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Social sciences are branches of biology

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Since biology is the study of living organisms, their behaviour and social systems, and since humans are living organisms, it is possible to suggest that social sciences (the study of human behaviour and social systems) are branches of biology and all social scientific theories should be consistent with known biological principles. To claim otherwise and to establish a separate science only for humans might be analogous to the establishment of *hydrogenology*, the study of hydrogen separate from and inconsistent with the rest of physics. Evolutionary psychology is the application of evolutionary biology to humans, and provides the most general (panspecific) explanations of human behaviour, cognitions, emotions and human social systems. Evolutionary psychology's recognition that humans are animals can explain some otherwise perplexing empirical puzzles in social sciences, such as why there is a wage penalty for motherhood but a wage reward for fatherhood, and why boys produce a greater wage reward for fathers than do girls. The General Social Survey data illustrate the evolutionary psychological argument that reproductive success is important for both men's and women's happiness, but money is only important for men's.

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> Blessed be the biologically ignorant for they shall see the Kingdom of Sociology.
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> (van den Berghe, 1990, p. 177)

1. Hydrogenology, anyone?

Biology is the scientific study of all living organisms, their behaviour and social systems. Human beings are living organisms. Thus, it is possible to suggest, as do

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Daly and Wilson (1999) and van den Berghe (1990), that social sciences (the study of human behaviour and social systems) may be within the purview of biology. Social sciences could be branches of biology, and all social scientific theories might be consistent with established principles and laws of biology.

Yet most social scientists would object to such subsumption of social sciences under biology, and claim that the uniqueness of the human species would require a separate science (van den Berghe, 1990; Ellis, 1996). Some would even claim that such uniqueness makes humans independent of and immune to laws and principles of biology; biology is not important for human behaviour. For instance, the 168 sociologists surveyed by Ellis (1996, Table 2) on average attribute only 4.7% of sex differences in occupational interests, and 15.3% of sex differences in aggressive criminality, to biological (genetic, prenatal and postnatal non-social) factors. A typical sociologist therefore believes that nearly 85% of the variance in sex differences in violence and aggression is explained by purely social and cultural factors like gender socialization.

There is no question that humans are unique; however, they may not unique in being unique (van den Berghe, 1990, pp. 174–6). In some ways, every species is unique. If uniqueness of a species required a separate scientific discipline, there would have to be as many scientific disciplines as there are species (dog science, cat science, giraffe science, etc.).[1] In reality, biology covers *all* species in nature, *except* for humans, or so appears to go the conventional wisdom in social sciences.

I suggest that to claim that social sciences are not part of biology and to establish a separate and incompatible science just for humans may be as peculiar and unnecessary as the establishment of *hydrogenology*, the study of hydrogen apart from, and incompatible with, physics. Yet I believe the idea of hydrogenology separate from physics makes as much sense as the idea of social sciences separate from biology. Hydrogen is a unique element: it is by far the most abundant element in the universe; it is the lightest and simplest element; it is the only element whose nucleus does not contain a neutron; it has the fewest number of isotopes in nature; it has extremely low boiling and melting points; the hydrogen molecule is the simplest molecule; it has a velocity higher than any other gas at any given temperature and it therefore diffuses faster than any other gas . . . the list goes on.

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[1] Humans may not be quite as unique or different from other species as we once thought, however. Culture, deliberate deception, homosexuality, Machiavellian intelligence, morality, murder, rape, romantic love, self-awareness, symbolic communication, sympathy and compassion, and tool use were all once thought to be uniquely human. The latest research has shown them all to exist among other species. (Culture (McGrew, 1998; Wrangham *et al.*, 1994); deliberate deception (de Waal, 1992); homosexuality (de Waal, 1995; Bagemihl, 2000); Machiavellian intelligence (Byrne and Whiten, 1988); morality (de Waal, 1996); murder (Goodall, 1986; Wrangham and Peterson, 1996); rape (Thornhill, 1980; Wrangham and Peterson, 1996, pp. 132–43); romantic love (Leighton, 1987; Smuts, 1985); self-awareness (Parker, Mitchell and Boccia, 1995); symbolic communication (Savage-Rumbaugh and Lewin, 1994); sympathy and compassion (de Waal, 1996); tool use (van Lawick-Goodall, 1964, 1968).)

Yet it is unnecessary to establish hydrogenology devoted only to the study of hydrogen because physics constructs *general* laws and principles applicable to all elements, including hydrogen. Boyle's Law and Avogadro's Law hold for hydrogen as they do for all other gases despite its uniqueness. Physics as a science has advanced as it has because it does not make exceptions; it formulates general laws and principles that apply to all elements, not specific ones for each element.

