



## Original Article

# EVOLUTIONARY PSYCHOLOGY:

## AN EMERGING INTEGRATIVE PERSPECTIVE WITHIN THE SCIENCE AND PRACTICE OF PSYCHOLOGY

By

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### Abstract

Evolutionary Psychology (EP) is an emerging integrative approach to the study of Human Nature, founded upon evolutionary biological theory and cognitive science.

This article evaluates the theoretical foundations and implications of EP from a Scientist-Practitioner perspective. EP is contrasted with its antecedent, human sociobiology, and theoretical differences are discussed. Cosmides & Tooby's EP is described; including EP's model of mind, the need for a computational theory and how this is provided by functional adaptationism, the strategic modelling of the past needed to make evolutionary inferences, and the role of present ontogenetic environment on the development and function of adaptations. The adaptationist approach to Human Nature is controversial; therefore the scientific validity of this approach is evaluated; the critique is not found convincing. The perceived paradox of EP's focus compared with behavioral genetics and comparative psychology is resolved. The compatibility between learning psychology and EP is addressed. Finally EP's implications for the mainstream academic fields of psychology – cognitive, social, developmental, and personality psychology - and to the practice of clinical psychology – Evolutionary Psychopathology - are considered.

EP is a growing, influential and promising field of study, and potentially a unifying theory of psychology.

Keywords: Evolutionary Psychology – Human Nature – Modular Mind – Human Sociobiology – Adaptationism - Scientist-Practitioner – Evolutionary Psychopathology

### I. Introduction

“In the distant future I see open fields for far more important researches. Psychology will be based on a new foundation, that of the necessary acquirement of each mental power and capacity by gradation.”

Charles Darwin, 1859/1996, p. 394.

“Nothing in Biology Makes Sense Except in the Light of Evolution”

Theodosius Dobzhansky, 1973, p. 125.

“Is it not reasonable to anticipate that our understanding of the human mind would be aided greatly by knowing the purpose for which it was designed?”

George C. Williams, 1966, p. 16.

With the publication of *On the Origin of the Species*, Charles Darwin (1859/1996) changed our world (Dawkins, 1976/1989; Mayr, 1983). There is no longer any reason to doubt the general idea of evolution. This article will not argue

against creationism; this is done at length elsewhere (e.g. Futuyma, 1983). This article accepts the less controversial stance that of the two explanations, evolution is the scientific explanation. It is the preferred theory when attempting to perform a scientific investigation of the nature of any biological phenomenon (Ridley, 1996), like Human Nature.

This article is founded upon two basic principles. First, humans are products of evolution, as are any other biological phenomena. Second, Human Nature is a biological phenomenon. It is also a sociocultural phenomenon, but as culture is a product of Human Nature, culture is also a biological phenomenon. Thus psychology is a life science, and is approached in an anti-dualistic manner. The theory of evolution is therefore essential to studying psychology. This has been accepted within Evolutionary Psychology (EP) (Cosmides & Tooby, 1987; Tooby, 1988); and has resulted in Charles Darwin being listed as one of psychology's pioneers as the father of EP (Masterton, 1998). Darwin contributed to psychology in so many ways prior to EP that this seems a limited focus; his studies of children inspired Freud's interest in child psychology (Suloway, 1979/1992), and his studies of emotional expressions (Darwin, 1872/1998) still generate research (Ekman, 1998). His work has formed and generated fields such as psychoanalysis, comparative psychology, behaviourism, psychometrics, behavioural genetics, ethology, ecology (Gangestad, 1995), and even existentialism.

The Modern Synthetic theory of evolution is a synthesis of Darwin's principle of natural selection and population genetics (Mayr, 1978). Darwin's own theory of heritability was logically opposed to the possibility of a mechanism such as natural selection being able to operate (Ridley, 1996), it also included the idea of heritability of acquired traits. This idea is often presented as Lamarckism, but it would be neither historically correct nor fair to Lamarck, to suggest that he was but the spokesman of a commonly held belief. In this article, where necessary, the idea of heritability of acquired traits will nonetheless be called Lamarckian-inheritance. This idea was finally laid to rest by Weismann's rediscovery of Mendelian "genetics" (Mayr, 1978; Ridley, 1996), a theory of

heritability that was perfectly compatible with natural selection. The synthesis of Darwin and Mendel is today's mainstream evolutionary theory.

EP is a synthesis of modern evolutionary theory, studies of behaviour inspired by evolutionary theory, and cognitive psychology. It proposes an integrative perspective for psychology, and as such, it aspires to become the first real unifying paradigm of psychology (Buss, 1995a, 1995b; La Cerra & Kurzban, 1995). Many will see this as meaning that EP is a new attempt at promoting the ideas of human sociobiology (SB), including the idea of reducing psychology to biology. One of the first problems in presenting any evolutionary perspective to Human Nature is the association to human SB; therefore this needs to be dealt with first (Section II). The basic theoretical principles that constitute EP will then be presented (Section III). Not all theoreticians accept the functional, adaptationist stance of mainstream evolutionary science. Gould and Lewontin's call for Pluralism (1979, Gould, 1983, 1991, 1993, 1997a, 1997b, 1997c; Lewontin, 1979; Rose, Lewontin & Kamin, 1984) has raised many issues critical to an evolutionary explanation of Human Nature. These controversies must be addressed (Section IV). There exist at, least three, wrongfully perceived paradoxes of EP. These follow from the prejudice that EP is theoretically on a par with SB, and need to be resolved in order to see how EP relates to both evolutionary theory and psychology (Section V). Finally, if EP is to integrate psychology within a theoretical framework that not only enables different areas of psychology to communicate, but also different levels of analysis, from biology to culture, then EP must show an ability to rigorously inform research, stringently discipline theory that is incompatible with empirical findings across sciences, and provide a conceptual level acceptable to most practitioners within the field. It is the aim of Section VI to show this.

The main questions to be addressed in this paper are thus:

Is EP a theoretically valid science? Its ability to synthesise evolutionary theory and psychology such that it presents both theories in a form acceptable to the different fields of study is important. Human SB had several problems in

that respect, and met claims of lack of theoretical validity from most disciplines. EP is more on a par with modern evolutionary science than was human SB. EP also comprises the cognitive approach, and although many cognitive theoreticians do not accept the evolutionary, adaptationist approach, their description of mind is compatible with evolutionary theory.

Is EP able to generate new theories and insights about Human Nature? This question will be addressed throughout this article; from the more rigorous, mature implementation of evolutionary principles compared to human SB, via the rephrasing of mainstream cognitive theory, to the application of the same theory in understanding normal personality, personality disorders and psychopathology.

Does EP have the potential to unite the science of psychology in a new theoretical paradigm (Buss, 1995a, 1995b; La Cerra & Kurzban, 1995)? This is a stronger form of the question posed above, and must be considered a tall order. This article will attempt to investigate the validity of Buss' (1995a) claim that EP is a new paradigm for psychology, based on its ability to integrate psychological traditions.

The three introductory quotations share a focus on the evolutionary basis of all things living, and their characters; including psychological. This article will attempt to evaluate this stance, through an exposition of EP.

## II. Antecedents: The Rise and Fall of Human Sociobiology

With the publication of *Sociobiology: The new synthesis* in 1975, Wilson inspired and provoked a debate on the ethics and politics of an evolutionary and gene-based view of Human Nature, as well as inspiring and heralding a burst of theoretical and empirical work. Wilson (1975, p. 4) defined SB as “the systematic study of the biological basis of all social behavior.” Dawkins (1979a) finds this definition neutral, on a par with sciences like geology and history, although he doubts that the definition is correctly understood by social scientists, due to “biological” being misunderstood as “genetic”, which is misunderstood as being deterministic. Dawkins (1979a, p. 427) offers his own “slightly irreverent epitome [...] ‘SB is the branch of ethology

inspired by W. D. Hamilton’.” Dawkins' (1976/1989) own *The Selfish Gene* is inspired by Hamilton's (1964a, 1964b) work on mathematical models explaining the genetics of social behaviour. However Dawkins objects to Wilson's prediction that ethology will be “cannibalized by” SB (Wilson, 1975, p. 6). The SB epoch seems to have passed, at least as the mainstream research program for the evolutionary study of Human Nature.

The political issues that flared due to Wilson's work centred on issues such as the genetic argument for social status, the argument being that social status is controlled by the heritable, individual differences of genetic makeup. It is thus perceived as an argument for genetic determinism (Rose, Lewontin & Kamin, 1984; Bateson, 1986). It also inspired theoretical work on evolutionary and genetic issues, providing scientific arguments against the perceived strain of evolutionary and genetic theory promoted within SB thinking (Gould, 1977a, 1980; Lewontin, 1979; Gould & Lewontin, 1979). This demanded a response from theorists who did not identify with the charges of genetic determinism (Dawkins, 1976/1989, 1982, 1986; Bateson, 1986).

This has caused a schism within evolutionary theory between the Modern Synthesis and Pluralist Theory (Eldredge, 1995; Gould, 1983, 1993, 1997a, 1997b). It may seem however that the schism is more of a reality from the perspective of the social sciences and humanities (Selzer, 1993) than from biology proper (Mayr, 1983; Dawkins, 1986/1991; Dennett, 1995; Ridley, 1996; Hurst, 1998).

In an evaluation of the academic and scientific value of SB, Ruse (1979, p. 214) concludes that:

[...] I am far from convinced that human [SB]s have yet made their case. What I do plead is that their sins are not as grave as their critics argue. Human [SB] should be given the chance to prove its worth. If it cannot deliver on its promises it will collapse soon enough [...]; but if it does prove viable, then its success could pay scientific dividends of the highest order.

Dawkins (1979a) does not disagree with this conclusion, but also claims one has to listen to the criticism. Ruse (1987, p. 77) sticks to this line of argument eight years later:

Human [SB] has far to go before it can claim to be as solid a science as quantum mechanics, or even molecular biology. But even in its present primitive state, it commands our attention. The critical arrows fired against it fail to penetrate to vital organs. As science, it bears full promise of a vital new way of understanding Human Nature.

This critique has rarely been aimed at animal SB, although Gould & Lewontin (1979, pp. 588-89) also use research on mountain bluebirds to illustrate poor adaptationist work. Most often, as in the following quote by Kitcher (1985, p. 435), animal SB receives great praise, while human SB attracts academic flack:

[SB] has two faces. One looks toward the social behavior of nonhuman animals. The eyes are carefully focused, the lips pursed judiciously. Utterances are made only with caution. The other face is almost hidden behind a megaphone. With great excitement, pronouncements about Human Nature blare forth.

Holcomb (1993, p. 7) claims: "Evolutionary biology has long been an established science, and animal [SB] is now an established science, whereas human [SB] is not." This statement may seem premature in a chapter that intends to provide the tools for the assessment of an emerging science. How may one explain this difference in epistemological value, apart from through an in-grown reluctance to admit that man is an animal, or that we should have evolved? In other words, what is the *scientific* fault of human SB?

Dawkins (1979a, 1981, 1982, 1986) argues forcefully against genetic determinism. Dawkins (1979a) finds the understanding of "biology" as "genetic" to be a social scientist's misunderstanding, and seems to prefer the label "ethologist". Dawkins (1986) repeats these themes, pointing out that he cannot see any reason for coining the word "sociobiology" in the

first place, rather he would use "behavioural Darwinist" for both ethologists and SBs. Although Dawkins is dubbed SB by many authors (Rose et al. 1984; Kitcher, 1985; Dennett, 1995), he is theoretically opposed to many ideas often associated with SB. In *The Extended Phenotype* Dawkins (1982) provides what Bateson (1986, p. 92) calls "the best rebuttal of genetic determinism [he has] come across", despite being described as the "archetypal biological determinist" (Rose et al., 1984, p. 292). He also discusses constraints on perfection, including time lag: "the animal [...] is very probably out of date, built under the influence of genes that were selected in some earlier era when conditions were different." (p. 35), and all but discards the value of the concept of inclusive fitness (pp. 179-94), the hallmark of SB. Inclusive fitness is a measure of the interaction between relatives on one another's fitness; that is reproductive success (Hamilton, 1964a). In addition he makes a point that SBs do not appreciate the fact that memes do not by definition enhance inclusive fitness, that they indeed are "selfish", and may be maladaptive for the individual's fitness. Memes (Dawkins, 1976/1989, 1982, 1993; Dennett, 1995) are imitated ideas or replicating units of culture. As such they are cognitive phenomena, although Dawkins (1976/1989) introduces them merely to illustrate the general principle of replicators (e.g. genes). Dawkins (1981) questions the behaviouristic language of ethology, wondering whether a more subjective, awareness-oriented perspective might not be beneficial; a similar view is expressed by Dennett (1983; see also Dawkins, 1983). All in all a theoretical development, which has been driven by his gene eye perspective, that maps neatly onto the later theoretical shift from human SB to EP.

Symons (1992) elaborates the difference between adaptiveness and adaptation to describe the difference between EPs versus some human SBs. According to Symons (1992, p. 146) these SBs are those "evolution-minded scholars who seek to construct a psychologically agnostic science of human behavior based on the hypothesis that human beings are reproduction (or inclusive fitness) maximizers." Adaptiveness is what enhances survival and reproduction, and is concerned with the present (Symons, 1992; Betzig, 1998). An adaptation, on the other hand, is the

result of what selection produced through evolutionary history, which served a certain function with greater adaptiveness than other available genetic variations could. Though it is an adaptation, it may no longer be adaptive, due to time lag, where the environment has changed faster than the adaptations (Dawkins, 1982). Symons (1992, p. 150) refers to a personal communication, where Tooby notes that “the study of adaptiveness merely draws metaphorical inspiration from Darwinism, whereas the study of adaptation *is* Darwinian” (Italics in original). Adaptiveness reasoning is caused by a bias for “reproduction-mindedness”, which follows from exclusive commitment to inclusive fitness (all behaviour will maximise reproductive success). Symons (1992, p 156) conclusion is that the adaptations are psychological, and therefore “A science of human behavior cannot be simultaneously psychological agnostic and genuinely Darwinian.” Cosmides & Tooby (1987) provided the missing link between the evolutionary process and manifest behaviour: the mental mechanism or psychological adaptation. Behaviour does not evolve; believing so would be reifying behaviour. Evolution takes place between genes (Dawkins, 1976/1989) and combinations of genes. Genes code proteins, and proteins build structures. The mind consists of such structures processing environmental information according to rules that caused them to be selected for (Darwinian algorithms, Cosmides & Tooby, 1987). The output these adaptations produce is behaviour. Evolutionary theory predicts behavioural variation due to varying environmental input (Cosmides & Tooby, 1987), but the mechanisms designed by natural selection – adaptations – will comprise a universal human nature (Tooby & Cosmides, 1990a). With the article *The Future of Sociobiology: Counting Babies or Studying Proximate Mechanisms* Crawford (1993) turned the table on SB by questioning the use of inclusive fitness (“counting babies”) and advocating cognitive methods in the study of adaptations of animal psychology.

The SB approach to psychology was behaviour oriented (Crawford, 1987), reductionist in its approach to defining evolution as changes in allele frequencies over time (Mayr, 1978, p. 45; Noonan, 1987, p. 34), and focused on individual differences (Crawford, 1987), thus omit-

ting the crucial aspect of adaptation (Mayr, 1978). The theoretical transition from *Sociobiology and Psychology* (Crawford, Smith & Krebs, 1987) - via Crawford & Anderson’s (1989) environmental SB - to *Handbook of Evolutionary Psychology* (Crawford & Krebs, 1998) documents the influence of EP on the evolutionary approach to psychology, as well as how the scientific faults of SB have been rectified.

My conclusion is that Dennett (1995, p 488) in describing EP merely as “the marriage of SB and cognitive psychology”, commits an oversimplification that does injustice to the matured approach of EP over SB. If SB, as an evolutionary behaviourism, had only been caught up by the cognitive revolution (Sperry, 1993), it could still focus on adaptiveness over adaptation, on individual genetic differences rather than universal Human Nature, and the major critique of SB would be sustained. EP is inspired by the theoretical work of Dawkins (1976/1989, 1982, 1986/1991) and Williams (1966, 1985), more than that of Wilson (1975) and his followers. Thus the attacks on adaptationism by authors like Gould and Lewontin have not toppled the project that Darwin (1859/1996) predicted; rather they have acted like selection forces honing the evolutionary theory of their opponents.

This look at the evolution of EP from SB through a selection for an emphasis on adaptations, has introduced a few theoretical points of debate that will be elaborated in the following pages, as well as prepare the ground for a description of EP.

### III. Evolutionary Psychology: Describing and Discussing the Theory

EP is an emerging, important new theoretical paradigm of psychology, claims Buss (1995a), which main axioms are that mind consists of an array of evolved mental mechanisms, and that these mechanisms are functional, species-specific, task-specific adaptations, which process contextual information in order to solve proximate and ultimate-level problems of genetic replication. These adaptations may be discovered through functional computational analysis using available models of our hominid past and general principles of evolution. EP aspires to become an integrative meta-theory, able to connect the em-

irical findings and mini-theories of psychological science.

This section attempt to describe and discuss central elements of the theory and its method of scientific examination of Human Nature, focusing especially on the theoretical work of Leda Cosmides and John Tooby.

### III.I. Models of Mind

“There is no such thing as a ‘general problem solver’ because there is no such thing as a general problem” claims Symons (1992, p. 142). Dennett (1995, p. 491) begs to differ; writing this off as a “luscious slogan”. He supports his opinion by referring to Williams’ (1966) classic work on adaptation, which is the major source of EP on the nature of adaptations, and this is not an unsubstantial challenge. Williams (1966, p. 86) writes “A precise adaptation might require more genetic information than one that would give a blanket coverage to a broad category of ecological demand.” It is thus more expensive, in evolutionary coinage, and therefore less likely to arise. Both Dennett and Williams use the example of wounds coming in all shapes and sizes, but the adaptation, whose function is wound healing, heals them all. Dennett (1995, p. 491) concludes that: “How general any cognitive mechanism is, or can be made to be through cultural enhancement, is always an open empirical question”, and of course this is true. One might draw attention to the fact that Symons is contrasting general problem solvers to more specific problem solvers. In that respect Dennett’s criticism seems too stringent, as the healing mechanism he describes does not do anything but heal what is recognised as wounds and is therefore quite specific.

Symons statement, slogan or not, draws attention to two major axioms of EP: the mechanistic, functional model of mind, inspired by work within Artificial Intelligence (AI), by alluding to Herbert Simon’s *General Problem Solver*, and the *modular, species-specific, domain-specific, mental mechanism model of mind*, as opposed to a model of mind that is described as domain-general (Buss, 1995a; Symons, 1992) or Lockean, empiricist or instructionalist (Gazzaniga, 1992). Tooby & Cosmides (1992) offer in their critique of what they perceive as the

dominant Standard Social Science Model (SSSM) a thorough attack on the notion of Human Nature as non-existent. They claim that the SSSM rests upon several defects, but focus on three clusters. First, “the central logic of the SSSM rests on naïve and erroneous concepts drawn from outmoded theories of development” (Tooby & Cosmides, 1992, p. 33). They exemplify this by pointing out that as (other) physical adult traits do not need to be present at birth, neither do features of adult mental organisation need to be explained as the result of sociocultural influence; they may have developed, like the complex physical (brain) structures they are. Second, “the SSSM rests on a faulty analysis of nature-nurture issues” (Tooby & Cosmides, 1992, p. 33). The main fault is the dichotomy of biological and environmental factors operating in a zero-sum relationship (the more of one, the less of the other), when the truth is that “environmentalist claims necessarily require the existence of a rich, evolved cognitive architecture” (Tooby & Cosmides, 1992, p. 34, see also pp. 21-22; Pinker, 1997a). Needless to say; anything evolved is biological. Thirdly, “[The SSSM] requires an impossible psychology” (Tooby & Cosmides, 1992, p. 34). They claim that the findings of important areas of research support their conclusion: “A psychological architecture that consisted of nothing but equipotential, general-purpose, content-independent, or content-free mechanisms could not successfully perform the tasks the human mind is known to perform” (Tooby & Cosmides, 1992, p. 34). The result of the SSSM is lack of communicability between the social and natural sciences, due to an acceptance of a core dualism (Tooby & Cosmides, 1992).

