the controversies surrounding them. Evolutionary psychology is a field that will continue to draw interest, both because evolutionary explanations in psychology are so compelling and because, eventually, they will be so necessary. The evolutionary psychologists have done much to wake up the wider world of psychologists to the fact that evolution is relevant to their field; to criticize particular claims and methodologies, as I have done here, is certainly not to diminish the importance of this wake-up call.

One problem with current efforts in evolutionary psychology is that the field melds together two sciences—psychology and evolutionary biology—in which scientific understanding is still quite limited. Any attempts to do this are bound to be questioned. However, Tooby and Cosmides give a hopeful version of a scientific future when things are better understood and agreed upon, presumably built on the earlier accomplishments of today and tomorrow's evolutionary psychology:

> Just as one can now flip open *Gray's Anatomy* to any page and find an intricately detailed depiction of some part of our evolved species-typical morphology, we anticipate that in 50 or 100 years one will be able to pick up an equivalent reference work for psychology and find in it detailed information-processing descriptions of the multitude of evolved species-typical adaptations of the human mind, including how they are mapped onto the corresponding neuroanatomy and how they are constructed by developmental programs. [45]

Just when such an atlas might appear is debatable, but all sides of the evolutionary psychology debates must agree that this would indeed be a marvelous accomplishment and a worthy goal of any science.

Acknowledgments

This work has been supported by the Santa Fe Institute. I am grateful to Daniel McShea, Andreas Wagner, Daniel Dennett, and Marcus Feldman for their helpful comments on this essay.

Notes

1. C. Darwin, quoted in S. Pinker (1997a) , p. 299.
2. Cosmides, Tooby, & Barkow (1992), p. 3.
3. Pinker (1997a).
4. Tooby & Cosmides (1992).
5. Ibid, p. 29.
6. Ibid, p. 46.
7. Wilson (1975).
8. Cosmides, Tooby, & Barkow (1992), p. 3.
9. Pinker (1997), p. 21.
10. Ibid, p. 21.
11. Newell, A. & Simon, H. (1976).
12. Cosmides, Tooby, & Barkow (1992), p. 9.
13. Pinker (1997a), p. 32.
14. My description is adapted from Pinker's (1997a) account, pp. 336-337.
15. Pinker (1997a), p. 336.
16. Cosmides (1989).
17. Tooby & Cosmides (1992), p. 64.
18. Pinker (1997a), p. 39.
19. Ibid, pp. 386-387.
20. Ibid, pp. 412-413.
21. Ibid, p. 446.
22. Gould (1997a).
23. Ahouse & Berwick (1998).
24. Ibid.
25. Gould (1997b).
26. John Maynard Smith in *The New York Review*, November 30, 1995, quoted in Gould (1997a).
27. Pinker (1997a), pp. 165-166.
28. Ibid, p. 172.
29. Pinker (1994).
30. Pinker (1997a), p. 525.
31. Cosmides, Tooby, & Barkow (1992), p. 5.
32. Pinker (1997a), p. 375.

33. Ahouse & Berwick (1998).

34. Tooby & Cosmides (1992), pp. 52-53.

35. E.g., see Weiner (1994) for a popular account of such a explanation of changes in the size and shape of finches' beaks.

36. C. Darwin, quoted in Gould (1997a).

37. Gould (1997a).

38. Ahouse & Berwick (1997b).

39. Hurst (1998).

40. Dennett (1995), p. 278.

41. Gould (1997b).

42. Kauffman (1993).

43. Pinker (1997a), p. 167.

44. Gould & Lewontin (1979).

45. Tooby & Cosmides (1992), p. 68.

References and Further Reading

Ahouse, J. C., and Berwick, R. C. (1998). Darwin on the mind. *Boston Review*, April/May, 1998.

Barkow, J. H., Cosmides, L., and Tooby, J. (eds.) (1992). *The Adapted Mind*. New York: Oxford University Press.

Dennett, D. C. (1995). *Darwin's Dangerous Idea*. New York: Simon & Schuster.

Dennett, D. C. (1997). 'Darwinian fundamentalism': An exchange. *New York Review of Books*, August 14, 1997.

Cosmides, L. (1989). The logic of social exchange: Has natural selection shaped how humans reason? Studies with the Wason selection task. *Cognition*, 31, 187-278.

Cosmides, L., Tooby, J, and Barkow, J. H. (1992). Introduction: Evolutionary Psychology and Conceptual Integration. In Barkow, Cosmides, & Tooby (1992).

Gould, S. J. (1997a). Darwinian fundamentalism. *New York Review of Books*, June 12, 1997.

Gould, S. J. (1997b). Evolution: The pleasures of pluralism. *New York Review of Books*, June 26, 1997.

Gould, S. J. (1997c). Evolutionary psychology: An exchange. *New York Review of Books*, October 9, 1997.

Gould, S. J., and Lewontin, R. (1979). The spandrels of San Marco and the Panglossian paradigm: A critique of the adaptationist programme. *Proceedings of the Royal Society, London* B 205, 581-598.

Hurst, L. (1998). The darling of the masses. *New Scientist*, June 6, 1998.

Kauffman, S. A. (1993). *The Origins of Order*. New York: Oxford.

Newell, A., and Simon, H. (1976). Computer science as empirical enquiry: Symbols and search. *Communications of the Association for Computing Machinery*, 19(3), 113-126.

Pinker, S. (1994). *The Language Instinct*. New York: William Morrow.

Pinker, S. (1997a). *How the Mind Works*. New York: W. W. Norton.

Pinker, S. (1997b). Evolutionary psychology: An exchange. *New York Review of Books*, October 9, 1997.

Tooby, J. and Cosmides, L. (1992). The psychological foundations of culture. In Barkow, Cosmides, & Tooby (1992a).

Weiner, J. (1994). *The Beak of the Finch*. New York: Alfred A. Knopf

Wilson, E. O. (1975). *Sociobiology: The New Synthesis*. Cambridge, MA: Belknap Press of Harvard University Press.

Wright, R. (1995). *The Moral Animal*. New York: Vintage Books.