Of course, physicists, like other scientists, specialize in certain elements: some are elementary particle physicists; others are condensed matter physicists. So there is nothing wrong with some scientists specializing in human behaviour. In chemistry, some specialize in the study of carbon compounds, but nothing in 'carbonology' (organic chemistry) is inconsistent with the general principles of chemistry.[2] I am *not* calling for the elimination of social sciences, only its subsumption as 'human biology'. Hirshleifer (1977, 1978) has long been an advocate of such subsumption of social sciences (economics, in particular) into biology. Wilson (1998) most comprehensively and emphatically calls for the unity, or *consilience*, of all sciences and humanities (such as arts, literature, music and ethics), guided by the principles of evolutionary biology.

Most social scientists do not see how the same laws of biology hold for humans as they do for all other species. For instance, most social scientists claim that, even though all other species have an innate, species-typical nature, which determines how members of the species behave, humans are an exception and have no innate nature; humans are born blank slates and all of their behaviour is determined by socialization and other environmental factors (Pinker, 2002). Most social scientists do not see how such human exceptionalism, their tendency to formulate theories specific only to humans, has hindered the development of social sciences.

Hydrogenology apart from physics is not necessary, because hydrogen, while unique, is only quantitatively, not qualitatively, different from other elements. Hydrogen is a distinct element from helium, but helium is nothing but hydrogen with an extra pair of proton and electron, and lithium, while distinct from hydrogen and helium, is nothing but helium with an extra pair of proton and electron. All elements are the same, except in the number of protons and electrons they contain; all unique properties of different elements derive from it. That is why the same laws and principles of physics apply to all elements, regardless of their unique natures.

The same may be true of biological organisms. Humans are a distinct species from chimpanzees, but it is possible to suggest that chimpanzees are nothing but humans with a few percentage points of genome altered, and gorillas are a few more percentage points away. All animal species are the same, except for the genes contained in their genomes. All laws and principles of biology may apply to humans

[2] I thank one anonymous reviewer for the example of organic chemistry as 'carbonology'.

as they do to all other animal species. Biology's *reductionism* (classifying all biological organisms in terms of their genetic make-up, and explaining their behaviour and social systems by the same set of principles of evolutionary biology) and *generality* (not making exceptions for any species) allow it to be applicable to all species. Reductionism and generality are two important principles of science, and, contrary to what most social scientists think, all good science is reductionist (Ridley, 1999, pp. 231–42; Weinberg, 1992, pp. 51–64).[3]

It is important to reiterate, however, that the reductionist approach that I advocate here decidedly does *not* mean that physics, the most fundamental of all sciences, can explain everything in nature, including human behaviour and social organization, *by itself*. Higher-level, emergent phenomena require separate laws, in addition to more fundamental laws, for their explanation. In other words, reductionism does not mean that we can do away with higher-level sciences, such as social sciences. The elementary particle physicist and Nobel laureate Steven Weinberg (2001), probably the strongest popular proponent of reductionism in science, puts it best.

> I do believe there is a sense in which everything is explained by the laws of nature and the laws of nature are what physicists are trying to discover. *But the explanation is an explanation in principle of a sort that doesn't in any way threaten the autonomy of the other sciences.* We see this even within physics itself. The study of statistical mechanics, the behaviour of large numbers of particles, and its applications in studying matter in general, like condensed matter, crystals, and liquids, is a separate science because when you deal with very large numbers of particles, new phenomena emerge. To take an example I have used elsewhere, even if you tried the reductionist approach and plotted out the motion of each molecule in a glass of water using equations of molecular physics to follow how each molecule went, nowhere in the mountain of computer tape you produced would you find the things that interested you about the water, things

[3] Critics might argue that the success of chaos and complexity theories contradicts reductionism and highlights the importance of *emergence* and *holism*. Their success may be temporary, however. Abell (2003, p. 22; emphases added) discusses the distinction between *strong* and *weak* emergence.

> By strong emergence I shall mean the doctrine that *in principle* macro states cannot be reduced to (or deduced from) micro states; nor can macro causal connections. Weak emergence, on the other hand, may be used to describe situations where, *in practice*, given our present intellectual understanding, it proves impossible to find an acceptable micro reduction.