If AI has any obvious value to the science of Psychology, it must be as an active tester of models of mind. One lesson that EP has learned is the need for a computational theory of mind (Cosmides & Tooby, 1994a, 1995). Pinker (1997a) provides the most elaborate defence of the computational theory of mind, and claims: “The proper label for the study of the mind informed by computers is not Artificial Intelligence but Natural Computation” (p. 83).

When attempting to build machines that could “see” several problems were encountered. Among these was the problem of inverse optics

(Poggio, 1984; Pinker 1997a); how can one, starting with the retinal image, compute the qualities of what we see. Pinker (1997a, p. 28) explains this paradox with the example of multiplication: “Just as it is easy to multiply some numbers and announce the product but impossible to take a product and announce the numbers that were multiplied to get it, optics is easy but inverse optics impossible”. The only way to solve the problem is to provide the “computer” with a set of algorithms that contain constraints on the possibilities. The result being that the *tabula rasa* view of mind is theoretically impossible. We need an innate representation of the world, in the form of specific algorithmic rules of information processing, to be able to compute reality. This is called the frame problem; the answer is a non-content-free mind, and as different problems need different content the mind must consist of several domain-specific computing mechanisms, or modules (Fodor, 1983, 1985).

Fodor (1985) describes the difference between modularity and interactions or global views of cognitive architecture, and argues that there is no continuity from perception to cognition. Perception is the result of “integrations [...] performed by computational systems that are informationally encapsulated” (Fodor, 1985, p. 3). These encapsulated computational systems are “modules”, where “modules” are defined as “an inference-making mechanism whose access to background information is constrained by general features of cognitive architecture, hence relatively rigidly and relatively constrained” (Fodor, 1985, p. 3). Pinker (1997a, p. 31) prefers Chomsky’s metaphor of “mental organ”, rather than module, in order to focus more clearly on the organic aspects of the mind’s information computing “modules”; they are not *as* encapsulated as Fodor (1985) would have them. Another point worth making is that EPs do not accept Fodor’s (1985) insistence that there is no continuity between perception (modular) and central or higher cognitive processes, such as “thought” and “problem solving” (Cosmides & Tooby, 1994b, 1995; Gallistel, 1995; Gallistel & Cheng, 1985; Sperber, 1994). These, Fodor (1985, p. 4) claims, are “global” and “everything perception is not”; which in this respect means non-modular. EP is theoretically committed to these

processes being modular too (Cosmides & Tooby, 1994a).

This specially modified version of Fodor’s model of mind is what EP adopts, but always with the note that these modules are adaptations (Cosmides & Tooby, 1995). In fact, it is because they are adaptations that the modular model of mind is co-opted (Cosmides & Tooby, 1994a, 1994b, 1995).

### III.II. The Functionality and Design of Adaptations

Adaptations are the evolved solutions to problems encountered consistently through periods of evolutionary history, designed through the natural selection of available genetic variation, which in the process will tend to be reduced. Thus human adaptations make up Human Nature, and are universal to almost all humans (Tooby & Cosmides, 1990a), degenerative mutations or non-nurturing environments causing the missing cases. Williams (1966) tied adaptations to non-chance function, “effect [...] produced by design” (p. 261), where there are two functions: proximate (what does the adaptation cause here and now) and ultimate, which Williams (1966, p. 252) defined as Hamilton’s (1964a) “inclusive fitness” (See Dawkins, 1979b, 1982). Adaptations are thus functional by definition. Adaptations designed by natural selection are the common explanation of any functional, complex design (Williams, 1966; see also Dawkins, 1986/1991; Dennett, 1995); although orthodoxy has been challenged (Gould, 1983, 1991, 1993, 1997; Gould & Lewontin, 1979; Gould & Vrba, 1982; Lewontin, 1979). I will return to this debate later. Presently it will suffice to state that EP (Buss, 1995a, 1995b; Buss et al, 1998; Cosmides & Tooby 1987, 1994a, 1994b, 1995, 1997; Gazzaniga, 1992, 1995b; Symons, 1987, 1992; Tooby & Cosmides 1990a, 1990b, 1995; Pinker, 1994, 1997a, 1997b) is committed to the adaptationist program (Mayr, 1983).

An adaptation is recognised by evidence of *special design* (Williams, 1966), which is a systematic interaction between environmental input and phenotypic output, where adaptiveness (inclusive fitness) is supposed to be to the ancestral environment to which it evolved, not

necessarily current conditions.

Tooby & Cosmides (1995, p. 1192) offer the formal properties of an adaptation in figure 1.

<b>Figure 1: The formal properties of an adaptation</b>	
1.	A Cross-generationally recurring set of characteristic of the phenotype,
2.	that is reliably manufactured over the developmental life history of the organism
3.	according to instructions contained in its genetic specification,
4.	in interaction with stable and recurring features of the environment (i.e., it reliably develops normally when exposed to normal ontogenetic environments),
5.	whose genetic basis became established and organized in the species (or population) over evolutionary time, because
6.	the set of characteristics systematically interacted with stable and recurring features of the environment (the “adaptive problem”),
7.	in a way that systematically promoted the propagation of the genetic basis of the set of characteristics better than the alternative designs existing in the population during the period of selection. This promotion virtually always takes place through enhancing either the reproduction of the individual bearing the set of characteristics, or the reproduction of the relatives of that individual.

It is important to note that the reproduction of “the individual bearing the set of characteristics”, in point 4) of the figure (i.e. replication of the genes “for” the characteristic) is quite sufficient. One ought to, in order to be precise, add that “the reproduction of the relatives of that individual” has to include only, or to a greater degree”, those relatives that share the genes for the characteristic, if one shall be true to Dawkins’ (1982). This is where the difference between Dawkins’ gene-perspective and Hamilton’s inclusive fitness becomes clear. Kin selection only works if genes for kin selection exist in those who survive due to the “altruistic” act of the bearer of the kin selection genes. If not the genes for kin selection will vanish as soon as they appear. Thus genetic similarity (or high likelihood of such) must specify kin. Also “normal” ontogenetic environments, ought to have been specified. My suggestion is that one defines “normal” in this respect as “an adequate approximation of the EEA” where the “EEA” will be specified below (III.III), and “adequate” means “recognisable to the developing adaptation.”

EP is interested in a certain kind of complex design, and although an evolved design is a genetic design, which causes the design of certain proteins, which in turn build neurological structure, EP is interested in the level of cognitive structure. This is the level of what may be called cognitive programs, mental organs, modules or Darwinian algorithms (Cosmides & Tooby, 1987).

Inspired by the Darwinian Functionalism of William James, Cosmides and Tooby (1987, 1994a, 1995) have focused on the need for a functional analysis of psychological phenomena. In order to do this, they advocate applying Marr’s (1982) computational model.

Marr (1982, p. 24-27) described three levels at which any information processing mechanism must be understood (Table 1).

Table 1

Three levels at which any machine carrying out an information processing task must be understood

<b>Computational theory</b>	<b>Representation and algorithm</b>	<b>Hardware implementation</b>
What is the goal of the computation, why is it appropriate, and what is the logic of the strategy by which it can be carried out?	How can this computational theory be implemented? In particular, what is the representation for the input and output, and what is the algorithm for the transformation?	How can the representation and algorithm be realized physically?

From Marr, 1982, p. 25.

Cosmides & Tooby (1994a, 1995) add to this that in the case of evolutionary biology “explanations at the level of the computational theory are called ultimate-level explanations. Explanations at the level of representation and algorithm, or at the level of hardware implementations, are called proximate-level explanations” (Cosmides & Tooby, p. 45; Cosmides & Tooby, 1995, p. 1200). The ultimate-level explanations are genetic reproduction, or fitness, explanations, which will be governed by the theory of natural selection and derivatives (Darwin, 1859/1996;



Hamilton, 1964a, 1964b; Williams, 1966; Dawkins, 1976/ 1989, 1982, 1986/1991; Trivers 1971, 1972). The functional mental mechanisms that these theories predict limits the hypothesis space for the scientist to search; some mechanisms become more likely - other mechanisms would not have been possible to develop.

In arguing for the value of a computational theory Marr (1982) claimed that “[a]lthough algorithms and mechanisms are empirically more accessible, it is the top level, the level of computational theory, which is critically important from an information-processing point of view” (p. 27). For EP this level has been elaborated: “Modern evolutionary biology constitutes, in effect, a foundational organism design theory, whose principles can be used to fit together research findings into coherent models of specific cognitive and neural mechanisms” (Tooby & Cosmides, 1995, p. 1186). Other areas of psychological research lack such a guiding computational theory. The reason why the computational theory is critical is according to Marr (1982, p. 27) that “an algorithm is likely to be understood more readily by understanding the nature of the problem being solved than by examining the mechanism (and the hardware) in which it is embodied.” Cosmides & Tooby (1995, p. 1201; 1994, p. 46) argue against the idea that empirical findings of “low-level” neuroscience “will place strong constraints on theory formation at the cognitive level.” They doubt that the properties of neurophysiology will lead to the discovery of cognitive programs, due to the fact that “[t]he same basic neural tissue embodies all of these programs” (Cosmides & Tooby, 1995, p. 1201, italics in original). Cosmides & Tooby (1994a, p. 46) claim: “For this reason a computational theory of function is not an explanatory luxury. It is an essential tool for discovery in the cognitive and neural sciences.” This it not to say that they believe that the theory of function will specify an algorithm’s design, but it “reduces the number of possibilities to an empirically manageable number ” (Cosmides & Tooby, 1994a, p. 46). This is due to a restriction of functions to those that were adaptive in our evolutionary past, and that there are a limited number of programs that may solve any of the adaptive problems. On an optimistic note they claim “once [a] program has been

identified, it becomes straightforward to develop clinical tests that will target its neural basis” (Cosmides & Tooby, 1995, p. 46).

Cosmides and Tooby (1995, p. 1209) offer this conclusion in Gazzaniga’s (1995) *The Cognitive Neurosciences*:

Through the computational theory, evolutionary biology allows the matching of algorithm to adaptive problem: Evolutionary biology defines information-processing problems that the mind must be able to solve, and the task of cognitive neuroscience is to uncover the nature of the algorithms that solve them. The brain’s microcircuitry was designed to implement these algorithms, so a map of their cognitive structure can be used to bring order out of chaos at the neural level.

Put more simply: “To figure out how the mind works, cognitive neuroscientists will need to know what problems our cognitive and neural mechanisms were designed to solve” (Cosmides & Tooby, 1995, p. 1201.)

### III.III The Environment of Evolutionary Adaptedness: Using Evolutionary Theory and Strategic Modelling to Guide Research on Adaptations

Stanislaw (1991) claims that one reason why all psychologists are not Darwinians, i.e. why evolutionary theory is not a viable foundation for psychologists, is the lack of independent (of psychological findings) knowledge about ancestral conditions. This knowledge is demanded if one shall be able to infer what problems needed to be solved, and predict what mental mechanisms we may have developed to solve them (Tooby & DeVore, 1987; Tooby & Cosmides, 1990b). Crawford & Anderson (1991) reply that rigorous evolutionary psychologists need not resort to tautology, due to an abundance of independent “[a]rchaeological and anthropological evidence about the life of our ancestors” (p. 249). They do not refer any source, e.g. Tooby & Devore (1987), however, and as that analysis is the major reference on the adaptationist EP approach to this evidence, Stanislaw’s fears were probably not properly put to rest.

Tooby & DeVore (1987) present the beginnings of an adaptationist conceptual model of hominid behavioural evolution. They criticise the use of existing referential models, stressing the need for a conceptual model to evaluate any referential model (studying a real phenomenon in the place of another real phenomenon less readily studied). Tooby & DeVore (1987) point out that “the use of such models is arbitrary” (p. 186), due to the lack of a validated conceptual model for selecting a living species as a parallel to an extinct species. They also claim that due to the referential perspective not having established any conceptual model for differences between hominids and the arbitrarily selected referential model species, two problems arise. First, an exaggerated interest in the evolutionary stage when differences between model and the extinct hominid species were supposedly minimal. This focus sheds little light on what events caused our ancestral line to evolve into humans, while other lines went extinct or evolved into e.g. apes. Second, what seems to be a result of the first, “similarities are emphasized at the expense of differences” (p. 187). Explaining human behavioural evolution is to explain the design of what is uniquely human, our species typical adaptations, and “one cannot invoke the features species have in common to explain their differences” (p. 187). Due to these limitations of referential models, Tooby & DeVore advocate that one discards them. Notice the importance placed on the specificity of human traits; a basic axiom of EP.

Tooby & DeVore (1987) introduce the term “strategic modelling” to describe the formation of conceptual models of primate and hominid behaviour building upon the comprehension of: “1) the genes as the unit of selection, and 2) animals as shaped to behave as strategists promoting their inclusive fitness” (p. 189). They call the recognition that the gene is the unit of selection, “a central achievement of modern evolutionary biology” (p. 189), of which EP has played a central part (Cosmides & Tooby, 1981). To construct a conceptual strategic model, one must be able to formulate general (in both time and species) principles of evolution designing both current and past adaptations. Such principles may include evolutionary stable strategies (Dawkins, 1976/1989, 1980; Maynard Smith, 1979), kin selection (Hamilton, 1964a, 1964b,

Dawkins, 1979b), parental investment (Trivers, 1972), reciprocal altruism (Trivers, 1971), and game theory (Maynard Smith, 1979; Axelrod, 1984), amongst others. Tooby & DeVore (1987, p. 191-200) provide a list of 25 heuristic guidelines for inference, and illustrate how these, even in their preliminary form, may be used to productively evaluate current models of human behavioural evolution. Tooby & DeVore’s hope is “that the application of evolutionary principles will constrain the range of possible hominid traits” (p.190), where likely parameters for the model will be provided by the investigation of “patterns of primate homology”, “characteristics present in modern humans”, “the paleontological [and] archaeological record” and “knowledge of ancient habitats.”

The conclusion I draw from this is that Stanislaw (1991) made an important challenge, although one recognised and addressed by EP. Also, though Crawford & Anderson (1991) are correct that information does exist, “abundance” might not be the correct term. In addition, by not specifying by what criteria they were evaluating the information from their archaeological and anthropological sources they were not as stringent as made possible by Tooby & DeVore (1987). Any scientific investigation into possible mental mechanisms would have to be founded on an analysis of what mechanisms were needed to solve what problems, as well as what mechanisms could possibly evolve or were likely to evolve.

With a strategic model of the past one may explain the present (Tooby & Cosmides, 1990b). Tooby & Cosmides (1990b) call the “past” the Environment of Evolutionary Adaptedness (EEA). The EEA is defined as “a statistical composite of the adaptation-relevant properties of the ancestral environments encountered by members of ancestral populations, weighted by their frequency and fitness-consequences” (p. 386-7). This does not make the EEA a certain habitat, instead it is the “complex statistical composite of structurally described contingencies of selection”; and these contingencies may vary (p. 387). Different adaptations and different periods of evolutionary change will demand the specification of specific EEA’s. The EEA for a specific species’ collection of adaptations (which may be used as a definition of species, within

EP) “can be taken to refer to the statistically weighted composite of the environmental properties of the most recent segment of a species’ evolution that encompasses the period during which it’s modern collection of adaptations assumed their present form.” For human evolution the Pleistocene period (which lasted from 1.6 million years ago till 10 thousand years ago) fulfils these requirements for most adaptations, and is often used within EP as equivalent to EEA.

The co-ordination of the problem-setting environment and the problem-solving adaptation designed through natural selection, cause the close fit between organism and environment. This fit need not be perfect, adaptations are not necessary “optimal”. Dawkins (1982, p. 46) describes them as “meliorizing”; that is being better than other competing designs. Any theory of evolution must explain the existence of these adaptations, and this was the main objective of Darwin’s theory (Ridley, 1996). As such present adaptations are records of the past (Tooby & Cosmides, 1990b, p 389). Some call this fossilised behaviour or call humans living fossils (Buss, 1995a, p.10).

#### III.IV The Present Ontogenetic Environment and Rules of Development

The past *created* us body and mind, to paraphrase Dawkins (1976/1989, p. 20 and p. 271) correctly. But, unlike what those who have read only Rose et al.’s (1984, p.287) misquote of Dawkins (See Oyama, 1991, p. 40) might believe, this does *not* mean that the past or “our genes control us”. The present environment has two functions in evolutionary thinking: phylogenetically speaking it is the selection forces for the present generation (“a single increment in the EEA of future generations” [Tooby & Cosmides, 1990, p. 388]) and ontogenetically speaking it is the input for genetic developmental programs. “[T]he organism blindly executes the programs it inherits, and the ontogenetic conditions it encounters serve as parametric inputs to these programs” (Tooby & Cosmides, 1990, p. 388). The word “blindly” is misleading; it is the environment that the programs “see” when running, and must “see” in order to run.

Adaptationist theory is aware of the influence of rules of development; these set certain

limitations to and interact with adaptations (Maynard Smith, 1986). Rules of development also make one aware of the need for a description of an adequate, stimulating, or repressing environment in order to explain the variance of development of any structure. The lack of certain ingredients as well as the addition of certain teratogenes (Greek for “monster makers”) will cause the disruption of the usual development, and like mutations, most of these new forms will be harmful to the organism. One will expect most adaptations to develop adequately, in an adequate environment, and vice versa.

An adaptation will be designed to solve problems that were invariant in the EEA; it is also designed to develop in an environment similar to the EEA. Thus, one may discover that adaptations cause maladaptive behaviour under environmental conditions that vary too much from the EEA. The empirical illustration provided by Tooby & Cosmides (1990b) describes the Westermarck mechanism for avoiding incest. This adaptation consists of “a mechanism that ‘judges relatedness’ for the purpose of incest avoidance [...] by the duration of intimate exposure in the first years of life” (p. 385) and uses this information to decrease sexual interest. This mechanism will be adaptive and functional in preventing inbreeding among siblings, but was found to be “maladaptive”, though still functioning, amongst those non-relations who grew up in kibbutz-crèches. There was no danger of inbreeding, but the mechanism could not tell that the environment had changed.

Tooby & Cosmides (1990b) advise that one describes the environment in terms of two different features. First, one must provide a description of “the state of those features that must be stably present for the organism’s adaptations to reliably develop” (p. 385), which must be an adequate approximation of the EEA. Second, one must describe “the state of those features that the organism’s adaptive procedures take as input and process into structured phenotypic output” (p. 385). This may be “anything that developmental programs contingently respond to”, including “information processed by cognitive mechanisms”.

Buss (1995a, p. 11) claims, reacting to charges that EP advocates “rigid, genetically inflexible behavior patterns”, that “there are few

other perspectives within psychology that place greater emphasis on a detailed and complex treatment of environmental, situational and contextual factors.” This may seem surprising to certain environmentally oriented disciplines, but the message is probably that EP is not the contextually naïve discipline that earlier evolutionary approaches have been criticised for being.

Buss (1995a) describes, in addition to the historical selective context (the phylogenetic context), two ontogenetic context-analyses. First, analyses of ontogenetic experience early in life may decide the track of development later in life. The early experience provides the child with information about what strategy to follow as an adult and specific contextual input that selects strategy choice. Second, analyses on ontogenetic experience “sets differing thresholds on species-typical psychological mechanisms” (p. 11). Ontogenetic context varies both with sex and culture. The third level of analysis Buss (1995a) describes is the “*immediate situational inputs* that activate the operation of particular psychological mechanisms” (p.11, italics in original).

### III.V. Summary & Conclusions

Having presented and discussed most of the features of an adaptationist analysis, this may be summed up in five “nested but distinct levels” (Tooby & Cosmides, 1990b, p. 384-385): 1) Models and principles of evolutionary biology. 2) A specification of the EEA (Tooby & DeVore, 1987; Tooby & Cosmides, 1990b), and the formulation of computational theories (Marr, 1982; Cosmides & Tooby, 1994a, 1995). 3) Through an implementation of level 1) and 2) one may discover, investigate, describe and analyse functionally the species’ adaptations. 4) A description of the present, ontogenetic environment. 5) An integration of the findings of level 3) and 4) into an individual’s normative developmental trajectory.

