chology. Clearly, such connections have served psychology very well, helping us, for example, to understand and treat a broad spectrum of mental diseases, as well as reducing the stigma previously associated with these diseases. Although the contributions that the physical sciences can make to the social sciences should be investigated, Buss et al. went a step beyond science and presented a philosophically committed view of the world, promoting an agenda that is not within the realm of the scientific method. Specifically, Buss et al. put the cart before the horse when they said that exaptations and spandrels provide "a promising theoretical perspective" when none of the exaptations and spandrels (borrowed from Gould, 1991) that they cited have met scientific standards of evidence. The consequences of their philosophical presuppositions are reductionistic and call into question much of what the American Psychological Association (APA, 1992) advocates in its code of ethics.

Any introductory text that treats the scientific method presents it as characterized by a cycle of theory building, hypothesis formation, data collection, empirical hypothesis testing, and theoretical modification (cf. Wagner & Hollenbeck, 1998). As such, the scientific method requires that "factual statements be verified by observation or by repeatable experiments" (Johnson, 1995, p. 200). This is in contrast to philosophical assumptions that cannot be proved empirically and that frequently cannot be disproved either. Buss et al.'s (1998) article seems to be arguing for a philosophical perspective, rather than a scientific one. For example, they advocated using the concepts of exaptations and spandrels, along with the concept of adaptation, to create hypotheses that may help explain psychological phenomenon. Yet, some of Gould's (1991) statements, which Buss et al. rely on to build their case, explain everything from art to religion as exaptations; these should clearly be categorized as metaphysical statements and are not subject to disproof through the use of scientific methodology.

Although Buss et al. (1998) presented five criteria for "testing" (p. 543) hypotheses about exaptations and spandrels, these criteria cannot be used to determine whether a particular phenomenon is actually an exaptation or a spandrel; that is, if such a hypothesis is supported, it demonstrates only that the hypothesis is internally consistent, not that it corresponds with how a particular behavior actually came about. Further, Buss et al. suggested that when a particular hypothesis "about an evolved mechanism fails to be supported empirically, then a number of options are available to researchers" (p. 543), and yet none of these alternatives involve rejecting the notion that exaptations and spandrels are a useful theoretical heuristic. This is particularly disturbing because, as the authors acknowledge, "none of the items on Gould's (1991) list of proposed spandrels and exaptations . . . have met these standards of evidence" (p. 546). In other words, we are being asked to accept that an idea that does not yet have any support in biology might be useful in the psychological sciences. However, if and when a hypothesis based on such an idea proves false, we should not question the idea on which it is based. This is clearly speculative philosophy of questionable quality—not science.

A second primary concern with this article relates to the consequences of using an unproved evolutionary psychology perspective in explaining human behavior. Viewing all human actions as genetically programmed expressions of self-interest has important ramifications for individual and organizational ethics. Many fundamental moral concepts, such as those promoted by the APA (1992) code of ethics, would be rendered meaningless. Moral standards and judgments rest on concepts such as freedom of action and responsibility for choices made. When all actions are viewed as the products of the unconscious and unguided forces of natural selection, moral culpability is clearly jettisoned because all actions are, to a large degree, preprogrammed into the brain.

In addition, the implications of explaining everything from religion to art through the lens of exaptations and spandrels undermines morality in an even more encompassing way. Specifically, such a view of the world has no basis on which to offer normative definitions of good (vs. evil) actions because these are concepts requiring input and authority from sources transcending nature. In other words, evolutionary psychology offers no basis for the judgment that the standards stated in the APA (1992) code of ethics, such as honesty, respect for others, and professional responsibility, are superior to duplicity, treachery, and shiftlessness. Can the adoption of standards be adequately explained through organizational survival? Although it is true that principles such as integrity can contribute to an organization's flourishing, that codes of ethics are necessary makes it clear that dishonesty can also pay. If the latter is proven to be the case, should members of the APA adopt such a code as a mere spandrel?