Human Nature may be defined as our collection of adaptations. A rigorous investigation of human psychology is guided by the forces that designed these adaptations; the principles of evolution. These principles are environmentally and genetically dependent; given an environmental problem and the genetic variance to allow for a solution that is better than compet-

ing solutions, one will get selection and adaptation. The design of these functional structures takes time, and once designed will very likely have used up the genetic variance. Any new variance (mutations) is likely to be harmful, as it is “random” and can be compared to noise. Thus adaptations will have near zero heritability, defined by population genetics as the lack of phenotypic difference among individuals that can be attributed to genetic differences, and will be shared by most members of the species - defining the species. However, due to the design taking time, and the need for the ontogenetic environment to provide the adaptations with the information they process and need to develop, there may be a lack of adaptiveness. This lag is obviously an important factor for humans, given the rapid change of our environment. Still, what define our nature are our evolved mental mechanisms, operating with our present environmental information.

This is a controversial view, and it is to the discussion of the centrality of adaptations to Human Nature we now turn.

### IV. The Adaptationist Controversy

So far, Adaptationism has been taken at face value, but as quite a few renowned theoreticians have claimed that this approach to the study of Human Nature is at fault, a discussion of the Adaptationist program is necessary. If the “Adaptationist program” (Gould & Lewontin 1979; Lewontin, 1979; Mayr, 1983; Williams 1985) is intellectually “bankrupt” this will effectively tumble EP’s theoretical foundation.

The conflicting stances have been described in many ways: Adaptationists are often also called neo-Darwinists, ultra-Darwinists, panselectionists or even grouped as SBs, though most would claim that they simply adhere to the Modern Synthetic Theory (Mayr, 1978), which is mainstream Evolutionary Theory (Ridley, 1996). Eldredge (1995) lists George C. Williams, John Maynard Smith and Richard Dawkins as the most central figures on this side. The opposing side is easier to define by referring to persons and ideas, Eldredge (1995) lists Stephen Jay Gould, Elisabeth Vrba and himself, on this side. One may add Richard Lewontin. The ideas are Punctuated Equilibrium, Spandrels, Exaptations,

Contingency and Constraint. They often choose the label Pluralists, invoking Darwin's 6<sup>th</sup> edition of *Origin*. Eldredge (1995) offers an extra guideline to understanding the differences; adaptationists are often geneticists, while pluralists are more likely palaeontologists. This naturally gives the two sides quite different perspectives on the same process; the one being here and now process-oriented, the latter being committed to geological time, structure and historical analysis. The fact that the Modern Synthetic theory is historically a genetic theory of evolution, may shed light on the paleontological resistance, at least as well as different, more or less well formulated, hypothetical political motives. Although the differences between these theoretical camps encompass several themes, I will focus on the controversy as it pertains to adaptationism. Many are familiar with the Gould & Eldredge (1977, 1993; Eldredge & Gould, 1972) critique of mainstream "phyletic gradualism", but this theme has not yet become relevant to the evaluation of EP. It will therefore not be discussed here.

#### IV.I. Adaptationism: The Panglossian Paradigm and Just So Stories

Adaptationism is defined by Gould & Lewontin (1979, p. 584-5) as the:

notion [of] the near omnipotence of natural selection in forging organic design and fashioning the best among possible worlds. This programme regards natural selection as so powerful and the constraints upon it so few that direct production of adaptation through its operation becomes the primary cause of nearly all organic form, function, and behaviour.

This definition will easily attack an adaptiveness approach, which is appropriate if the target is exclusively SB, the adaptiveness argument claiming that natural selection will always maximise inclusive fitness, without constraint. Not accepting the adaptiveness-position will be considered to "underestimate the power of natural selection" (Betzig, 1998, p. 271). However, this was perceived to be an attack on mainstream English and American evolutionary theory and

practice, as opposed to the Continental European tradition. This is how the critique of adaptationism will be understood in this section, as the adaptiveness stance has been dealt with previously (section II). Lewontin (1979) makes a more explicit attack on SB, but uses the broader faulty adaptationist strain of the last 25 years (as opposed to the last four, since Wilson published *Sociobiology* in 1975), yet again including mainstream evolutionary theory in the attack. Lewontin (1979) defines the adaptationist program as the "approach to evolutionary studies which assumes without further proof that all aspects of the morphology, physiology and behavior of organisms are adaptive optimal solutions to problems" (p. 6). Mayr (1983), in defence of the adaptationist program, claims that these definitions caricature adaptationism. Sober (1987), discussing the different forces that influence evolution (selection, mutation, genetic drift, and pleiotropy), concludes that adaptationism is:

The thesis that certain simple models are good predictive approximations. It does not deny that other forces were at work. Nor should it pretend that there is an intelligible way to compare the magnitudes of all the factors that contribute to an evolutionary outcome. Rather, adaptationism holds that the predictions that follow from simple selectional models, in which the true selection coefficients are recorded, would not be much perturbed by taking other factors into account.

This is a more balanced account, as long as it admits that adaptationists accept that other forces are at work. If the selectional models in addition are framed as asymptotic, that is as the perfect but highly unlikely model to test against, then the simplicity of the selectional models becomes unproblematic. These definitions set the stage for the discussion that follows.

Gould & Lewontin (1979) use two literary metaphors to characterise (or caricature) the adaptationist program. First, the Panglossian Paradigm, the perspective that all is for the best of all, named after Dr. Pangloss, the caricature of the philosopher Leibniz created by Voltaire (1759/19) in his satirical work *Candide*. Second, "story telling", later dubbed "Just So Stories"

(Gould, 1980). A Just So story is the derogatory label awarded any overly simplistic, evidentially unfounded, account of phyletic history which caused the evolution of the adaptation considered. Both these metaphors are theory-of-science attacks, implemented to posit the research thus labelled as unscientific. They are famous outside of biology proper (where they tend toward being considered more as infamous), and are easily wielded against adaptationist accounts- whether the attacks are valid or not (Dennett, 1995, p. 239).

Just So stories (Gould, 1980) are named after Kipling's (1902/1994) book of classic fables describing e.g. *How the Leopard Got His Spots* through Lamarckian-inheritance. The reason for choosing this label is that the book, in offering simple, intuitive stories, is fictional and of no scientific worth, though Kipling's hypotheses may be tested against the adaptationist, functional hypothesis (Williams, 1985). Gould & Lewontin (1979) attack adaptationist storytelling, which is the evolutionary ecological and selectionist explanation provided to account for observed functional behaviour, physiological process, or anatomical structure. Thus it predicts what functions, or ecological interactions one should expect (Williams, 1985). Gould & Lewontin (1979, p.587) criticise the adaptationists for revising these stories when they are found wanting: "the rejection of one adaptive story usually leads to its replacement by another, rather than to a suspicion that a different kind of explanation may be required." This does not necessarily strike one as being a weakness. When a hypothesis is falsified, one changes one's hypothesis, and usually one does so until one finds one that is not falsified; as Dawkins (1983, p. 361) puts it: "that is what science is all about!" Dawkins (1983, p. 361) points out that the untestable hypothesis is the "hypothesis of no adaptive function at all". This does not mean that this might not be the truth, merely that one cannot test it. Gould & Lewontin object to the idea of explaining the reason and cause of function, and as such they are attacking the mainstream science model, and not only SB. This is not only due to their objection to natural selection and adaptations being the most focused research guiding theory or principles: "The key to historical research lies in devising criteria to identify

proper explanations among the substantial set of plausible pathways to any modern result" (Gould & Lewontin, 1979, p. 588). This shows the focus of the palaeontologist as much as that of the pluralist. The idea is that if only the adaptationist approach could be falsified, other explanations would be sought out. The continuous reformulation of "adaptationist stories" or functional hypotheses prevents this. Gould (1989) has since then worked on historical contingency, elaborating the effect chance events may have on evolution. This might not be necessary beyond the constraints the adaptationists themselves are aware of (Gould & Lewontin, 1979; Dawkins, 1982; Maynard Smith, 1986; Mayr, 1983; Ridley, 1996). Holcomb (1996) addresses the worry expressed (Gould & Lewontin, 1979; Gould, 1980) that when one at last "concocts" a "plausible story", a theory that makes sense of the data, using the adaptationist perspective one stops there. Holcomb (1996, p. 528) concludes that:

We cannot prove that the theoretical hypothesis is objectively correct in a sense that is not an artifact of skilful mutual adjustment. Given the failure of being able to (inductively) justify or (deductively) falsify a theory, this is the best we can do [...].

Ridley (1996, p. 364), a mainstream adaptationist, is fully aware of the problem:

This method [of moving from one factor to another, making analyses made purely in adaptationist terms], if carried far enough, will almost inevitably find a factor that predicts [the studied hypothetical "adaptation"] correctly. Eventually, by chance, a relation will be found, if enough other factors are studied. One will be found even if [the presumed adaptation] is a neutral character.

The major problem is, according to Ridley (1996), to be able to recognise adaptations, because "[t]he methods of studying adaptations work well *if we are studying an adaptation*" (p. 364, italics in original). The cautionary note being that "[t]he evidence of history, although it may

encourage the study of adaptation, certainly does not prove that all characters are adaptations” (p. 365). Mayr (1983, p. 327) admits that “[t]he attack directed by Gould and Lewontin against unsupported adaptationist explanations [...] is fully justified.” He goes on to point out that in his opinion these are not supplied by modern evolutionists. Ridley’s (1996) modern adaptationist, and in no way perfectionist, claim is that “[p]luralism is appropriate in the study of evolution, not of adaptation” (p. 341) though “[a]daptations in nature are not perfect” (p. 349).

By calling the adaptationist program the Panglossian paradigm, Gould & Lewontin (1979) were perceived as attacking the Modern Synthetic theory. The Panglossian paradigm, or versions of it, have been offered several times prior to Gould & Lewontin’s exaptation of Voltaire’s caricature of Leibniz: Dawkins (1983) refers to a personal communication from John Maynard Smith, in which he recalls that J. B. S. Haldane used Pangloss to debunk group-selection; Gould (1993) quotes William Bateson’s use of Pangloss in attacking early panselctionism. Voltaire used the character Pangloss to caricature the philosophy claiming that “this is the best of the possible worlds”, by twisting it to claim “this is the best possible world” (Mayr, 1983, p. 327). Once one accepts constraints of any kind, the Panglossian paradigm is no longer valid. Adaptationists accept constraints; Mayr (1983, pp. 331-2) describes several constraints “based in part on independent analysis”, and Dawkins (1982) spends a chapter discussing constraints, noting (1983, p. 361) that “constraints on perfection are fascinating objects of study in their own right” (see also Ridley, 1996). Mayr (1983, p. 327) puts it this way: “Selection does not produce perfect genotypes, but it favours the best which the numerous constraints upon it allow.” Mayr (1983) casts constraint-free perfectionism as the pre-Darwinian natural theologian’s *Weltanschauung*; an omnipotent Creator has no constraints, but does not accept that this is the common view of modern evolutionary scientists (see also Eldredge, 1983, for a similar analysis from the other side of the “high table” [Eldredge, 1995]).

The Panglossian paradigm is closely tied to optimality theory, which is understood by some as the idea that an adaptation or organism

is optimally functional (this is either a strawman or an outdated perfectionist stance), by others as the asymptotic value one measures constraints or selection forces against, not a theory to be confirmed or refuted (Dawkins, 1980; Maynard Smith 1983). Dawkins’ (1982) focus of meliorising systems seems to be very close to Gould’s (1993, 312) use of Panglossian, quoting Voltaire: “le meilleur des mondes possibles”. Although Dawkins’ focus is not on the best but on the better design. Dawkins (1976/1989, 1980) even argues that as long as designs are evolutionary stable they are selected for even when introducing strategies, which from an engineering perspective might be better. If it does not manage to disrupt the existing strategy’s stability it is ecologically, and thereafter evolutionary, the worse strategy. One may reconsider the relevance of the Panglossian paradigm attack; it is not the best of all possible solutions, but it may be a solution all the same. Then again, bearing in mind Ridley’s (1996) warning, it may not be. The fact that this is mainstream adaptationism, renders the Panglossian paradigm into a non-relevant attack.

Dennett (1995, p. 239) reveals the identity of the anonymous critic (Dennett, 1983; see also Dawkins, 1983, p. 360) who had first introduced him to Gould & Lewontin’s (1979) article which claimed to have shown adaptationism to be “bankrupt” (Dennett, 1983, p. 351). The nonadaptationist was none other than Jerry Fodor, the proponent of the modularity of mind. Fodor’s claim, according to Dennett (1983, 1995) was that Dennett’s intentional stance was a logical continuation of adaptationism, and thus also intellectually “bankrupt”. This was the impetus which caused Dennett (1983) to write his defence of the Panglossian paradigm, or adaptationism, and thereby the intentional stance. Dennett counters Fodor’s criticism by casting Gould & Lewontin’s perceived nonadaptationism (though the conclusion was “pluralism”) as a continuation of Skinner’s behaviourism, a common target for both Dennett and Fodor.

Skinner’s (1983) reply is interesting as he points out that both natural selection and operant conditioning are “examples of selection by consequences”, though “they have features in common just because they exemplify selection but otherwise represent different biological and so-

cial processes” (p. 377; see section V.III. for a discussion of learning and EP). Lewontin’s (1983) reply focuses on the open pluralistic program, and adaptation versus adaptationism, there being an important difference between accepting other evolutionary mechanisms and denouncing selection.

Dawkins (1983) in commenting on Dennett’s defence of adaptationism concludes that adaptationism never was in need of such a defence; it is a thriving science. The adaptationist program is defended by Mayr (1983), as the mainstream functional inquiry of physiological and other biological phenomena. Williams (1985) defends the reductionist aspects and secures the methodological value of adaptationism. Holcomb (1996) addresses EP specifically, and although he claims EP is not yet science (it is “protoscience”), using the label of Just So stories to reduce scientific credibility is unfair compared to practice in other sciences. The practice dubbed “telling Just So stories” is the standard scientific method of inference. Holcomb (1996) claims: “[EP] has progressed beyond telling just-so stories. It has found a host of ingenious special techniques to test hypotheses about the adaptive significance and proximate mechanisms of behavior.”

There does not seem to be any reason to question the general scientific standard of evolutionary science (Holcomb, 1993, 1996; Mayr, 1983; Ridley, 1996; Williams, 1985), or the scientific standards of the adaptationist foundations of EP (Holcomb, 1996).

#### IV.II. Adaptations versus Exaptations and Spandrels

As opposed to the concepts discussed above, which are used to debunk certain findings and to oppose research traditions and bodies of theory, most notably human SB, the following concepts are attempts at expanding the number of interesting evolutionary structures: spandrels and exaptations.

The concept of the spandrel was first proposed in Gould and Lewontin’s famous 1979 paper *The spandrels of San Marco and the Panglossian paradigm: a critique of the adaptationist programme*. Spandrels are architectural structures that arise as a necessity of structure, but do

not bare any inherent function. Dennett (1995) broadly challenges the idea of nonadaptive structures. He suggests that the architectural concept of *pendentive* would be a more correct name (see Gould, 1997c), and even claims that examples of spandrels that Gould & Lewontin (1979) suggested no-one would propose as primary (i.e. the reason for the design), may indeed be primary (See Gould & Lewontin, 1979, p.582-3; Gould, 1993, p. 334; Dennett, 1995, p. 274). It is not necessary however to suppose that there do not exist nonadaptive structures. Spandrels are defined and understood, within evolutionary theory, by Gould & Lewontin’s (1979) definition: “necessary architectural by-products” (p. 147) and “architectural constraints” (p. 148). “Design” or “structural” may substitute “architectural”. Spandrels are not designed by natural selection; rather they are the result of natural selection operating within the constraints of the given *Bauplan*, the set, possible, pre-existing structure. As Dennett (1995, p. 272) puts it “spandrels are what remains of a wall once you punch an arch through it.” Gould is most often structuralist in his writings (Gould, 1987a), as one would expect from a paleontological perspective; a fossil will, with greater ease, provide data on structure, anatomy, rather than processes or function; physiology and behaviour. The chin is offered as a favourite example. It is not an independent structure; what we call “the chin” is the result of what is called neoteny, the principle of retaining “formerly juvenile characters by adult descendants [...] produced by the retardation of somatic development” (Gould, 1977b, p. 483). The two growth fields, the alveolar and the dentary; which make the jawbone and hold the teeth, respectively, have both been getting smaller through neotenic human evolution. The fact that the alveolar has become allometrically smaller compared to the dentary has resulted in the human chin (Gould, 1977b; Lewontin, 1978; Gould & Lewontin 1979; Lewontin, 1979; Gould, 1993). Note that in order to identify a spandrel one needs to identify the adaptation as well as the developmental constraints or *Bauplan*. The only way of identifying an adaptation is through the adaptationist program.



**Table 2**  
A Taxonomy of Fitness

Process	Character		Usage
Natural selection shapes the character for a current use- adaptation	Adaptation	Aptation	Function
A character, previously shaped by natural selection for a particular function (an adaptation), is co-opted for a new use- cooptation	Exaptation	Aptation	Effect
A character whose origin cannot be ascribed to the direct action of natural selection (a nonaptation) is coopted for a current use- cooptation	Exaptation	Aptation	Effect

Adapted from Gould & Vrba (1982) and Gould (1991).

The other concept, exaptation, was introduced by Gould & Vrba (1982) as a necessary level of analysis of function and structure, not made possible without an available concept to describe it and inspired by the concept of the spandrel (or nonaptation) (Gould, 1993). Gould & Vrba (1982) define exaptation as “such characters, evolved for other usages (or for no function at all), and later ‘coopted’ for their current role” (p. 6). See table 2. They follow Williams (1966) classic division between function, what natural selection has designed the adaptation to do, and effect, something caused but not selected for (see section III). The non-functional characters are spandrels. Also they saw this as a contribution to the solution of the problem of preadaptation. The idea is that the word implies foreordination, which is unacceptable. If one changes between different function and effect it becomes meaningless to claim that the former was a preadaptation to the latter. Gould & Vrba (1982) also address nonaptations (spandrels), and the article continues the challenge against the adaptationist program. The result is that several (functional) adaptations, which are effective in aiding current

survival and reproduction in an other way than that they were originally designed for, are re-named as exaptations. However most characters have had such varied “function” historically. Ridley (1996, p. 348) in commenting on this claims that:

[M]ost study of adaptation is not concerned with the past history of function changes, but with how natural selection maintains the adaptation in its modern form. [...] Biologists studying current function of organs are not obliged to show that the organ has always served the same function.

However, he accepts that “organs undoubtedly can change their function during their history, and the reason why natural selection is maintaining an organ now may not be the reason why it initially evolved” (p. 348). This seems to be a focus on adaptiveness, and that may not be a problem; Wilson’s (1975) methods were good enough for studies on animals that were under selection pressures similar to those that had shaped them. Humans are not. Thus one may call any modern human mental mechanism an exaptation if the modern human environment is not adequately consistent with the EEA, but in considering the mechanism that evolved due to the selection pressure of the EEA one is conceptually considering an adaptation. Thus in referring to the mechanism that is causing the behaviour, whether it is adaptive or not, one is referring to an adaptation. However if it almost invariably increases current fitness it is either a recently evolved adaptation (unlikely) or it may be called an exaptation (Gould, 1991).

The interesting point, from the elusive exclusively adaptationist point of view, is that both spandrels and exaptations are offered as complementary levels of analysis: adaptations still play a major role (Gould, 1993). This is pluralism. But an exclusively adaptationist point of view is most likely not the mainstream perspective (Mayr, 1983; Eldredge, 1983); thus all are pluralists and constraints are accepted by all, as well as the power of historical contingency. The question ends up being one of relevance, and to the adaptationist natural selection is the only evolutionary force able to produce complex

functional design (Dawkins, 1986/1991). Whether this design is actually doing what it originally was selected/ designed to do or not, is beside the point; that would be framing adaptations in the adaptiveness mode of thought (see section II). Phyletic new environmental input will cause novel output from the proximate mechanism (the adaptation) which may or may not be functional, or adaptive, ultimately speaking, though an effect will be found (Williams, 1966; Gould & Vrba, 1982; Ridley, 1996).

Tooby & Cosmides (1990a, 1995) follow this mode of thought when analysing the outcomes of selection: adaptations, concomitants of adaptations and noise. This is an adaptationist account of evolution, and one that most evolutionists would probably accept as uncontroversial. It is not “panselectionist”, it allows for certain non-adaptive structures, yet it is neither “pluralist” enough to fit that label. Maybe this is due to adaptationism not being panselectionism, because the description of the panselectionist is a non-existent caricature. The great difference may be more a question of focus and interest of study, and a result of Weismann’s Mendelism being such a forging influence on the Modern Synthetic theory. This only allows room for “pluralists” to expand evolutionary theory. It does not falsify the existing theory by default.

So far the discussion has focused on adaptationism as it pertains to the foundations of EP, but debated mostly within biology. Lately the discussion has entered psychology proper. Gould (1991), *Exaptation: A Crucial Tool for an Evolutionary Psychology*, is an attempt at advocating his own version of evolutionary psychology; he does not discuss EP. He does mention Pinker’s mental mechanisms, in passing, but keeps to the Fodor (1983,1985) line that perception is modular, but consciousness is not (Gould, 1991), and chooses to use Chomsky’s version of language, as an example. I find that the lack of discussion of the existing theoretical body of EP puts Gould at a disadvantage. His discussion is still being framed against SBs (Gould, 1991), much on their terms as when Gould offers the spandrels of language or modern warfare without explaining what kind of mechanism may be behind it. By defining the evolved product of modern warfare as an unspecified, presupposed, structure, Gould (1991) is close to committing

the fault of reifying the behaviour (Gould, 1981), and only claiming *it* is not an adaptation (as EP would agree with) will not help. Gould (1991) claims that “Those characteristics we share with other closely related species are most likely conventional adaptations” (p. 61). That may be true, but he does not explain why, or list these likely adaptations. This opposes EP’s focus on species-typical adaptations; EP defines the species or special Human Nature as the species-specific collection of adaptations. On the other hand, Gould (1991) claims that our species-specific traits are more likely exaptations. Gould (1991) lists many of the reasons that Pinker & Bloom (1992), Gazzaniga (1992) and Pinker (1994, 1997b) use to show that language shows special, complex design (Williams, 1966; Dawkins, 1986/1991), and that language is an adaptation. Pinker & Bloom (1992, p. 486) after discussing whether language is better explained as an exaptation or an adaptation based on a Chomskian interpretation of data, but adding a computational theory/ ultimate level explanation (see section III) conclude:

[H]uman language, like other specialized biological systems, evolved by natural selection. Our conclusion is based on two facts that we would think would be entirely uncontroversial: Language shows signs of complex design for the communication of propositional structures, and the only explanation for the origin of organs with complex design is the process of natural selection. Although distinguished scientists from a wide variety of fields and ideologies have tried to cast doubt on an orthodox Darwinian account of the evolution of a biological specialization for grammar, upon examination none of the arguments is compelling.

Gould’s (1991) conclusion is that language is an exaptation. Exaptations come in two forms: co-option of spandrels or of adaptations, the latter being close to the old concept of preadaptations, thus have an inherent function that has lately (evolutionary speaking) lost this function and acquired an effect. The spandrel would be non-functional from the start, and would be the more structuralist alternative. By suggesting that the

brain grew for an unknown adaptive reason, and even by offering what could hardly be anything but a Just So Story (sic!); though one of structural effect not cognitive function, Gould (1991, p. 62-63) is defining the resulting co-optable features of this structural change as spandrels. Language is considered a likely spandrel of brain growth, and a likely reason for brain growth is that the brain is a “radiator”, an “efficient cooling device” needed to protect against the “intense solar radiation of savannah habitats” favoured by our ancestors (Gould, 1991, p. 62). Why should this be a likely or even good interpretation of data? Gould concludes that this is a less threatening construct “for those feeling the breath of biological imperialism” (Gould, 1991, p. 63). It is also “opposed to the conventional Darwinian account”; it is “quirky and unpredictable”, “contingent”, and “discontinuous”, all in all almost impossible to use for scientific investigation. Though the pluralist alternative was originally presented as being able to “put organisms, with all their recalcitrant, yet intelligible, complexity, back into evolutionary theory” (Gould & Lewontin, 1979, p. 597)- note the word “intelligible”, pluralism does “not offer a council of despair [...] for non-adaptive does not mean non-intelligible” (p. 597). Thus exaptation ends up being a tool for not accepting EP; it is an argument for the position that any causal or functional analysis is impossible, unless one wants to study physiology. This may be considered a modern version of dualism (although that attack has been aimed at “adaptationism” too, see Oyama [1991]).

Gould (1991, p. 48-49) starts off with two opposing positions for accepting an evolutionary psychology: the brain might be “altered and enlarged under natural selection”, but “adaptationism” is the base of “dubious social behaviors” like “colonial expansionism”, “industrial exploitation” and “modern sexism”. Thus, though Gould wants an evolutionary psychology, he cannot advocate adaptationism. The remaining alternative is therefore to “seek a more adequate evolutionary version” (p. 49). This version is what Gould (1991) is attempting to formulate. In this version adaptations are not interesting when considering Human Nature, or current human behaviours, because spandrels “determine the design of the ‘main’ structure” and “exapta-

tions must greatly exceed adaptations in number and importance” (p. 55). One can be tempted to conclude that Gould believes that there never was a reason why the mind would evolve, only the physiologically framed version of the brain, also that there never was a strong selection for adaptations that were better at solving survival and reproduction problems cognitively. This sounds very unlikely, given the intra-species arms races (Dawkins & Krebs, 1979; Dawkins, 1982) that would cause an exaptation of these spandrels and thereafter adapt them through selection, once they were present, for surely it must be possible for natural selection to adapt exaptations.

Recently Buss, Haselton, Shackelford, Bleske & Wakefield (1998) have published a response to Gould’s (1991) alternative. They react to the definition of the exaptation as enhancing current fitness, as this does not explain why it arose (Tooby & Cosmides, 1990b) and adaptiveness is not an interesting focus for explanation, unless the environment of current adaptation is similar to the EEA (see sections II & III). The functional analysis of evolutionary explanation focuses on why a trait exists, not the current effect it has in interacting with the environment (Buss et al., 1998). Buss et al. (1998) discuss several of the terminological and conceptual confusions due to theoretical inconsistency in Gould & Vrba (1982) and Gould (1991). Their conclusion is that there is utility in the concept of exaptation. In focusing solely on Gould & Vrba’s fitness enhancing definition, Buss et al. (1998) catch Gould & Vrba’s concept of exaptation in the functional, evolutionary analysis of EP; which in itself proves to be a mature and effective analytical tool - the point I find most interesting with the discussion. They also show that Gould’s (1991) proposed exaptations of writing and reading are too new historically be co-opted by natural selection. Thus these activities must be a product of or co-opted by existing human mechanisms. I would like to add that since Buss et al. (1998) specifically focused on the fitness enhancing criterion of exaptation, it is surprising how effortlessly they were able to disqualify several of Gould’s (1991) examples of exaptations by invoking that criterion. The important point is that Gould (1991) lists several proposed exaptations, without these being in any

way analysed as fulfilling the criteria of exaptation (Buss et al., 1998). Buss et al. (1998, p. 546), after accepting the value of the concepts of exaptation and spandrels, further highlight the fact that in order to call a trait either an exaptation or a spandrel one has to identify an adaptation:

Although all three concepts require documentation of special design for a hypothesized function, co-opted exaptations and spandrels carry the additional evidentiary burdens of documenting both later co-opted functionality and a distinct original adaptational functionality. To our knowledge, none of the items on Gould's (1991) list of proposed spandrels and exaptations- language, religion, principles of commerce, warfare, reading, writing, and fine arts- have met these standards of evidence. Moreover, even if they did meet such standards, this would in no way diminish the need to place such items within an overall evolutionary framework in order to adequately understand and explain them- a point agreed in by all sides of these debates.

I find that Buss et al. (1998) take advantage of the understanding of function, which is ultimately connected to differential gene replication or inclusive fitness, and apply it to the definition of co-opted spandrels (or nonaptations) and adaptations as exaptations, which do not have function, they only have effect (Gould & Vrba, 1982; Gould, 1991; Williams, 1966; Ridley, 1996), in such a manner as to allow for an adaptationist analysis. This results in a correct semantic analysis, but I consider that it misses the intention of Gould (1991). See table 2. Buss et al. (1998, p. 539) are aware of the different definitions in Gould & Vrba (1982) and Gould (1991), and I agree with Buss et al. (1998) that the conceptual problem lies with Gould & Vrba (1982) and Gould (1991). But in their attempts to solve the confusion that arises Buss et al. (1998) focus exclusively on the quote that exaptations are "features that now enhance fitness, but were not built by natural selection for their current role" (Gould & Vrba (1982, p. 4; Gould, 1991, p. 46). This causes exaptation to be rendered solely as an

adaptationist concept. I find Buss et al.'s (1998) analysis important, but too willing to co-opt exaptation as an adaptationist concept; it specifies much the same problem I find with Gould & Vrba's exaptations, but does not make enough of the lack of conceptual consistency. My initial problem with exaptations is this: Are they or are they not potentially designs for later selection? I cannot see how these traits can escape this. Their effect is, to at least some extent, due to genetic makeup, as much as any other biological trait. Thus, as they currently are enhancing fitness, they are causing a differential replication of the genes for the trait, and thus effectively an exaptation by definition is only a passing concept. Gould (1991) claims that an exaptation may be redesigned by secondary modification. He calls this "superimposed, true adaptation" (p. 47). All the same he claims this "tinkering does not alter the primary status of such a structure as coopted rather than adapted" (p. 47). So due to some trait changing from having biological, ultimate function to having current effect it is no longer an adaptation but an exaptation, even though it has been redesigned by natural selection (sic!) in order to be "effective" and "it enhances fitness"(sic!). One might conclude that renaming the structure and removing the function is the main objective; there are no important adaptations, and thus adaptationism is bankrupt. Consider Gould's (1991) own example: "the elaborate plumages and behavioral displays of male birds of paradise are true adaptations for mating success" (p. 47). Feathers in birds were by Gould & Vrba (1982) already defined as exaptations for flight, as Gould points out in the paragraph preceding the quote; previously (or originally) the function of feathers was thought to be thermoregulation (Gould & Vrba, 1982; Gould, 1991). Gould has allowed for "tinkering", selection (sic!), to make thermoregulatory adaptations effective exaptations for aerial locomotion, but not adaptations for aerial locomotion; although the elaboration of the same thermoregulation in order to mate successfully is not considered a change in function, or an exaptation, but is given status as an adaptation. I consider these inconsistencies in Gould's conceptualisation of the exaptation to be important enough to postpone use of the concept until it is possible to differentiate between effect and function (Williams, 1966;

Ridley, 1996), and to specify what kind of selection or how much selection is needed in order to be able to accept the character as an adaptation again. Of course, if Buss et al.'s (1998) reformulated conceptualisation is incorporated into adaptationist thinking, then this might have certain value.

My conclusion is that by entering the psychological domain as an evolutionary theorist, as he has done previously; with splendour (Gould, 1981), Gould is also inviting psychological analysis of evolutionary theory. From within psychology, Buss et al.'s (1998) response, proves the academic maturity of EP's adaptationist theorising. The theory of evolution is becoming ever more interdisciplinary within the life sciences.

#### IV.V. Summary and Conclusions

Both sides have a tendency to refer to Darwin's *Origin* (1859/1996) or later works to argue that their position is orthodoxy (Gould, 1993), although Gould, critical of this on the one hand, often seems in his essays and articles to do this most explicitly, offering the "correct" interpretation of Darwin's work (Gould & Lewontin, 1979, p. 589; Gould, 1993, p. 312; Gould, 1997a, 1997b). The Modern Synthesis depends on Darwin being wrong or agnostic about processes of heritability and genetics. Gould invokes Darwin's own call for pluralism, but as critics of Darwin's brand of pluralism point out Darwin included almost any current theory in addition to his own in order to withstand the criticism of his ideas. Gould & Lewontin (1979) even make a point that they do not "regard all of Darwin's subsidiary mechanisms as significant or even valid", though they advocate his "attitude of pluralism in attempting to explain Nature's complexity" (p. 590). One may claim that the attitude of pluralism was a forced move in order to protect the theory of selection, due to the lack of a theoretically acceptable theory of heredity, as Darwin's own theory of heredity would not allow for selection to work (Dennett, 1995; Ridley, 1996). A move that no longer was necessary with the re-discovery of Mendel's work by August Weismann in the early 1890's, thereby allowing Weismann and Huxley's "panselctionism" rather than "pluralism" (see Gould, 1993).

Criticism of certain concepts, and the addition of others, is obviously necessary when developing a body of theory, and as the major critic of modern evolutionary theory Gould has performed an admirable service. This being said; most of his major points are either assimilated or rejected in major articles within evolutionary science, and as such a new theory does not seem warranted, though additional work on macroevolutionary phenomena and developmental theory is needed (Williams, 1985; Maynard Smith, 1986).

The adaptationist program seems empirically and methodologically secure, as the mainstream evolutionary scientific approach. As such, any evolutionary psychology would be well advised to primarily attempt to develop within this framework, before attempting to expand it.

#### V. Demarcation and Inclusion: EP and Three Important, Wrongfully Perceived Paradoxes

This section attempts to address three perceived paradoxes of EP. First, as a theory founded on the Modern Synthetic theory, it is ultimately based on genetics. Unlike the adaptiveness-oriented SB, adaptationist EP does not share the focus of behavioural genetics. Adaptations have close to zero heritability, whereas behavioural genetics study behaviour that has high heritability. Second, a commonly accepted influence of Darwinism on psychology is the use of comparative studies, due to the explanation of accepted common features of all animals. EP is more restrictive than mainstream psychology in this respect, focusing almost exclusively on species-specific or species-typical adaptations, which as a system define the species. Third, there is a perceived paradox between focus on adaptations (the innate behaviour modifying mechanisms) and learning. This is not a problem within EP. Environmental factors are considered vital to the development of any adaptation and constitute the input for mental mechanisms to process and return as behavioural output. An exposition of these three topics is necessary in order to understand fully the implications of EP's theoretical foundations for psychology.

## V.I. EP versus Behavioural Genetics

Behavioural genetics (BG) addresses “the genetic and environmental sources of differences among individuals” (Plomin, 1989, p. 105; see also Bouchard, Lykken, McGue, Segal & Tellegen, 1990, p. 228), not human universals or differences between gender-groups or other groups. EP addresses Human Nature as expressed through mental adaptations, where genetic differences among individuals will be considered “perturbations in these mechanisms” (Tooby & Cosmides, 1990a, p. 18), due to the likelihood of random genetic change increasing entropy. Thus EP does not address differences between human groups, with one exception: gender-specific adaptations (Tooby & Cosmides, 1990a; Gaulin, 1995; Buss, 1995a).

Bailey (1998), considering the possibility of reconciling the differences between EP and BG, focuses more on the possibility of significant genetic variance between group differences than either Plomin or Cosmides & Tooby. The lack of interest in differences between groups due to genetic-variance in Plomin’s BG or Cosmides & Tooby’s EP is not the exclusive theoretical stance within psychology, there is a tradition for this focus within psychometrics dating from Francis Galton via Arthur Jensen to Herrnstein & Murray’s (1994) *The Bell Curve*. The focus in this section will be the difference between EP and BG in accepting traits with significant heritability as significant targets for scientific enquiry.

Adaptations are created through the selection of the better combinations for survival and reproduction given the existing selection forces and genetic variance. Genetic variance is depleted during selection, as the fitness enhancing genes out-compete their less fitness enhancing alleles. There do exist cases where there is a frequency dependent selection for different alleles. These are called polymorphs, and may be understood by applying the ESS-model, where the frequency of the different strategies as a system is evolutionary stable and thus adaptive (Dawkins 1980, Maynard Smith, 1979). Bailey (1998) looks at several other mechanisms that may maintain genetic variation, like antagonistic pleiotropy, but admits that most of these are controversial among adaptationists.

An adaptiveness-oriented approach to existing genetic variance, which does not “underestimate the power of natural selection”, will explain this variance as a result of current conditions - or vice versa: current conditions cause the existing genetic variance. This leads to the idea that an evolutionary approach to Human Nature is a biological determinist, political statement about current socioeconomic differences, advocating the naturalness and *status quo* of existing inequality (Rose et al, 1984).

BG is not committed to an adaptiveness-oriented approach, but has been inspired by and is theoretically compatible with SB where existing genetic variance is considered adaptive. The major theoretical difference between BG and SB is the unequal focus on explaining the variance as a result of selection forces or not, as well as the focus on differences between groups. Within BG one does not object to the idea of genetic variance that modifies adaptations being adaptive (Bailey, 1998). This may easily be confused with adaptiveness-oriented approaches, but is not necessarily similar, the difference being that the adaptive variance need not be selected for the here-and-now environment - rather selection has caused the variance in evolutionary time.

EP’s approach to genetic variance is quite different. Tooby (1982) addressed the variance from an immunological point of view as well as attempting to explain the evolutionary paradox of sexual reproduction. Sexual reproduction without genetic variance is pointless, but any gene has only a 50% chance of being passed on to next generation (at each successful mating), and the individual’s genotype is lost, as well as a functional design that was a product of that specific genotype (in that specific environment). Tooby & Cosmides (1990a) claim that “sex is clearly an adaptation” (p. 31), so there must also be benefits, not only cost. Tooby’s (1982) answer is that sexual reproduction and genetic variance (which does not disrupt design monomorphism) both are evolved defences against pathogens. Pathogens evolve at a higher rate than humans, or other large, longevous animals; they may therefore evolve to crack the immunological code of the larger organism, unless this code is constantly different due to genetic variance and sexual reproduction. The same arms race (Dawkins & Krebs, 1979) may

be observed between bacteria and human-designed antibiotics; the antibiotic has a certain biochemical effect, and unless it is changed the bacteria will evolve resistance. Thus “noise” or superficial variance is adaptive, especially in longevous species. Tooby & Cosmides (1990a) offer this as the explanation to “the paradox of design monomorphism in a world of genetic polymorphism” (p. 30). Variance in the genotype of adaptations is thus superficial; it does not affect the adaptation in an ultimate functional manner, although it may be measured by genetic research. Also, if Tooby (1982) is correct that parasitism is a major selection pressure, then one will have a frequency dependent selection causing the more common allele to become maladaptive, and the more superficial variation (accumulation of genes that differ biochemically, but give rise to the same design) will accumulate at different loci. One may note that the interaction of these “reserve” genes may be potential variance for later selection, even though they when they became a part of the gene pool “coded” for similar designs. Tooby & Cosmides (1990a) refer to Rose et al. (1984), who note that the major variance is between individuals and not between geographical populations, in order to substantiate their claims (an unusual and refreshing fraternisation with the anti-adaptationists, worth noting). Tooby & Cosmides (1990a, p. 35) sum up the potentially surprising finding of genetic variance among humans thus:

Human groups do not differ substantially in the types of genes found, but instead only in the relative proportions of those alleles. Eighty-five percent of human genetic variation is within-group variation, 8 % is between tribes or nations within a “race,” and only 7 % is between “races” [...] This result [...] is consistent with the pathogenic theory: People catch diseases from their neighbors, so it is important to be genetically different from them...

Note that the idea of human “races” becomes meaningless, a point taken by EP: “There is no structured genetic substrate separating human groups discretely into different kinds” (Tooby & Cosmides, 1990a, p. 35). Tooby & Cosmides (1990a) conclude that as selection eliminates

variation, adaptations are therefore structures that have a genetic base, but no or low heritability, as defined within genetics. Humans do not vary qualitatively in their cognitive architecture. Mental mechanisms, as adaptations, are monomorphic, although EP accepts quantitative variation (Tooby & Cosmides, 1990a).