We do believe that investigations of the intersections of the natural sciences and social sciences are valuable and should continue. However, our basic concerns with Buss et al.'s (1998) article relate to their lack of acknowledgment that they are advocating a worldview (rather than truly empirical science) and the fact that they do not address the potential implications of their metaphysical assumptions.

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## Interactionism, Flexibility, and Inferences About the Past


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We thank the nine commentators for their thoughtful reactions to our article "Adaptations, Exaptations, and Spandrels" (Buss, Haselton, Shackelford, Bleske, & Wakefield, 1998). Several offer useful suggestions for new directions for empirical research (Roney, 1999, this issue; Scher, 1999, this issue), conceptual elaborations (Hatcher, 1999, this issue), and an extended set of important references (Jerison, 1999, this issue). Roney's (1999) commentary is especially important, and we endorse his points fully—testing evolutionary psychological hypotheses requires documenting "special design." Furthermore, we agree with Roney's proposed integration with cognitive science and note that evolutionary psychology is taking steps in this direction (see Cosmides & Tooby, 1994).

The commentators raise a number of key issues that require clarification. Evolutionary psychology generates an astonishing number of misunderstandings (Buss, 1999).

It violates cherished notions about human nature, such as the belief that humans are blank slates on which culture and socialization write their scripts. It threatens scientists who worry about intellectual territorial invasion, and it creates concerns about misuse for pernicious political purposes. Some just wish it would go away. As Lady Ashley, a Darwin contemporary, commented when she first heard about the theory of evolution by selection, "Let's hope that it's not true; but if it is true, let's hope that it doesn't become widely known." Below we address the issues the commentators raise and thereby attempt to allay some of these concerns.

### Evolutionary Psychology Is Truly Interactionist

Several commentators worry about "genetic reductionism," but nowhere in our article (Buss et al., 1998) did we argue for such reductionism. Evolutionary psychology provides a truly interactionist framework, as we outlined in our article. Current behavior is a function of evolved mechanisms combined with environmental input; without environmental input, clearly there would be no behavior. As we explained in "Adaptations, Exaptations, and Spandrels," psychological mechanisms require environmental input at each stage of development. Moreover, existing mechanisms evolved precisely because they interacted with features of the ancestral environment in particular ways—ways that led to their propagation more than coexisting alternative designs. Attempts to characterize evolutionary psychology as "genetic determinism" wildly miss the central tenets of evolutionary psychology.

Consider the hypothesis that sexual jealousy is a psychological mechanism that evolved to combat intrasexual threats and mate defections (e.g., Buss, Larsen, & Westen, 1996). The mechanism is activated only when a person encounters social input, such as interest in one's mate from rivals or cues to infidelity (Shackelford & Buss, 1997). Proposed design features include sensitivity to the social context of marriages, such as sex-linked components of mate value (Buss & Shackelford, 1997), as well as sex differences in the weighting given to cues to sexual versus emotional infidelity, corresponding to the different adaptive problems ancestral men and women confronted (Buss et al., 1999). This is not genetic determinism; it's a precisely specified form of interactionism.

### Plasticity, Flexibility, and Adaptability

Several commentators present arguments for *plasticity* and *adaptability*, and these words have intuitive resonance. Clearly humans learn, grow, develop new patterns, and adjust to changing circumstances. Clearly the human brain can do things it was not "designed" to do, including reading, writing, pecking on typewriters, and surfing the Internet. Evolutionary psychology does *not* propose a rigid, robotic set of "instincts" that manifest themselves invariantly in behavior, nor does it propose that existing psychological mechanisms cannot be coopted for new uses during a person's life.

In our view, however, words like *plasticity* can be misleading and often obscure more than they clarify. Plasticity connotes lack of form, a shapeless mass that can be molded and fashioned into nearly anything, but surely that's not an accurate description of the human brain. No amount of higher education will cause a human brain to suddenly develop the echolocation abilities of bats, the elaborate olfactory sensitivity of dogs, or the web-spinning ability of spiders. Without specifying more precisely which features of the environment the brain responds to and in which predictable ways it responds, invocations of plasticity or adaptability constitute theoretical hand waving.