As mentioned above there is one between-group effect that receives attention within EP: gender differences. Gaulin (1995) argues that evolutionary theory predicts sex differences in the brain; such differences are caused by sexual selection (Darwin, 1871/1981) a result of different reproduction-problems between the genders. Apart from the Y-chromosome, all genes have been equally present in males and females through phyletic history. The key to differentiation is therefore the affects of the Y-chromosome, which carries the gene called testes determining factor (TDF). The testes produce androgens, which literally turn the foetus into a male, by affecting the autosomes “environmentally”. Gaulin (1995, p. 1214) concludes:

In this way, genes that only one sex carries (genes on the Y) produce a signal of sexual identity for the rest of the genotype. Against this reliable background signal, selection has apparently constructed a wide array of modulatory mechanisms that restrict the expression of sexually competitive traits to the sex where they will produce the net benefit.

EP’s stance is thus more restrictive than the adaptiveness-oriented approach, as environmental differences will be expected to be influential and only adaptations predicted by survival or reproduction-problems in the EEA of these traits are addressed.

BG has documented the influence of genetic and environmental variance on a large array of human behaviours (Plomin, 1989; Plomin, Owen & McGuffin, 1994; Plomin, DeFries, McClearn & Rutter, 1997; Bouchard et. al. 1990; Bouchard, 1994; Bouchard, Lykken, Tellegen & McGue, 1996; Bailey, 1998). This approach to the study of humans has been controversial for years (see Rose et al., 1984), but Bailey (1998, p. 219) concludes: today it is not interesting “re-

jecting the null hypothesis that heritability is equal to zero.”

The fact that EP, as a theory of inherited (genetically based) Human Nature, does not address those traits that have high heritability and which are focused on by BG may be potentially surprising. The near zero heritability demand is due to the theoretical resistance to viewing genetic variation as adaptive, as natural selection will reduce variation in designing the adaptation through the effect of differential rates of reproduction. The lack of overlap between the scientific focus of BG and EP is due to their initial disagreement on whether genetic variation is adaptive or not, and due to one describing individual differences in the present and the other predicting universal Human Nature due to evolutionary principles.

Bailey (1998) questions whether this independence or opposition of focus may be scientifically resolved, focusing on the reluctance within EP to address the substantial invariably found variation, which BG has shown to be, to a large extent, genetic in origin. Bailey (1998) observes that EP explains variance in traits due to environmental variance, but advocates consideration of the question of how particular behavioural variance is adaptive. This would be the first step in distinguishing “empirically between adaptive genetic variation and a universal Human Nature’s contingent responses to different environments” (Bailey, 1998, p. 226). This question may appear to focus on current behaviour being adaptive, rather than the pattern of environmentally contingent behavioural responses which may be used to infer the existence of a mental mechanism - the adaptation. As such it would not bridge the theoretical cleft between EP and BG, but rather be an expression of the more familiar theoretical and empirical connection between psychometric-traditions, adaptive-ness-oriented human SB and BG.

Bouchard (1994) quotes Charles Darwin as evidence of the age of the idea of genetic influence on behaviour, including personality. Darwin (1871/1981) addresses transmission of traits that define the species or breeds of domesticated animals. Darwin, as he most likely had not read Mendel’s work (he owned a copy, but left the pages uncut), is not really talking about “genes” and in the quote offered by Bouchard

variance is not a point; the traits mentioned are inherited but need not have greater than zero heritability due to selection (in the case of domesticated animals this would be artificial selection, on top of previous natural selection). Thus quoting Darwin does not address the question whether the BG approach to personality is interesting or even if genes are the mechanism involved.

Bouchard et al. (1990, p. 228) identify the interface of BG and SB as “the question of the origin and function, if any, of the within-species variability” discussed within BG. Bouchard et al. (1990) do not differentiate between SB and EP. The question continues to be whether genotypic variance is noise or adaptation, and is the phenotypic variance noise or adaptation. Bouchard et al. (1996) attempt to provide an answer. They start by questioning the EP point of view of natural selection having designed mental adaptations in the same manner as our physiology, which “is monomorphic within a functional design” (Tooby & Cosmides, 1990a, p. 29). Bouchard et al (1996) claim that identifying physiological adaptations that are phylogenetically ancient, characters of the mammalian line or earlier, and comparing them with the more recent human mental adaptations, allows one to question whether selection has had time to fix the mental adaptations genetically, or if “most of them are in a transitional phase” (p. 32). The logic of Bouchard et al. (1996) slips a little when they thereafter compare the genetic variance of mental adaptations with physiological adaptations in order to question whether the variance is superficial or not; the monomorphism of the phyletic older traits was an accepted benchmark, a likely fixed trait, used to question the fixation of mental adaptations. Second, the “ongoing selection” hypothesis and the “adaptive effect of genetic variance as a means for adaptation” arguments are offered. The former as an opposition to the idea of one, monomorphic, Human Nature, and Tooby’s (1982) theory of the adaptive effect of sexual reproduction as a defence against parasites in longevous species. In such a framework, some genes are *better* than others, and populations *will* differ in respect to mental abilities and functioning due to genetic differences. The latter argument is teleological. The variance may not exist in case of specific



change, but a greater mutation rate may be selected for, as long as it does not become maladaptive (the design must not be subject to too much entropy, it must replicate with a high enough fidelity in order to ensure a relatively stable transmission). EP's perspective is that any genetic variance, which does not affect adaptations, is superficial variation, and attempts therefore to discover phenotypic design patterns, which due to their nature as adaptations are expected to be monomorphic. Bouchard et al. (1996) conclude that the fundamental thrust of EP is correct (that is EP's theories of modularity and origin of mental traits), but they also quote their earlier conclusion regarding BG's relevance to EP: "If genetic variation was evolutionary debris at the end of the Pleistocene, it is now a salient and essential feature of the human condition." (Bouchard et al 1990, p. 228).

The differences between EP and BG are mainly issues of focus and method, to cite Plomin et al. (1997):

[I]nvestigating the causes of average differences between species, which is the focus of [EP], is a different level of analysis that asks questions and gets answers different from those asked and received in investigation of the causes of individual differences within species, which is the focus of [BG].

If EP is to be evolutionary and adaptationist then EP's must focus on evolutionary time, the selection pressures of a statistical composite like the EEA, and predict adaptations that are universal for all humans, or specific to gender (or any group that has had statistically stable, different survival or reproduction problems over evolutionary time, which is why gender-specific adaptations may exist). Thus actual here-and-now differences in grade will not be evolutionary predictable. However, genetic variance will be predicted due to mutations and the nature of meiosis and sexual reproduction. What also may be predicted is the fact that variance in itself may be adaptive, and has been so for as long as sexual reproduction has existed. A genetic variance discovered in BG to be large enough to be significant will not necessarily be evolutionary pre-

dictable or universal, and need not be explained as adaptive.

## V.II. EP versus Comparative Psychology

The common origin of all life, explained by Darwin's *Origin* (1859/1996), is the major theoretical foundation for comparative studies. Among the shared traits of all living creatures (Skinner, 1983), psychology has focused on the general principles of learning. The focus on species specific responses grew out of the behaviouristic research on what was originally presumed to be general and plastic, but which proved to be governed by each individual species predispositions. The implications for learning will be elaborated further below.

So far the terms "species-specific" and "species-typical" have not been discussed. "Species-typical" would be an adaptation that defines a species, a species' universal trait. "Species-specific" demands more attention, as many adaptations are shared by many species. Within evolutionary theory, the concepts of "homology" and "analogy" are used to differ between perceived similar adaptations. A homology is a "[c]haracter shared by a set of species and present in their common ancestor" (Ridley, 1996, p. 665), there is therefore reason to believe that the (in the case of psychology) neurological structure and genetics are relatively similar. An analogy is a "[c]haracter shared by a set of species but not present in their common ancestor" (Ridley, 1996, p. 665), and there is no reason to believe that the neurological structure or genetics need be similar. Thus a species' adaptation may be genetically equivalent, or approximately equivalent due to certain changes, and although this prevents a single adaptation truly being species-specific *an sich*, the coadapted system of adaptations may be. Also, species facing similar survival or reproduction problems may evolve similar adaptations to solve the problems - as such the evolutionary adaptationist comparative model is a theoretically rigorous approach to inter-specific studies.

One example of this approach is Gaulin (1995) who describes how one may use the adaptations discovered in one species to predict adaptations in another species that faces similar survival or reproduction problems. Note that the

reason why the comparative approach is theoretically valid is not the idea that the adaptations are homologous but that they solve similar survival or reproduction-problems.

Preuss (1995) argues how the idea of similarity and continuity within neuroscience in regard to representative neural architecture is opposed to modern evolutionary theory, where “[t]he changes organisms undergo in evolution represent departures or deviations from an ancestral condition, rather than different expressions of a common type” (p. 1230). Preuss (1995) concludes that a “review of the literature suggests that mammalian brains display a number of remarkable variations, at several levels of organization” (p. 1231). The existence of neural diversity implies that non-human species may have evolved mental mechanisms that did not evolve or have been lost in humans (Preuss, 1995), just as we have evolved human-specific adaptations.

Tooby & DeVore (1987) offered the same line of argumentation in order to explain why modelling human evolution by course of representative modelling would be invalid *per se* unless based upon a rigorous conceptual model (See section III). This extends a special status to humans, but not more special than other animals; we are special in encompassing our particular integrated system of adaptations and we remain products of evolution.

Due to this, EP ends up being interested in typical species-adaptations, which as a co-adapted system will be species-specific. This prevents EP from committing the more hazardous inter-species generalisations for which Wilson (1975) and other SBs were notorious. At the same time a description of the different species’ EEA may predict analogous adaptations, and as such provide information about possible adaptations one may expect to find in a specific species based upon knowledge of the adaptations of another species.

### V.III Learning and EP

Gould<sup>1</sup> & Marler (1987a) heralded the idea of the priority of innate factors for learning, in their article *Learning by Instinct*. They did so at the

expense of what they deemed an exclusively environmentalist discipline: behaviourism. This caused a certain debate, as Todd (1987a, 1987b) disagreed with the validity of Gould & Marler’s (1987a, 1987b) historical and theoretical description of Behaviourism. Gould & Marler’s contributions to this debate were fuelled to a certain degree by the negative responses that Garcia (1981) describes his work, on the constraints of learning, received from journal-editors.

The priority of innate factors for learning does not mean that learning is not important when explaining behaviour. It does mean that an organism cannot learn without biology. Learning itself is something a living organism is capable of doing due to being a living organism (see Skinner, 1983). As Öhman, Fredrikson, Hugdahl & Rimmö (1976) point out, the evidence that biological constraints exist has come from within learning psychology (e.g. Garcia & Koeller, 1966; Bolles, 1970; Seligman, 1971, Seligman & Hager, 1972; Öhman et al., 1976). The organism is predisposed to learn specific responses, and may be unable to learn others, due to no existing neural potential within the organism to perform certain tasks. Potential is as much a question of hardwiring as plasticity and size (for contrast see Gould, 1991, on brain size and function). There are biological constraints, as well as predispositions, to learning.

Williams (1985) argues for the stringent, antimentalistic behaviouristic language within animal behavioural ecology studies, although Dawkins (1981, 1983) and Dennett (1983) advocate the opposite stance. Behaviourism has since merged to a great extent with cognitive psychology both within the experimental domain, e.g. Rescorla’s (1988) focus on stimulus as information, and the clinical domain, e.g. Kanfer & Phillips’s (1970; see also Mash & Terdal, 1988) SORCK model. This allows for the language of biology to follow up the cognitive shift without having to worry about the scientific value of the new cognitive terminology. The merger of all three traditions influences EP - evolutionary ethology, contextual learning psychology and modular cognitive psychology.

Learning, predispositions and domain-specificity may explain the ontogenetic development of adaptations, the calibration of mental-mechanisms, and the re-setting of the same

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<sup>1</sup> NB! James L. Gould, not Stephen Jay Gould.

mechanisms in examples like phobias and anxiety (see section VI.II.).

Todd (1987a, 1987b) wants to preserve behaviourism, and claims behaviourism already is informed of the synthesis Gould & Marler (1987a) are heralding, thus adding Garcia to the behaviouristic tradition. Gould and Marler (1987a, 1987b) are opposing what they perceive as an overly environmentalist tradition within learning, and want to shift focus to the innate biological constraints and predispositions for learning. The survival of behaviourism (Todd, 1987b) is hardly a point in it self, as the ideas and theory the research programme has borne are durable truths of the science of psychology. Hypothesising equipotentiality allows research to attempt to falsify this idea, it could not falsify a research program attempting to “discover the rules of learning” – however, uniting research programs and creating synthesis might naturally lead to a lessened necessity for “sectarian” labels; “learning psychology” ought to be adequate. Since Seligman & Hager’s (1972) *Biological Boundaries Of Learning* learning psychology has been biologically informed, just as ethological perspectives to behaviour are informed by learning psychology (Houck & Drickamer, 1996).

The step EP is calling for is that the findings of learning psychology also apply to cognitive psychology; the modularity, species-specificity, and biological preparedness of mind, mirror the way certain species solve their survival and reproduction problems, also when the adaptation needs contextual input, learning and development. EP advocates the abandonment of the false dichotomies of “nativist” vs. “environmental”, “biological” vs. “social”, “genetic” vs. “environmental”. As Tooby & Cosmides (1992, p. 87) claim: “All ‘environmentalist’ theories necessarily depend upon and invoke ‘nativist’ theories, rendering environmentalism and nativism interdependent doctrines, rather than opposed ones.”

#### V.IV. Summary and Conclusions

While most of the false expectations to EP’s stance to these three topics are due to a popular knowledge of adaptiveness-oriented SB, the reason why EP does not take the expected stance is

based upon knowledge from the psychology of learning, both ethological studies and mainstream behaviouristic studies, as well as the developing theoretical body within both evolutionary biology and psychology proper.

EP is interested in the human species’ specific coadapted system of adaptations. To the extent that particular survival and reproduction problems have differed for males and females, gender-specific adaptations are expected to have evolved; these will have to be tied to Y-chromosome effects. Human adaptations are considered universal to the human species. Thus there is little or no focus within EP on genetic variance between individuals, as long as it does not disrupt adaptations. Comparative studies and inter-specific generalisations are not the favoured. This lack of overlap of interest between EP and BG, and comparative, studies may initially seem paradoxical, and the aim of this section has been to provide the theoretical argument for the differing interest.

Just as one would expect EP to be compatible with BG and comparative studies, one might expect EP to be in opposition to general learning theory. The fact that EP is inspired by discoveries within learning and is focused on environmental input for the development of adaptations might be perceived as paradoxical by some. There does not appear to be any reason for a conflict between EP and learning. Rather the findings of biological preparedness and modularity found in learning psychology may inform the study of mind.

Much of the criticism toward earlier Darwinian oriented approaches to Human Nature and behaviour is dissolved within the mature theoretical framework of adaptationist EP. Whether EP is a new school of thought, which would cause a shift of paradigm within the science of psychology, or a comprehensive reorganisation of existing biological and psychological empirical findings and theory remains to be seen. This is the theme of the next section: a look at EP’s effect on academic psychology.

#### VI. The Influence of EP on Academic Psychology: A Scientist-Practitioner Perspective

The following section will briefly consider EP’s influence on mainstream academic psychology,

before illustrating the theoretically unifying potential of EP on academic psychology, as well as practice, through a more detailed look at clinical psychology, or Evolutionary Psychopathology (EPP).

### VII. EP's Influence on Mainstream Academic Psychology.

**Cognitive Psychology.** Cosmides & Tooby's (1987, 1992, 1994a, 1994b, 1995, 1997; Tooby & Cosmides, 1995; Cosmides, 1989; Tooby, 1988) EP is a cognitive as well as biological psychological theory, and as such it has inspired cognitive neuroscientists. Davies' (1996a) claim that EP "is a species of cognitive psychology" (p. 445) ought not to surprise anyone. Gazzaniga (1995a, 1995b) views EP as the new perspective, guiding his own thinking and research, and he has actively promoted EP in his work (Gazzaniga, 1992, 1995a, 1995b). Thus EP has become a serious contender as the guiding theoretical framework within modern, mainstream Cognitive Neuroscience. Pinker (1997a) provides in his book *How The Mind Works* an extensive presentation of evolutionary, adaptationist cognitive psychology. Both Gazzaniga and Pinker are inspired by the work of Cosmides & Tooby, and accept as the main points the modularity of mind, the functional approach to investigation of mental processes and the adaptationist approach to the evolution of functional mental organs.

Chomsky argued for the modularity of mind with his theory of mental organs, as did Fodor (1983, 1985), but none of them accept the modularity of all of mind (Davies, 1996a). Marr (1982) advocated the computational or functional approach but not the adaptationist approach (Davies, 1996a). Fodor is by Dennett (1995) portrayed as an anti-adaptationist, adhering to Gould & Lewontin's (1979) critique of the adaptationist program, and Chomsky is reported by Gould (1991) to agree with Gould's spandrel theory of mind and language. The interesting historical situation concerning evolutionary explanations of human behaviour or nature is that these thinkers, operating outside evolutionary biology, largely had the choice between two explanations: Gould & Lewontin's pluralism versus Wilson's SB. The climate at the time may

have prevented any inspiration to seek the answer within adaptationism. This remains much the same backdrop for critiques such as Lewontin (1990), Davies (1996a, 1996b) and Richardson (1996). EP is continuously inspiring authors within cognitive psychology, as illustrated by Wells (1998) and Kenrick, Sadalla & Keefe (1998).

**Social Psychology.** The major selection force driving human evolution has very likely been other humans. Therefore social cognition plays an important role within EP, e.g. Cosmides' (1989; Cosmides & Tooby, 1992; 1997) research on social exchange and cheater-detection-mechanisms, using the Wason selection task (Wason, 1966, 1983). This is why Buss & Kenrick (1998, p.982), may claim that social psychology "is not merely an additional domain of [EP]; it is the central domain", in their recent article in *the Handbook of Social Psychology* (Gilbert, Fiske & Lindzey, 1998). The cognitive influence on social psychology facilitates the adoption of EP within social psychology. Also the new focus on family studies (Buss & Kenrick, 1998) and placing social relationships at the core of social psychology (Buss, 1997; Buss & Kenrick, 1998), is informed by an analysis of the survival and reproductive problems males and females, respectively or commonly, faced during the adaptation-specific EEA. Recently Simpson & Kenrick (1997) edited a collection of articles called *Evolutionary Social Psychology*, covering themes from descriptions of evolutionary theory and EP's relevance to social psychology (Kenrick & Simpson, 1997; Buss, 1997) to studies of social psychological phenomena such as social perception (e.g. Springer & Berry, 1997), interpersonal attraction (e.g. Graziano, Jensen-Campbell, Todd & Finch, 1997), pair bonding and mating strategies (e.g. Gangestad & Thornhill, 1997), kinship and social relations (e.g. Daly, Salmon & Wilson, 1997) as well as a more controversial section including chapters on group selection (e.g. Wilson, 1997). One may speculate that the lack of influence SB has had on social psychology may be due to the lack of focus on social influence and contextual factors. EP is significantly more contextualist in its approach (e.g. Buss & Kenrick, 1998). Evolutionary social psychology is a theoretical framework offering

an analysis of what mental mechanisms for processing social input may exist and providing a potential theoretical integration of social psychological data.

**Developmental psychology.** In recent years, much as a response to Piaget's description of children's minds, and the tabula rasa point of view of certain behaviouristic theories, the "competent infant" and child has been given more appreciation (Trevathan, 1980; Grieve & Hughes, 1990; Surbey, 1998) - the child needs to solve age-specific problems. The evolutionary study of ontogeny, the development of the organism, attempts to explain functionally, all stages or periods of life from conception, through early childhood, adolescence, puberty and parenthood to senescence and death. The concept of "human life histories" provides a theoretical framework for researching life-span development (Low, 1998; Surbey, 1998).

Child development is within EP the study of how different domain-specific adaptations form, mature and solve problems specific for the individuals ontogenetic situation (e.g. Baron-Cohen, 1994; MacDonald, 1998, provides an evolutionary approach to development from the domain-general perspective). Adaptations are contextually dependent, but will develop normally as long as the environmental input is adequate (viz. does not differ too much from the EEA. For discussion on this point see Scarr, 1993, 1992 vs. Baumrind, 1993). EP is now a theoretical position being considered within mainstream developmental psychology (Campbell & Muncer; 1998).

**Personality psychology.** McCrea & John (1992) discussed EP's explanation in order to overcome the "dustbowl empiricism" of the five-factor model of personality. They note that evolutionary theory is better suited to explain within-species similarity rather than within-species differences. This is much the point of view offered by Tooby & Cosmides (1990a) in their analysis of individual uniqueness and human universal nature. Covariance of personality traits within "[s]tructured systems of coordinated individual differences" (Tooby & Cosmides, 1990a, p. 60) are accounted for by three alternative explanations: 1) condition-responsive adaptive strate-

gies; the universal human mental-mechanisms vary in phenotypic output due to varying input conditions. Cases where this is due to heritable traits may be called reactive heritability. 2) Frequency-dependent adaptive strategies (see section V.I.). 3) Nonadaptive developmental amplification; the adaptively nonarbitrary effect of the same neurophysiological trait may affect systems of mental mechanisms. This latter explanation offered as a critique of personality psychology; the patterns studied may not be adaptations. Tooby & Cosmides (1990a) advocate that one start with the analysis of what survival and reproduction problems were faced during the EEA, and then search for the mechanisms, and eventual interaction between mechanisms, which exists to solve these problems. Buss (1995a, 1996) offers an analysis of the five-factor model based upon EP. His conclusions are that the social adaptive problems faced by humans demanded individual differences and that the personality traits the five-factor model consists of both influence the adaptive problems causally and influences the solution to them adopted by the individual. Buss (1996) argues that EP is an important framework for incorporating personality psychology within the broader field of psychology.

Anticipating the next section, the adaptationist, modular, domain-specific model of mind is also able to explain the lack of normal functions, due to a defect in the mental mechanism that solves a certain function, which we conceptualise as personality, thus causing personality disorders. This defect may occur due to mutations causing entropy in the mechanism's genotype, or due to an inadequate ontogenetic environment. This approach is adopted by Blair (1995) in a cognitive developmental investigation of the psychopath, where the mechanism hypothesised to be lacking (or not fully developed) is the adaptation that causes social animals to inhibit aggression toward conspecifics that display submission cues.

## VI.II. Integrating Clinical Psychology: Evolutionary Psychopathology as a Scientist-Practitioner Perspective.

“After all, nothing in medicine makes sense except in the light of evolution.”

Randolph M. Nesse & George C. Williams, 1996, p. 249

Darwinian medicine (Nesse & Williams, 1991, 1996) is a new perspective to medicine and disease, and other frailties of the human organism, mental disorders included. The perspective is founded on the same theoretical ground as EP: in this case the adaptationist program and the functional approach, in this case, to disease. In their notes to the chapter on mental disorders Nesse & Williams (1996) suggest introductory reading in both SB and EP (e.g. Barkow et al., 1992), but their analysis of evolution shows that they are not adaptiveness-oriented, as the discrepancy between current environment and adaptations is a major reason for disorders; what they call “diseases of civilization” (Nesse & Williams, 1996). Baron-Cohen (1997) edited a collection of “classic readings in evolutionary psychopathology” called *The Maladapted Mind* (an explicit and intentional echo of Barkow et al., 1992, *The Adapted Mind*), thus tying Darwinian medicine and EP together. So although Nesse & Williams (1996, p. 233) conclude that “[t]here is every expectation that an evolutionary approach will bring the study of mental disorders back to the fold of medicine”, there is no need to worry about the division between medicine and psychology; Nesse & Williams (1996) contrast psychiatry as a non-functional discipline to functional physiological medicine - in the same way EP contrasts descriptive, non-functional psychological research against functional physiology, following Mayr (1983) who tied the adaptationist program to William Harvey’s classic work on the coronary system, a functional approach to the investigation of a system. So when Nesse & Williams in the quotation introducing this section rephrase Dobzhansky’s famous quote, which introduced this article, it may be rephrased specifically for EP and EPP: Nothing in psychology, the understanding of psychopathology included, makes sense except in the light of evolution. This may provoke more resistance than the two

former versions, due to a cultural bias toward dualism.

The Darwinian medicine-perspective to mental disorders (or EPP) is that mental disorders are not diseases themselves; viewed within from an evolutionary point of view the symptoms of mental disorders are, as are cough and fever, defences (Nesse & Williams, 1996). The predisposition for these defences evolved due to the increased fitness of these characters. The reason why human psychology must endure the pain of disorder is not due to “flaws” but “design compromises” (Nesse & Williams, 1996). In this system emotions are adaptations. They solve survival or reproduction problems by providing the organism with an informational context, and Nesse & Williams (1996; Nesse, 1990) willingly accept Cosmides & Tooby’s (1987) term “Darwinian algorithms of the mind” to illustrate this inherent information-processing quality of emotions. Nesse & Williams (1996) are critical to the “apparent rigor” of descriptive empirical research within psychiatry, as the findings are not systemised by a “coherent theory”.

McGuire, Marks, Nesse & Troisi (1992) argue that psychiatry’s lacking integrative paradigm may be provided by evolutionary biology. This does not mean that culture and personal experience are unimportant factors, but that culture and mind are products of evolution. Thus, an evolutionary analysis may provide a greater understanding of these phenomena. The theory is also contextual. It considers the effect of normal genetic influences, as well as the effect of genetic anomalies, and it views the mental mechanism’s function and potential malfunction from what Gilbert (1992; see also Nesse, 1987) calls the biopsychosocial perspective. Many theoreticians and practitioners adopt the biopsychosocial perspective, as it unites methods and theory more clearly than the concept of “eclectic”. Without a theory of why the biopsychosocial perspective is a fruitful stance it might become more an ideologically preferable stance than an empirical and informed theoretical perspective.

The effect of EP on clinical psychology, EPP, may be illustrated by considering two examples. First, the way Freud’s psychoanalysis has been attacked and reformulated by modern evolutionary theorists. Second, how the understanding of anxiety from an evolutionary per-

spective has led to a broader understanding of the natural function of anxiety. Obviously other examples may have been presented; e.g. Stevens & Price (1996) offer an *Evolutionary Psychiatry* based on Jungian archetypes; Gilbert (1992; see also Price, Sloman, Gardner, Gilbert & Rohde, 1994; McGuire, Troisi & Raleigh, 1997) presents a theoretically extensive analysis of the evolutionary function of depression; and Baron-Cohen (1994), building on EP's mental mechanisms, has constructed a theory of autism. It is, alas, beyond the scope of this article to perform an exhaustive review of EPP; such a review is recently available in McGuire & Troisi's (1998) *Darwinian Psychiatry*. The discussion included in the two examples offered ought to illustrate the versatility and potential for uniting and selecting empirical findings and theoretical constructs by adopting the EP/EPP or Darwinian medicine stance.

**Freud, the evolutionary psychologist.** Webster (1996), having found fault in Freud's metatheory, as well as biological and medical theory, though simultaneously accepting both implicitly and explicitly most of Freud's description of Human Nature and mind, called for a new theory of mind, founded on evolutionary. Criticising Freud has been quite common within evolutionary theory and EP/EPP. There may be many reasons why; most noteworthy is the fact that Freud formulated a biological theory of Human Nature<sup>2</sup> (Sulloway, 1979/1992), based mainly on the rejected biological theories of recapitulation, which is "[t]he repetition of ancestral stages in embryonic or juvenile stages of descendants" (Gould, 1977b, p. 485), and Lamarckian-inheritance (Sulloway, 1979/1992; Webster, 1996; Gould, 1977b, 1987b). One may defend calling Freud an evolutionary psychologist. Although his evolutionary theoretical foundation was quite different from EP's, and even outmoded (or at least less popular; see Gould, 1987b, who also offers a critical view of Freud's

adaptationist thinking) in his own time, Freud's interest in evolutionary explanations of Human Nature was consistent (for an illustrative example see Freud, 1987). When defending the reality of castration anxiety within the Oedipus complex Freud (1964) refers to the "phylogenetic reinforcement" and claims: "It is our suspicion that during the human family's primeval period castration used actually to be carried out by a jealous and cruel father upon growing boys" (p. 86). The only way such an anxiety could be passed on would be if the anxiety of the boys that observed the deed (obviously not the boy "castrated"! ) was passed on through Lamarckian-inheritance. Gould (1987b), in discussing *Freud's Overview of the Transference Neuroses* claims that "Freud's decision stems directly from his commitment to an evolutionary explanation of neurosis – one that would find its primary evidence in the theory of recapitulation" (pp. 14-16). Thus the ontogenetic timing of a fixation would map onto a phylogenetic recapitulation, through the adult expression of a phylogenetic earlier species, thus shedding light on the nature of the neurosis at hand. Even modern Freudians, or psychodynamic theoreticians, seem to be hampered by Freud's outmoded evolutionary speculations, but still the interest for evolutionary explanations exists. Malan (1995) refers to Haeckel's recapitulation, albeit adding the cautionary note that "Haeckel overstated his case", when invoking evolutionary origin of human aggression (pp. 212-215), and several other phenomenon. Malan is as such an evolutionary psychologist too (though not an EP, as defined in this article). Consider the following quote by Malan (1995, p. 63) on the Oedipus complex and evolution:

The observation that, even when the father is weak or absent, male patients tend to have a fantasy of a powerful and punishing father, forces one into thinking seriously about theories involving evolution. This is one of the many examples of the way in which psychoanalysis provides evidence about the evolution of human beings – a link between two areas that has been very little explored, and needs to be explored in collaboration

<sup>2</sup> I acknowledge the distinction between "psychoanalytic" and "psychodynamic" often adopted, but will in this chapter use these terms as synonymous to "Freudian", which is all theory based upon Freud's original observations of Human Nature, but excludes theories that do not accept innate motivational drives. The authors, cited in this chapter, neither make this distinction.

with scientists familiar with modern theories.

Obviously the above example shows the lack of “modern theories” within Malan’s (1995) own evolutionary thinking. Adding to the recapitulation-inspired account of aggression, Malan (1995) now offers a Lamarckian account of the Oedipus complex that mirrors Freud’s phylogenetic cause cited above. One may add that the kind of research Malan (1995) is calling for is being pursued and has borne interesting results (e.g. see Gazzaniga’s [1992] account of Daly & Wilson’s empirical research).

Gazzaniga (1992), in his chapter *Selection Theory and the Death of Psychoanalysis*, starts by describing how several psychoanalytic theories, in which Freud’s ideas were taken to extremes, have been proven wrong, and urges psychoanalysis to become scientifically stringent and biologically compatible. Gazzaniga (1992, p. 160) quotes Freud: “the shortcomings of our (the psychoanalysts’) description would probably vanish if we were already in a position to replace the psychological terms by physiological or chemical ones... Biology is truly a land of unlimited possibilities.” Gazzaniga’s (1992, pp. 175-177) conclusion is that psychodynamic processes are “rampant”:

They are the result of the simple introduction of a special capacity of the human brain, the capacity to make voluntary expressions, which, in turn, allows for deception and the hiding of intentions. This capacity can, however, quickly compound, resulting in complex psychological states. From this viewpoint, selection theory gives us a rich way of thinking about how we humans have developed the complex psychological processes we commonly enjoy.

Gazzaniga’s (1992) position is equivalent to that of Webster (1996); the meta-theory is false due to outmoded theories of biology and lack of scientific stringency, but many observations and the psychodynamic formulations of Human Nature may be true, and deserve the modern scientific and evolutionary foundation Freud was incapable of providing. Badcock (1998) and Nesse &

Lloyd (1992) present two, somewhat different, EP/EPP approaches to making these necessary corrections to the theory.

Badcock (1998) avoids almost all critique of Freud. Rather he attacks the SSSM’s “debiologized” interpretation of Freud and advocates the original, biological understanding as intended by Freud. Badcock (1998) quotes Freud “who denounced those who ‘have picked out a few cultural overtones from the symphony of life and have once more failed to hear the mighty and primordial melody of the instincts’” (p. 458). It is worthwhile noting that Gould (1987b) advocates the same approach to understanding Freud, in order to argue against Freud’s recapitulatory, Lamarckian-inheritance and adaptationist claims within a biological rather than metaphorical framework. Badcock (1998) thereafter reinterprets Freud in a modern Darwinian light, having noted that although Freud has been criticised for arguing for Lamarckian-inheritance this is a charge of which Charles Darwin was also guilty. The theoretical drive of Badcock’s (1998) argument lies in pointing out how modern evolutionary theory, even the Dawkinsian gene-level perspective, may be not only be compatible with Freud’s theories, but, as Badcock (1998, p. 458) claims, that:

Indeed, it is the argument here that, whatever his own misconceptions may have been, Freud’s findings can only be understood in terms of advances in genetics and evolution that were not to take place until he had been dead for some decades.

An example of this is how Trivers’ (1972) theories on differential parental investment may explain conflict, at the interpersonal or between-gender level, at the intrapsychic level (see also Gazzaniga, 1992; Nesse & Lloyd, 1992 above) and also at the intragenomic level (Badcock, 1998; see also section V.I). This is obviously an interesting perspective, but one may also question the validity of the inference of the validity of Freud’s concept of “bisexuality” based on the fact that the X-chromosomes are present in both genders. In addition, inferring what Freud may have believed about evolution “had he been alive today” (Badcock, 1998, p. 462), is an unneces-



sary and simplistic speculation. There is a certain eagerness in Badcock's (1998) defence and reinterpretation of Freud's evolutionary insights. This may fruitfully be tempered by accepting Freud's theories more as inspiration to guide modern EPP and EP research within areas where there is reason to believe that further research is warranted, rather than as truths to be vindicated by EPP and EP.

Nesse & Lloyd (1992, p. 601) introduce their analysis of the evolution of psychodynamic mechanisms by making the following integrative claim:

This converging focus on human information-processing mechanisms may give new significance to psychodynamics. Cognitive and evolutionary psychologists may find in psychodynamics careful descriptions of traits that may closely match the functional subunits of the mind that they are seeking. Psychodynamic psychologists and psychiatrists may find in evolutionary psychology new possibilities for a theoretical foundation in biology.

A "functional subunit" is an adaptationist formulation that implies that psychodynamic mechanisms are equivalent to EP's evolved domain-specific mental mechanisms. Also it is worthwhile noticing the need to found the psychodynamic theory of Human Nature in biology. This was Freud's original position (Sulloway, 1979/1992; Badcock, 1998), and made it theoretically possible to infer human universals from a limited sample of observations (much on a par with Piaget's work and biological underpinnings; founded on the idea that ontogeny recapitulates phylogeny, though Piaget denied influence by Haeckel's evolutionary theory [Gould, 1977b]).

Nesse & Lloyd (1992) admit that Freud's evolutionary ideas (they add group selectionism to the list) are an obstacle to integrating psychodynamic theory with EP, but they view the ultimate, functional, biological perspective Freud's theoretical forte. Other obstacles would be the "justified" critique of the difficulty of disentangling "empirical observations from the complex theory in which they are often embedded" (Nesse & Lloyd, p. 602), and the "repugnance of

some psychoanalytic discoveries" (Nesse & Lloyd, p. 603). Attempting to overcome the former obstacle is justified by the claim that "psychoanalytic methods can, nonetheless, provide a unique window on high levels of mental organization" (Nesse & Lloyd, p. 602). One might add that the process of having psychoanalysis and EP inform each other ought to result in a more rigorous conceptualisation and operationalised definitions. Nesse & Lloyd pass the latter obstacle by connecting the "repugnance" of psychoanalytic findings to the similar reaction to the evolutionary work by e.g. Dawkins (1976/1989, 1982). Nesse & Lloyd (1992, p. 603), as Badcock (1998), then build upon Trivers' (1971, 1972, 1985) work. They quote Trivers' comment in the foreword to the American edition of *Dawkins' The Selfish Gene*: "the conventional view that natural selection favours nervous systems which produce ever more accurate images of the world must be a very naïve view of mental evolution." They justly add that Trivers did not explicitly connect his hypothesis with psychoanalysis. Nesse & Lloyd (1992) thus focus on self-deception and repression as major traits of both psychoanalytic and evolutionary theory of Human Nature, as well as the modularity of the traits focused within psychoanalysis.

The most important benefit to psychoanalysis from an integration with EP is "the possibility of a solid theoretical foundation in the natural sciences" (Nesse & Lloyd, 1992, p. 618). This is the same point made by Symons (1987), Tooby & Cosmides (1992) and Buss (1995) about psychology proper, and which was the original goal of Freud (Sulloway, 1979/1992). Nesse & Lloyd (1992) claim that consistency with evolutionary theory is the first test for any level of psychoanalytic hypothesising. Commenting on the similarity of psychoanalytic reports of phenomena and early ethological investigations, Nesse & Lloyd (1992, p. 620) conclude: "The systematic application of evolutionary principles has transformed ethology into a mature science; perhaps it can do the same for psychoanalysis. If so, psychoanalysts will someday be recognized as pioneering naturalists of the mind." This would demand a shift from the SSSM interpretation of psychoanalysis.

The integrative, rigorous nature of EP and EPP is such that one may use the perspective

to discipline other bodies of theory. Whether one's point of departure is that Freud or Freudians are correct or not is not as interesting as whether one, by adopting the EP/EPP stance, may provide a theoretically and empirically valid framework for evaluating theory and data within fields as seemingly separate as cognitive science and psychoanalysis. The feat of EP lies in providing an integrative framework. Even if "some of *The Adapted Mind's* editors share [the] concerns" that psychodynamic theory is "a tangle of vague concepts and inconsistently defined phenomena" (Barkow et al., 1992, p. 600) – the work cited above indicates that their theory may untangle and bring consistency to psychodynamic theory.

**Anxiety, as adaptive defence - not disease.**

Nesse & Williams (1996) criticise the common psychiatric understanding of anxiety, which holds that anxiety is a disease in itself, capable of being divided into distinct types. They would rather view anxiety as a defence, an adaptation governing the organism's response to a contextual cue. These contextual cues will - most often - be phenomena found in our phylogenetic past, very rarely a novel danger. When one has an anxiety reaction to a phyletic new cue, it will usually be to a quality of that cue that was found in our EEA (e.g. claustrophobia might be a better label for most cases of Fear of Flying).

The need for contextual input into innate, domain-specific information processing mechanisms - the learning instincts - regulate anxiety-responses, too. Mineka, Davidson, Cook & Keir (1984) found that fear in primates could arise due to observational learning, noting the "striking [...] rapidity with which the fear was acquired" (p. 369). Mineka et al. (1984) conclude that such rapidity is a necessity given an ultimate functional interpretation of the fear-response and context; if you do not learn the fear fast you might not survive the next cue-exposure. The same preparedness and rapidity, but with a different, or domain-specific, defence-response, was noted by Garcia & Koelling (1966); the ultimate functional reason why the domain-specific conditioning must occur after such limited exposure to the cue, and be long lasting, is similar. Öhman et al. (1976) found that the predominant behaviouristic theory of equipotential-

ity in conditioning phobic responses to stimuli was false. Some cues could be conditioned to give phobic reactions with greater ease than other stimuli, and with longer lasting effect. The stimuli that were potentially phobic were cues that were potential dangers in our EEA. This approach was necessary in order to explain Öhman et al.'s (1976) results. These classic findings of learning psychology illustrate lucidly the interdependency between environment and organism. For further elaboration on the interaction between learning and domain-specific, adaptationist biological preparedness, see section V.III.