According to the central tenets of evolutionary psychology, human behavior is indeed flexible, but our intuitions mislead us about the source of that flexibility. Flexibility is not achieved because the human brain is a formless plastic lump or because the brain is a general information processor (Tooby & Cosmides, 1992). Flexibility is achieved because of the elaborate suite of specific evolved mechanisms humans possess, activated in designed sequences in different combinations from an astonishingly complex menu. Flexibility is achieved because of the tremendous complexity, precision, and number of evolved psychological mechanisms. Invoking plasticity to explain this precision and complexity obscures more than it clarifies.

### Can Inferences Be Made About the Past?

Some argue that we cannot rewind the tape of human evolutionary history and so cannot make scientific inferences about the selective events of the past. But if this were true, then there could be no science of cosmology, no studies of stellar evolution, and no geological theory of continental drift, nor could there be any science of evolutionary biology, archeology, or paleontology. Should cosmologists, geologists, archeologists, paleontologists, evolutionary biologists, and evolutionary psychologists pack their bags and call it quits?

Many scientific disciplines require making inferences about the past. Although such inferences are obviously fraught with conceptual and empirical difficulties, legitimate scientific standards can be imposed. Three-degree black body radiation, observations of the expansion of galaxies, studies of critical mass, and other sources of data permit reasonable inferences about events surrounding the origin of the universe billions of years ago. In evolutionary psychology, a wide variety of data sources are available, including archeological records, data from traditional hunter–gatherer cultures, and skull and skeletal finds.

Perhaps even more important, the current design of evolved mechanisms provides a window into the past (Tooby & Cosmides, 1992). That humans tend to develop fears of snakes, spiders, heights, darkness, and strangers more than fears of cars or electrical outlets reveals something important about the "hostile forces of nature" our ancestors confronted. The design features of sexual jealousy, to take another example, provide windows for viewing the likely infidelity and defection threats faced by human ancestors struggling to hold on to a long-term mate. The current design of a mechanism provides a promising working hypothesis about the fitness-relevant features of our past evolutionary environment.

### Evolution and Ethics

Some worry that accepting the science of evolutionary psychology carries abhorrent ethical consequences, such as exoneration of personal responsibility. If it can be demonstrated conclusively that men have evolved a desire for sexual variety, will this provide an excuse for men to be unfaithful? Perhaps some men will argue, "I couldn't help playing around; my evolved psychology made me do it!"

Evolutionary psychology is a science that describes and explains; it does not prescribe. It is a fallacy to argue that just because something exists, it ought to exist. Humans try to eliminate many things that are deemed natural, including certain parasites and diseases. Many laws are created specifically to deter people from doing things that they might naturally be inclined to do if there were not such laws.

Those who object to evolutionary psychology because of a fear of pernicious ethical implications often commit another fallacy—a fallacy that conflates what they want to exist with what does exist (Buss, 1994). Some don't want it to be true that the sexes differ in their evolved sexual psychology, for example, and this leads some to reject theories and evidence that suggest that they do. Clearly, committing this fallacy is the road to obscurantism. The science of evolutionary psychology is designed to explain and understand human nature. If it threatens to discover some unpleasant truths about human nature, are we really better off with blinders?

## Conclusion

Evolution by selection remains the only viable scientific theory that can explain the origin and complex functional design of human nature. From this perspective, the issue is not "evolutionary or not evolutionary," but rather, "what is the design of human nature that evolution by selection has created?" We can go the route of Lady Ashley and hope that it doesn't become widely known. We can attempt to suppress its discoveries. Or we can face the fact that humans evolved, have been subjected to the principles of evolution by selection, and have a distinctive human nature. The goal of evolutionary psychology is to use all of the conceptual and empirical tools we now have available to elucidate where we came from, the selective forces that fashioned us, and the mechanisms of mind that define who we are.

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