Nesse (1987), presenting an evolutionary perspective on panic order and agoraphobia, claims that panic is an adaptation - a normal defence-reaction with the evolved function to make the organism escape threatening situations. Escaping these situations and learning what situations are threatening provides a survival advantage. Panic disorder is therefore the occurrence of normal defence-reactions in the absence of real threat. Nesse (1987) claims that this attitude is a benefit not only to understanding panic disorders, but also in facilitating a positive therapeutic alliance. The added understanding the evolutionary perspective brings, and other theories can not, is, according to Nesse (1987), the ability to explain the anxiety symptoms that constitute the agoraphobia syndrome, the specific factors that reduce anxiety, and the fact that repeated panic attacks often lead to agoraphobia. Exposure therapy will provide information that the situations are not threatening, yet an exclusive behavioural approach will offer merely a partial explanation of the disorders aetiology. Nesse (1987) advocates the integration of psychological, social and biological treatment of panic disorder and agoraphobia, but warns that removing the natural defence-reaction may be harmful. Marks & Nesse (1994) share this perspective to anxiety disorders in general; "hypophobia-disorder" would be the lack, e.g. due to medication, of natural defensive reactions to threatening situations. Marks & Nesse (1994) adopt Cosmides & Tooby's (1987) Darwinian algorithms to explain the domain-specific information processing involved in different specific threats and responses to avert these. The evolutionary perspective explains why we have anxiety responses to archaic threat cues, rather than

more real dangers of our modern world (Marks & Nesse, 1994; Öhman et al., 1976).

Anxiety, as a natural defence response, with a genetic basis (Marks, 1986), whose variation may be due to genetic defects or normal variation (Nesse & Williams, 1996), and an adaptive function, is obviously an evolutionary phenomenon. This does not imply that it is impossible to treat, or even more difficult than if it was defined differently. On the contrary, anxiety thus defined becomes more available for analysis and intervention at several levels due to the biopsychosocial-perspective. The integration with cognitive-behavioural theory and therapy is almost self-evident (see section V.III). One must identify danger cues and, through exposure, remove their information as danger signals (Marks, 1986; Kanfer & Philips, 1970; Rescorla, 1988), but with the addition of an ability to ask ultimate questions and explain “why”, opening a vista for new research (Marks & Nesse, 1994; Nesse, 1987), instead of merely describe “how”.

The two examples above, the evolutionary approach to both the theory of Freud and the mental disorder anxiety, illustrate two points. First, a psychological theory, even one that is not usually accepted as scientific within mainstream psychology, may be given a frame of reference and a set of basic principles from which to evaluate itself. The result being greater communicability of findings and ideas with mainstream science at several levels of analysis. Second, a mental disorder may be reformulated in more psychological valid terms, i.e. independently of the typical “medical model”, while still acceptable from a biological perspective, and even gaining new approaches to understanding and levels of analysis.

Gilbert (1992), though focusing primarily on depression, provides an excellent example of the theory’s potential. The evolutionary perspective does not specify a method of treatment, but may provide theories for understanding the disorder and a framework for evaluating what methods and other theories may be worthwhile implementing or adopting. Gilbert (1992) presents and evaluates an array of major theories of depression, from Freud’s Psychoanalysis to Beck’s Cognitive Theory, and has at his disposal a framework that allows him to make informed theoretical decisions (based on other information

than subjectively perceived pragmatic value). Thus the result is a refreshing open-mindedness to different theories and a theoretically governed eclecticism, rather than the far too common sectarianism or *con amore* or *ad hoc* eclecticism. EP and EPP may hone existing theory by providing selection criteria for theories, while simultaneously allowing for a theoretically guided integrative approach by adding an analysis at several levels; such as ultimate, proximate, neurocognitive, psychophysiological, learning, psychodynamic, social-psychological, cultural etc., which may be summed up as the biopsychosocial-perspective.

Baron-Cohen (1997b) describes how EP may contribute to the understanding and study of psychopathology: “First the universal, adaptive, neurocognitive mechanism must be identified in its healthy state, and only then can its breakdown be studied and its link to pathology explored” (p. XI). But Baron-Cohen (1997b) also claims that EPP may inform EP: “It also happens that a universal, adaptive, neurocognitive mechanism is first revealed by its breakdown” (p. XI). One may overlook a mechanism when the mind is functioning normally, but when an anomaly causes the system to malfunction, one becomes aware of the “crucial mechanism at work” (p. XI). This is similar to Cosmides & Tooby’s (1994a) critique of “instinct-blindness” within cognitive psychology. Research too often focuses on what we have difficulties in performing, but not what we do naturally and efficiently; which may reveal a lot more about our mental architecture.

## VII. Conclusions

Some worry that EP is just a new example of sectarianism within the science of psychology. Others (e.g. Buss, 1995a, 1995b) herald it as a new paradigm of psychology, which is compatible with Nesse & Williams (1996) and McGuire et al. (1992) claims about EPP. A response to the former is that a theory that pretends to collect the dustbowl empiricism of psychological science within a common framework, which also will allow for communication with other levels of scientific analysis relevant to a life science, does not fulfil the criteria for sectarian. La Cerra & Kurzban (1995) provide a cogent response to the

second claim; one cannot have a "new" paradigm where there has been no unifying theory. The conclusion this article reaches, based on the presented arguments, is that EP may be a contribution to psychological science at several different, important levels. First, EP allows psychologists to communicate between different areas of psychological interest, and with other branches of science relevant to psychology as a life science. Second, EP provides a well-researched, rigorously formulated theory for evaluating any other psychological theory. The theory may prevent one from suggesting abilities that could not evolve but have been suggested within almost all psychological disciplines. The versatility EP shows as a theoretical framework for disciplines as different as psychoanalysis and cognitive science, suggests that EP may succeed in integrating psychological science. It also supports the claim that EP is as theoretically valid a science as cognitive science and evolutionary biology. EP also brings to psychology the focus on a theoretically rigorous and predictive theory of Human Nature, and the functional approach, which may provide maturation from the level of mere descriptive science. At the level of generating new theories and insights about Human Nature, EP seems to have proven its worth.

This article therefore concludes that EP offers the most promising and likely unifying paradigm for psychological science available today. An appreciation of the versatility of EP, from a scientist-practitioner perspective, supports this conclusion. EP's ability to convince mainstream psychology of the possibility and need to found its constructs and concepts on evolutionary valid ground will facilitate this shift.

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## References

- Axelrod, R. (1984). *The evolution of cooperation*. Harmondsworth, UK: Penguin.
- Badcock, C. R. (1998). PsychoDarwinism: The new synthesis of Darwin and Freud. In C. B. Crawford & D. L. Krebs (Eds.), *Handbook of evolutionary psychology. Ideas, issues and applications* (pp. 457-483). Mahwah, NJ: Lawrence Erlbaum Associates.
- Bailey, J. M. (1998). Can behavior genetics contribute to evolutionary behavioral science. In C. B. Crawford & D. L. Krebs (Eds.), *Handbook of evolutionary psychology. Ideas, issues and applications* (pp. 211-233). Mahwah, NJ: Lawrence Erlbaum Associates.
- Barkow, J. H., Cosmides, L. & Tooby, J. (Eds.). (1992). *The Adapted Mind: Evolutionary psychology and the generation of culture*. New York: Oxford University Press.
- Baron-Cohen, S. (1994). How to build a baby that can read minds: cognitive mechanisms in mindreading. *Cahiers de Psychologie Cognitive/ Current Psychology of Cognition*, 13, 513-552.
- Baron-Cohen, S. (Ed.). (1997a). *The maladapted mind: Classic readings in evolutionary psychopathology*. Hove, UK: Psychology Press.
- Baron-Cohen, S. (1997b). Preface: Why evolutionary psychopathology? In S. Baron-Cohen (Ed.), *The maladapted mind: Classic readings in evolutionary psychopathology* (pp. ix-xiii). Hove, UK: Psychology Press.
- Bateson, P. (1986). Sociobiology and human politics. In S. Rose & L. Appaganesi (Eds.), *Science and beyond*. (pp. 79-99). Oxford, UK: Blackwell.
- Baumrind, D. (1993). The average expectable environment is not good enough: A response to Scarr. *Child Development*, 64, 1299-1317.
- Betzig, L. (1998). Not whether to count babies, but which. In C. B. Crawford & D. L. Krebs (Eds.), *Handbook of evolutionary psychology. Ideas, issues and applications* (pp. 265-273). Mahwah, NJ: Lawrence Erlbaum Associates.

- Blair, R. J. (1995). A cognitive developmental approach to morality: Investigating the psychopath. *Cognition*, 57, 1-29.
- Bolles, R. C. (1970). Species-specific defense reactions and avoidance learning. *Psychological Review*, 77, 32-48.
- Bouchard, T. J., Jr. (1994). Genes, environment, and personality. *Science*, 264, 1700-1701.
- Bouchard, T. J., Jr., Lykken, D. T., McGue, M., Segal, N. L., & Tellegen, A. (1990). Sources of human psychological differences: The Minnesota study of twins raised apart. *Science*, 250, 223-228.
- Bouchard, T. J., Jr., Lykken, D. T., Tellegen, A., & McGue, M. (1996). Genes, drives, environment, and experience: EPD theory revised. In C. P. Benbow & D. Lubinski (Eds.), *Intellectual talent: Psychometric and social issues* (pp. 5-43). Baltimore, MD: The Johns Hopkins University Press.
- Buss, D. M. (1995a). Evolutionary psychology: A new paradigm for psychological science. *Psychological Inquiry*, 6, 1-30.
- Buss, D. M. (1995b). The future of evolutionary psychology. *Psychological Inquiry*, 6, 81-87.
- Buss, D. M. (1996). Social adaptation and five major factors of personality. In J. Wiggins (Ed.), *The five factor model of personality: Theoretical perspectives* (pp. 180-207). New York: Guilford Publications.
- Buss, D. M. (1997). The emergence of evolutionary social psychology. In J. A. Simpson & D. T. Kenrick (Eds.), *Evolutionary social psychology* (pp. 387-400). Mahwah, NJ: Lawrence Erlbaum Associates.
- Buss, D. M., & Kenrick (1998). Evolutionary social psychology. In D. T. Gilbert, S. T. Fiske, & G. Lindzey (Eds.), *The handbook of social psychology: Vol. 2* (4<sup>th</sup> ed.) (pp. 982-1026). Boston: McGraw-Hill.
- Buss, D. M., Haselton, M. G., Shackelford, T. K., Bleske, A. L., & Wakefield, J. C. (1998). Adaptations, exaptations, and spandrels. *American Psychologist*, 53, 533-548.
- Campbell, A., & Muncer, S. (Eds.). (1998). *The Social Child. Studies in developmental psychology*. Hove, UK: Psychology Press.
- Cosmides, L. (1989). The logic of social exchange: Has natural selection shaped how humans reason? Studies with the Wason selection task. *Cognition*, 31, 187-276.
- Cosmides, L., & Tooby, J. (1981). Cytoplasmic inheritance and intragenomic conflict. *Journal of Theoretical Biology*, 89, 83-129.
- Cosmides, L., & Tooby, J. (1987). From Evolution to Behavior: Evolutionary Psychology as the Missing Link. In J. Dupré (Ed.), *The latest on the best : Essays on evolution and optimality* (pp. 276-306). Cambridge, MA: The MIT Press.
- Cosmides, L., & Tooby, J. (1992). Cognitive adaptations for social exchange. In Barkow, Cosmides & Tooby (Eds.), *The adapted mind: Evolutionary psychology and the generation of culture* (pp. 163-228). New York: Oxford University Press.
- Cosmides, L., & Tooby, J. (1994a). Beyond intuition and instinct blindness: Toward an evolutionary rigorous cognitive science. *Cognition*, 50, 41-77.
- Cosmides, L., & Tooby, J. (1994b). Origins of domain specificity: The evolution of functional organization. In L. A. Hirschfeld & S. A. Gelman (Eds.), *Mapping the mind: Domain specificity in cognition and culture* (pp. 85-116). Cambridge, UK: Cambridge University Press.
- Cosmides, L., & Tooby, J. (1995). From Function to Structure: The Role of Evolutionary Biology and Computational Theories in Cognitive Neuroscience. In M. S. Gazzaniga (Ed.), *The Cognitive Neurosci-*

- ences (pp. 1199-1210). Cambridge, MA: The MIT Press.
- Cosmides, L., & Tooby, J. (1997). Dissecting the computational architecture of social inference mechanisms. In G. R. Bock & G. Cardew (Eds.), *Characterizing human psychological adaptations: Ciba Foundation symposium, 208* (pp. 132-161). New York: John Wiley & Sons.
- Crawford, C. B. (1987). Sociobiology: Of What Value to Psychology? In C. B. Crawford, M. F. Smith, & D. L. Krebs (Eds.), *Sociobiology and psychology: Ideas, issues and applications* (pp. 3-30). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Crawford, C. B. (1993). The Future of Sociobiology: Counting Babies or Studying Proximate Mechanisms. *Trends in Ecology and Evolution, 8*, 183-186.
- Crawford, C. B., & Anderson, J. L. (1989). Sociobiology: An Environmentalist Discipline? *American Psychologist*, December, 1449-1459.
- Crawford, C. B., & Anderson, J. L. (1991). Reply to Stanislaw: Why We Are More Optimistic. *American Psychologist*, March, 248-249.
- Crawford, C. B., & Krebs, D. (Eds.). (1998). *Handbook of evolutionary psychology. Ideas, Issues and Applications*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Crawford, C. B., Smith, M. & Krebs, D. (Eds.). (1987). *Sociobiology and Psychology. Ideas, Issues and Applications*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Daly, M., Salmon, C., & Wilson, M. (1997). Kinship: The conceptual hole in psychological studies of social cognition and close relationships. In J. A. Simpson & D. T. Kenrick (Eds.), *Evolutionary social psychology* (pp. 265-296). Mahwah, NJ: Lawrence Erlbaum Associates.
- Darwin, C. (1859/1996). *The origin of species*. Oxford, UK: Oxford University Press.
- Darwin, C. (1871/1981). *The descent of man, and selection in relation to sex*. Princeton, NJ: Princeton University Press.
- Darwin, C. (1872/1998). *The expression of the emotions in man and animals* (3<sup>rd</sup> ed). London: HarperCollins.
- Davies, P. S. (1996a). Preface: Evolutionary theory in cognitive psychology. *Minds and Machines, 6*, 445-462.
- Davies, P. S. (1996b). Discovering the functional mesh: On the methods of evolutionary psychology. *Minds and Machines, 6*, 559-585.
- Dawkins, R. (1976/1989). *The selfish gene* (New ed.). Oxford, UK: Oxford University Press.
- Dawkins, R. (1979a). Defining sociobiology. *Nature, 280*, 427-428.
- Dawkins, R. (1979b). Twelve misunderstandings of kin selection. *Zeitschrift für Tierpsychologie, 51*, 184-200.
- Dawkins, R. (1980). Good strategy or evolutionary stable strategy? In G. W. Barlow & J. Silverberg (Eds.), *Sociobiology: beyond nature/nurture? Reports, definitions and debate* (pp.3 31-367). Boulder, CO: Westview.
- Dawkins, R. (1981). In Defence of Selfish Genes. *Philosophy, 56*, 556-573.
- Dawkins, R. (1982). *The Extended Phenotype*. Oxford, UK: Oxford University Press.
- Dawkins, R. (1983). Adaptationism was always predictive and needed no defence. *The Behavioral and Brain Sciences, 3*, 360-361.
- Dawkins, R. (1986). Sociobiology: The New Storm in a Teacup. In S. Rose & L. Apapanesi (Eds.), *Science and Beyond* (pp. 61-78). Oxford, UK: Blackwell.
- Dawkins, R. (1986/1991). *The blind watchmaker*. Harmondsworth, UK: Penguin.

- Dawkins, R. (1993). Viruses of the mind. In B. Dahlbom (Ed.), *Dennett and his critics* (pp. 13-27). Oxford, UK: Blackwell.
- Dawkins, R., & Krebs, J. R. (1979). Arms races between and within species. *Proceedings of the Royal Society of London, B* 205, 489-511.
- Dennett, D. C. (1983). Intentional systems in cognitive ethology: The 'Panglossian paradigm' defended. *The Behavioral and Brain Sciences*, 6, 343-390
- Dennett, D. C. (1995). *Darwin's dangerous idea: Evolution and the meanings of life*. Harmondsworth, UK: Penguin.
- Dobzhansky, T. (1973). Nothing in biology makes sense except in the light of evolution. *The American Biology Teacher*, 35, 125-129.
- Ekman, P. (1998). Introduction, afterword and commentaries. In Darwin, C. (1872/1998), *The expression of the emotions in man and animals* (3<sup>rd</sup> ed). London: HarperCollins.
- Eldredge, N. (1983). A la recherche du docteur Pangloss. *The Behavioral and Brain Sciences*, 3, 361-362.
- Eldredge, N., & Gould, S. J. (1972). Punctuated equilibria: An alternative to phyletic gradualism. In T. J. M. Schopf (Ed.), *Models in paleobiology* (pp. 82-115). San Francisco: Freeman, Cooper and Company.
- Eldredge, N. (1995). *Reinventing Darwin: The great debate at the high table of evolutionary theory*. New York: J. Wiley & Sons.
- Fodor, J. A. (1983). *The modularity of mind*. Cambridge, MA: The MIT Press.
- Fodor, J. A. (1985). Précis of the modularity of mind. *Behavioral and Brain Sciences*, 8, 1-42.
- Freud, S. (1964). New introductory lectures on psycho-analysis. In J. Strachey (Ed. and Trans.), *The standard edition* (Vol. 22, pp. 3-182). London: Hogarth Press and The Institute of Psycho-Analysis. (Original work published in 1923).
- Freud, S. (1987). *A phylogenetic fantasy*. (A. Hoffer & P. Hoffer, Trans.). Cambridge, MA: Belknap Harvard. (Original work published 1985).
- Futuyma, D. J. (1983). *Science on trial: The case for evolution*. New York: Pantheon.
- Gallistel, C. R. (1995). The replacement of general-purpose theories with adaptive specializations. In M. S. Gazzaniga (Ed.), *The Cognitive Neurosciences* (pp. 1255-1267). Cambridge, MA: The MIT Press.
- Gallistel, C. R., & Cheng, K. (1985). A modular sense of place? *Behavioral and Brain Sciences*, 8, 11-12.
- Gangestad, S. (1995). The new evolutionary psychology: Prospects and challenges. *Psychological Inquiry*, 6, 38-41.
- Gangestad, S. W., & Thornhill, R. (1997). Human sexual selection and developmental stability. In J. A. Simpson & D. T. Kenrick (Eds.), *Evolutionary social psychology*. (pp. 169-196). Mahwah, NJ: Lawrence Erlbaum Associates.
- Garcia, J. (1981). Tilting at the paper mills of academe. *American Psychologist*, 36, 149-158.
- Garcia, J., & Koelling, R. A. (1966). Relation of cue in consequence to learning. *Psychonomic Science*, 4, 123-124.
- Gaulin, S. J. (1995). Does evolutionary theory predict sex differences in the brain? In M. S. Gazzaniga (Ed.), *The Cognitive Neurosciences* (pp. 1211-1225). Cambridge, MA: The MIT Press.
- Gazzaniga, M. S. (1992). *Nature's Mind: the biological roots of thinking, emotions, sexuality, language and intelligence*. New York: Basic Books.

- Gazzaniga, M. S. (1995b). Consciousness and the cerebral hemispheres. In M. S. Gazzaniga (Ed.), *The Cognitive Neurosciences* (pp. 1391-1400). Cambridge, MA: The MIT Press.
- Gazzaniga, M. S. (Ed.). (1995a). *The Cognitive Neurosciences*. Cambridge, MA: The MIT Press.
- Gilbert, D. T., Fiske, S. T., & Lindzey, G. (Eds.). (1998). *The handbook of social psychology*, 2 (4<sup>th</sup> ed.). Boston: McGraw-Hill.
- Gilbert, P. (1992). *Depression: The evolution of powerlessness*. Hove, UK: Lawrence Erlbaum Associates.
- Gould, J. L., & Marler, P. (1987a). Learning by instinct. *Scientific American*, 256(1), 62-73
- Gould, J. L., & Marler, P. (1987b). Learning by Instinct: Reply. *Scientific American*, 256(4), 4.
- Gould, S. J. (1977a). *Ever since Darwin: Reflections in natural history*. Harmondsworth, UK: Penguin.
- Gould, S. J. (1977b). *Ontogeny and phylogeny*. Cambridge, MA: Belknap Harvard.
- Gould, S. J. (1980). Sociobiology and the theory of natural selection. In G. W. Barlow & J. Silverberg (Eds.), *Sociobiology: beyond nature/nurture? Reports, definitions and debate* (pp.257-269). Boulder, CO: Westview.
- Gould, S. J. (1981). *The Mismeasure of man*. Harmondsworth, UK: Penguin.
- Gould, S. J. (1983). The hardening of the modern synthesis. In M. Grene (Ed.), *Dimensions of Darwinism: Themes and counterthemes in twentieth-century evolutionary theory* (pp. 71-93). Cambridge, UK: Cambridge University Press.
- Gould, S. J. (1987a). Freudian Slip: What mental blinders caused the master psychologist to make a mistake so hurtful to women? *Natural History*, 96(2), 14-21.
- Gould, S. J. (1987b). Freud's phylogenetic fantasy: Only great thinkers are allowed to fail greatly. *Natural History*, 96(12), 10-19.
- Gould, S. J. (1989). *Wonderful life: The Burgess Shale and the nature of history*. New York: W.W. Norton.
- Gould, S. J. (1991). Exaptation: A crucial tool for an evolutionary psychology. *Journal of Social Issues*, 47(3), 43-65.
- Gould, S. J. (1993). Fulfilling the spandrels of world and mind. In J. Selzer (Ed.), *Understanding scientific prose* (pp. 310-336). Madison, WI: University of Wisconsin Press.
- Gould, S. J. (1997a). Darwinian Fundamentalism. *New York Review of Books*, June 12.
- Gould, S. J. (1997b). Evolution: The Pleasures of Pluralism. *New York Review of Books*, June 26.
- Gould, S. J. (1997c). The exaptive excellence of spandrels as a term and prototype. *Proceedings of The National Academy of Sciences*, 94, 10750-10755.
- Gould, S. J., & Eldredge, N. (1977). Punctuated equilibria: The tempo and mode of evolution reconsidered. *Paleobiology*, 3, 115-151.
- Gould, S. J., & Eldredge, N. (1993). Punctuated equilibrium comes of age. *Nature*, 366, 223-227.
- Gould, S. J., & Lewontin, R. C. (1979). The spandrels of San Marco and the Panglossian paradigm: A critique of the adaptationist programme. *Proceedings of the Royal Society of London, B* 205, 581-598.
- Gould, S. J., & Vrba, E. (1982). Exaptation- a missing term in the science of form. *Paleobiology*, 8(1), 4-15.
- Graziano, W. G., Jensen-Campbell, L. A., Todd, M., & Finch, J. F. (1997). Interpersonal



- attraction from an evolutionary psychology perspective: Women's reactions to dominant and prosocial men. In J. A. Simpson & D. T. Kenrick (Eds.), *Evolutionary social psychology*. (pp. 141-167). Mahwah, NJ: Lawrence Erlbaum Associates.
- Grieve, R., & Hughes, M. (1990). *Understanding children: Essays in honour of Margaret Donaldson*. Oxford, UK: Basil Blackwell.
- Hamilton, W. D. (1964a). The genetical evolution of social behaviour I. *Journal of Theoretical Biology*, 7, pp. 1-16.
- Hamilton, W. D. (1964b). The genetical evolution of social behaviour II. *Journal of Theoretical Biology*, 7, pp. 17-52.
- Herrnstein, R. J., & Murray, C. (1994). *The bell curve: Intelligence and class structure in American life*. New York: Free Press.
- Holcomb, H. R., III. (1993). *Sociobiology, sex and science*. Albany, NY: State University of New York Press.
- Holcomb, H. R., III. (1996). Just so stories and inference to the best explanation in evolutionary psychology. *Minds and Machines*, 6, 525-540.
- Houck, L. D., & Drickamer, L. C. (Eds.). (1996). *Foundations of Animal Behavior: Classic papers with commentaries*. Chicago: University of Chicago Press.
- Hurst, L. (1998). The Darling of the Masses. *New Scientist*, 6 June.
- Kanfer, F. H., & Philips, J. S. (1970). *Learning foundations of behaviour therapy*. New York: Wiley.
- Kenrick, D. T., & Simpson, J. A. (1997). Introduction: Why social psychology and evolutionary psychology need one another. In J. A. Simpson & D. T. Kenrick (Eds.), *Evolutionary social psychology* (pp. 1-20). Mahwah, NJ: Lawrence Erlbaum Associates.
- Kenrick, D. T., Sadalla, E. K., & Keefe, R. C. (1998). Evolutionary cognitive psychology: The missing heart of modern cognitive science. In C. B. Crawford & D. L. Krebs (Eds.), *Handbook of evolutionary psychology. Ideas, issues and applications* (pp. 485-514). Mahwah, NJ: Lawrence Erlbaum Associates.
- Kipling, R. (1902/1994). *Just So Stories*. Harmondsworth, UK: Penguin.
- Kitcher, P. (1985). *Vaulting Ambition: Sociobiology and the Quest for Human Nature*. Cambridge, MA: The MIT Press.
- La Cerra, P., & Kurzban, R. (1995). The structure of scientific revolutions and the nature of the adapted mind. *Psychological Inquiry*, 6, 62-65.
- Lewontin, R. C. (1978). Adaptation. *Scientific American*, 239, 157-169 .
- Lewontin, R. C. (1979). Sociobiology as an Adaptationist Program. *Behavioral Science*, 2, 5-14.
- Lewontin, R. C. (1983). Elementary errors about evolution. *The Behavioral and Brain Sciences*, 3, 367-368.
- Lewontin, R. C. (1990). The evolution of cognition. In D. N. Osherson & E. E. Smith (Eds.), *An invitation to cognitive science: Thinking*, 3 (pp. 229-246). Cambridge, MA: The MIT Press.
- Low, B. S. (1998). The evolution of human life histories. In C. B. Crawford & D. L. Krebs (Eds.), *Handbook of evolutionary psychology. Ideas, issues and applications* (pp. 131-161). Mahwah, NJ: Lawrence Erlbaum Associates.
- MacDonald, K. (1998) Evolution and development. In A. Campbell & S. Muncer (Eds.), *The social child: Studies in developmental psychology* (pp. 21-49). Hove, UK: Psychology Press.
- Malan, D. H. (1995). *Individual psychotherapy and the science of psychodynamics* (2<sup>nd</sup>

- ed.). Oxford, UK: Butterworth-Heinemann.
- Marks, I. M. (1986). Genetics of fear and anxiety disorders. *British Journal of Psychiatry*, *149*, 406-418.
- Marks, I. M., & Nesse, R. M. (1994). Fear and fitness: An evolutionary analysis of anxiety disorders. *Ethology and Sociobiology*, *15*, 247-261.
- Marr, D. (1982). *Vision. A Computational Investigation into the Human Representation and Processing of Visual Information*. San Francisco: W. H. Freeman and company.
- Mash, E. J., & Terdal, L. G. (Eds.) (1988). *Behavioral assessment of childhood disorders: Selected core problems* (2<sup>nd</sup> ed.). New York: The Guilford Press.
- Masterton, R. B. (1998). Charles Darwin: Father of evolutionary psychology. In G. A. Kimble & M. Wertheimer (Eds.), *Portraits of pioneers in psychology*, *3* (pp. 17-29). Washington, DC: American Psychological Association.
- Maynard Smith, J. (1979). Game theory and the evolution of behaviour. *Proceedings of the Royal Society of London, B* *205*, 475-488.
- Maynard Smith, J. (1983). Adaptation and satisficing. *The Behavioral and Brain Sciences*, *3*, 370-371.
- Maynard Smith, J. (1986). Structuralism versus selection- is Darwinism enough? In S. Rose & L. Appaganesi (Eds.), *Science and beyond* (pp. 39-46). Oxford, UK: Blackwell.
- Mayr, E. (1978). Evolution. *Scientific American*, *239*, 39-47.
- Mayr, E. (1983). How to carry out the adaptationist program. *American Naturalist*, *121*, 324-334.
- McCrea, R. R., & John, O. P. (1992). An introduction to the five-factor model and its applications. *Journal of Personality*, *60*, 175-215.
- McGuire, M. T., & Troisi, A. (1998). *Darwinian Psychiatry*. New York: Oxford University Press.
- McGuire, M. T., Marks, I. M., Nesse, R. M. & Troisi, A. (1992). Evolutionary biology: A basic science for psychiatry? *Acta Psychiatrica Scandinavica*, *86*, 89-96.
- McGuire, M. T., Troisi, A. & Raleigh, M. (1997). Depression in evolutionary context. In S. Baron-Cohen (Ed.), *The maladapted mind: Classic readings in evolutionary psychopathology* (pp. 255-282). Hove, UK: Psychology Press.
- Mineka, S., Davidson, M., Cook, M., & Keir, R. (1984). Observational conditioning of snake fear in Rhesus monkeys. *Journal of Abnormal Psychology*, *93*, 355-372.
- Nesse, R. M. (1987). An evolutionary perspective on panic disorder and agoraphobia. *Ethology and Sociobiology*, *8*, Supplement, 73-83.
- Nesse, R. M. (1990). Evolutionary explanations of emotions. *Human Nature*, *1*, 261-289.
- Nesse, R. M., & Lloyd, A. T. (1992). The evolution of psychodynamic mechanisms. In J. H. Barkow, L. Cosmides & J. Tooby (Eds.), *The adapted mind: Evolutionary psychology and the generation of culture* (pp. 601-624). New York: Oxford University Press.
- Nesse, R. M., & Williams, G. C. (1996). *Why we get sick: The new science of Darwinian medicine*. New York: Vintage Books.
- Noonan, K. M. (1987). Evolution: A primer for psychologists. In C. B. Crawford, M. F. Smith, & D. L. Krebs (Eds.), *Sociobiology and psychology: Ideas, issues and applications* (pp 31-60). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Öhman, A., Fredrikson, M., Hugdahl, K., & Rimmö, P.-A., (1976). The premise of equipotentiality in human classical condi-

- tioning: Conditioned electrodermal responses to potentially phobic stimuli. *Journal of Experimental Psychology: General*, 105, 313-337.
- Oyama, S. (1991). Bodies and minds: Dualism in evolutionary theory. *Journal of Social Issues*, 47(3), 27-42.
- Pinker, S. (1994). *The language instinct: The new science of language and mind*. Harmondsworth, UK: Penguin.
- Pinker, S. (1997a). *How the mind works*. Harmondsworth, UK: The Penguin Press.
- Pinker, S. (1997b). Language as a psychological adaptation. In G. R. Bock & G. Cardew (Eds.), *Characterizing human psychological adaptations: Ciba Foundation symposium*, 208 (pp. 162-180). New York: John Wiley & Sons.
- Pinker, S., & Bloom, P. (1992). Natural language and natural selection. In Barkow, Cosmides & Tooby (Eds.), *The adapted mind: Evolutionary psychology and the generation of culture* (pp. 451-493). New York: Oxford University Press.
- Plomin, R. (1989). Environment and genes: Determinants of behavior. *American Psychologist*, 44, 105-111.
- Plomin, R., DeFries, J. C., McClearn, G. E., & Rutter, M. (1997). *Behavioral Genetics* (3<sup>rd</sup> ed.). New York: W. H. Freeman.
- Plomin, R., Owen, M. J., & McGuffin, P. (1994). The genetic basis of complex human behaviors. *Science*, 264, 1733-1739.
- Poggio, T. (1984). Vision by man and machine. *Scientific American*, April, 68-78.
- Preuss, T. M. (1995). The argument from animals to humans in cognitive neuroscience. In M. S. Gazzaniga (Ed.), *The Cognitive Neurosciences* (pp. 1227-1241). Cambridge, MA: The MIT Press.
- Price, J., Sloman, L., Gardner, R., Jr., Gilbert, P., & Rohde, P. (1994). The social competition hypothesis of depression. *British Journal of Psychiatry*, 164, 309-315.
- Rescorla, R. A. (1988). Pavlovian conditioning: It's not what you think it is. *American Psychologist*, 43, 151-160.
- Richardson, R. C. (1996). The prospects for an evolutionary psychology: Human language and human reasoning. *Minds and Machines*, 6, 541-557.
- Ridley, M. (1996). *Evolution* (2<sup>nd</sup> ed.). Boston: Blackwell Scientific.
- Rose, S., Lewontin, R. C., & Kamin, L. J. (1984). *Not in our genes: Biology, ideology and human nature*. Harmondsworth, UK: Penguin.
- Ruse, M. (1979). *Sociobiology: Sense or Nonsense*. Dordrecht, Holland: D. Reidel.
- Ruse, M. (1987). Sociobiology and Knowledge: Is Evolutionary Epistemology a Viable Option? In C. B. Crawford, M. F. Smith, & D. L. Krebs (Eds.), *Sociobiology and psychology: Ideas, issues and applications* (pp 61-79). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Scarr, S. (1992). Developmental theories for the 1990s: Development and individual differences. *Child Development*, 63, 1-19.
- Scarr, S. (1993). Biological and cultural diversity: The legacy of Darwin for development. *Child Development*, 64, 1333-1353.
- Seligman, M. E. P. (1971). Phobias and preparedness. *Behavior Therapy*, 2, 307-320.
- Seligman, M. E. P., & Hager, J. L. (Eds.) (1972). *Biological boundaries of learning*. New York: Meredith Corporation.
- Selzer, J. (Ed.) (1993). *Understanding scientific prose*. Madison, WI: University of Wisconsin Press.
- Simpson, J. A., & Kenrick, D. T. (Eds.) (1997). *Evolutionary Social Psychology*. Mahwah, NJ: Lawrence Erlbaum.

- Skinner, B. F. (1983). A better way to deal with selection. *The Behavioral and Brain Sciences*, 3, 377-378.
- Sober, E. (1987). What is Adaptationism? In J. Dupré (Ed.), *The latest on the best: Essays on evolution and optimality* (pp. 105-118). Cambridge, MA: The MIT Press.
- Sperber, D. (1994). The modularity of thought and the epidemiology of representations. In L. A. Hirschfeld & S. A. Gelman (Eds.), *Mapping the mind: Domain specificity in cognition and culture* (pp. 39-67). Cambridge, UK: Cambridge University Press.
- Sperry, R. W. (1993). The impact and promise of the cognitive revolution. *American Psychologist*, 48, 878-885.
- Springer, K., & Berry, D.S. (1997). Rethinking the role of evolution in the ecological model of social perception. In J. A. Simpson & D. T. Kenrick (Eds.), *Evolutionary social psychology* (pp. 49-72). Mahwah, NJ: Lawrence Erlbaum Associates.
- Stanislaw, H. (1991). Why Aren't We All Darwinians? *American Psychologist*, 46, March, 248.
- Stevens, A., & Price, J. (1996). *Evolutionary psychiatry: A new beginning*. London: Routledge.
- Sulloway, F. J. (1979/1992). *Freud, biologist of the mind: Beyond the psychoanalytic legend*. Cambridge, MA: Harvard University Press.
- Surbey, M. K. (1998). Developmental psychology and modern Darwinism. In C. B. Crawford & D. L. Krebs (Eds.), *Handbook of evolutionary psychology. Ideas, issues and applications* (pp. 369-403). Mahwah, NJ: Lawrence Erlbaum Associates.
- Symons, D. (1987). If we're all Darwinians, what's all the fuss about? In C. B. Crawford, M. F. Smith, & D. L. Krebs (Eds.), *Sociobiology and psychology: Ideas, issues and applications* (pp. 121-146). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Symons, D. (1992). On the use and misuse of Darwinism in the study of human behavior. In Barkow, Cosmides & Tooby (Eds.), *The adapted mind: Evolutionary psychology and the generation of culture* (pp. 137-162). New York: Oxford University Press.
- Todd, J. T. (1987a). Learning by instinct: Comment. *Scientific American*, 256(4), 4.
- Todd, J. T. (1987b). The great power of steady misrepresentation: Behaviorism's presumed denial of instinct. *Behavior Analyst*, 10, 117-118.
- Tooby, J. (1982). Pathogens, polymorphism, and the evolution of sex. *Journal of Theoretical Biology*, 97, 557-576.
- Tooby, J. (1988). The emergence of evolutionary psychology. In D. Pines (Ed.), *Proceedings of the founding workshops of the Santa Fe Institute, Santa Fe, New Mexico, 1* (pp. 67-76). Redwood City, CA: Addison-Wesley Publishing Company.
- Tooby, J., & Cosmides, L. (1990a). On the universality of human nature and the uniqueness of the individual: The role of genetics and adaptation. *Journal of Personality*, 58, 17-67.
- Tooby, J., & Cosmides, L. (1990b). The past explains the present: Emotional adaptations and the structure of ancestral environments. *Ethology and Sociobiology*, 11, 375-424.
- Tooby, J., & Cosmides, L. (1992). The psychological foundations of culture. In Barkow, Cosmides & Tooby (Eds.), *The adapted mind: Evolutionary psychology and the generation of culture* (pp. 19-136). New York: Oxford University Press.
- Tooby, J., & Cosmides, L. (1995). Mapping the evolved functional organization of mind

- and brain. In M. S. Gazzaniga (Ed.), *The Cognitive Neurosciences* (pp. 1185-1197). Cambridge, MA: The MIT Press.
- Tooby, J., & DeVore, E. (1987). The reconstruction of hominid behavioral evolution through strategic modeling. In W. G. Kinzey (Ed.), *The evolution of human behavior: Primate models* (pp. 183-237). Albany, NY: State University of New York Press.
- Trevarthen, C. (1980). The foundations of intersubjectivity: Development of interpersonal and cooperative understanding in infants. In D. R. Olson (Ed.), *The social foundations of language and thought: Essays in honor of Jerome S. Bruner* (pp. 316-342). New York: W.W. Norton & Company.
- Trivers, R. L. (1971). The evolution of reciprocal altruism. *The Quarterly Review of Biology*, 46, 35-57.
- Trivers, R. L. (1972). Parental investment and sexual selection. In B. Campbell (Ed.), *Sexual selection and the descent of man, 1871-1971* (pp. 136-179). Chicago: Aldine.
- Trivers, R. L. (1985). *Social evolution*. Menlo Park, CA: Benjamin/Cummings.
- Voltaire. (1759/1993). *Candide: Or optimism*. Ware, UK: Wordsworth Editions Limited.
- Wason, P. C. (1966). Reasoning. In B. Foss (Ed.), *New horizons in psychology, 1* (pp. 135-151). Harmondsworth, UK: Penguin.
- Wason, P. C. (1983). Realism and rationality in the selection task. In J. St B. T. Evans, (ed.), *Thinking and reasoning: Psychological approaches* (pp. 44-75). London: Routledge and Kegan Paul.
- Webster, R. (1996). *Why Freud was wrong: Sin, science and psychoanalysis* (Rev. ed.). London: HarperCollins.
- Wells, A. (1998). Evolutionary Psychology and theories of cognitive architecture. In C. B. Crawford & D. L. Krebs (Eds.), *Handbook of evolutionary psychology. Ideas, issues and applications* (pp. 235-264). Mahwah, NJ: Lawrence Erlbaum Associates.
- Williams, G. C. (1966). *Adaptation and Natural Selection*. Princeton, NJ: Princeton University Press,
- Williams, G. C. (1985). A defence of reductionism in evolutionary biology. *Oxford Surveys in Evolutionary Biology*, 2, 1-27.
- Williams, G. C., & Nesse, R. M. (1991). The dawn of Darwinian medicine. *The Quarterly Review of Biology*, 66, 1-22.
- Wilson, D. S. (1997). Incorporating group selection into the adaptationist program: A case study involving human decision making. In J. A. Simpson & D. T. Kenrick (Eds.), *Evolutionary social psychology* (pp. 345-386). Mahwah, NJ: Lawrence Erlbaum Associates.
- Wilson, E. O. (1975). *Sociobiology: The New Synthesis*. Cambridge, MA: Belknap Harvard.