I have no doubt that, given the current state of knowledge, there are many phenomena which we cannot explain at a lower level of aggregation and thus that computer simulations provide useful tools for analyzing chaos and complexity. In other words, I believe in Abell's *weak* emergence. However, I fully concur with Abell (2003, p. 22) in rejecting strong emergence; I believe all phenomena are *in principle* explainable by mechanisms at a lower level of aggregation, in combination with additional laws at a higher level, even though we cannot do so currently and for many years and decades to come.

> like turbulence, or temperature, or entropy. Each science deals with nature on its own terms because each science finds something else in nature that is interesting. Nevertheless, there is a sense that the principles of statistical mechanics are what they are because of the properties of the particles out of which bodies are composed. *Statistical mechanics does not have principles that stand alone and cannot be deduced from a deeper level.* (p. 40, emphases added)
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> No one thinks that the phenomena of phase transitions and chaos . . . could have been understood on the basis of atomic physics without creative new scientific ideas, but does anyone doubt that real materials exhibit these phenomena because of the properties of the particles of which the materials are composed ? (p. 18)

Similarly, laws of evolutionary biology *alone* cannot explain why some men become career criminals while others become law-abiding citizens, or why some marriages last forever while others end in divorce, let alone why wars and revolutions occur or why some economies are more successful than others. In order to explain these macrolevel, emergent phenomena, one needs laws of sociology, political science and economics. However, these additional laws of social sciences cannot be inconsistent with more fundamental laws of evolutionary biology; for instance, a complete macrosociological theory of revolutions cannot contain an assumption which states that human actors equally value the welfare of their own genetic offspring and that of someone else's offspring or that men and women are equally predisposed to engage in physical violence. It is in this limited sense that I believe social sciences are branches of biology.

Tooby and Cosmides (1992, p. 19) remind us that, before Galileo and Newton, celestial science (about the motions of heavenly bodies) and terrestrial science (about the movements of objects on earth) were considered to be separate sciences, governed by separate sets of laws and principles. It was a huge step forward in the history of science to break down the wall of separation between them, as Galileo and Newton did, and to recognize that the same set of laws and principles applies to both celestial and terrestrial bodies. I suggest it's about time that we did the same with regard to the human sciences (social sciences) and non-human sciences (biology).

It appears, however, that the days of human exceptionalism may finally be numbered (Alcock, 2001). Theory and research in the emerging field of evolutionary psychology have demonstrated that humans are animals and therefore subject to the same laws and principles of evolutionary biology governing the behaviour of all other animal species. The introduction of evolutionary psychology into social sciences, as if the latter were branches of biology, may help us understand human behaviour and human social systems as completely as physicists understand elementary behaviour. It can also help us solve some otherwise perplexing empirical puzzles about human behaviour.

2. Principles of evolutionary psychology[4]

Every species has its unique nature. Humans are no exception. Evolutionary psychology (EP) is the study of universal human nature, which is a collection of domain-specific evolved psychological mechanisms. *An evolved psychological mechanism* is an information-processing procedure or decision rule that evolution by natural and sexual selection has equipped humans to possess in order to solve a particular adaptive problem (a problem of survival or reproduction). Unlike decision rules in microeconomic subjective expected utility maximization theory or game theory, however, evolved psychological mechanisms *mostly* operate behind and beneath conscious thinking.

Figure 1 presents the basic theoretical structure of EP. Some adaptive problem during the course of human evolutionary history has led to the evolution of psychological mechanisms through natural and sexual selection. Individuals who possess certain psychological mechanisms live longer (because the psychological mechanisms help them survive) and reproduce more successfully (because the psychological mechanisms help them find and keep mates and invest in their offspring). Those with such psychological mechanisms outreproduce those without them in each generation, and more and more individuals come to possess the psychological mechanisms generation after generation. Eventually, all individuals come to possess them, and they become part of universal (species-typical) human nature. Evolved psychological mechanisms then engender desires, values, preferences, emotions and other internal states which serve as the proximate causes of behaviour (Kanazawa, 2001*a*).

Our preference for sweets and fats is an example of an evolved psychological mechanism (Barash, 1982, pp. 144–7). Throughout most of human evolutionary history, procurement of sufficient calories to sustain the body physically was a particularly severe problem of adaptation (survival); malnutrition was a common problem. In this environment, those who had a 'taste' for sweets and fats (which contain higher calories) were better off physically than those who did not have such a taste. Those who had this taste therefore lived longer, led healthier lives and produced higher-quality offspring than those who didn't. They in turn passed on their taste to their offspring, over many thousands of generations, until most of us living today have a strong preference for sweets and fats. (See Buss, 1995, pp. 5–9 for other examples of evolved psychological mechanisms.)

I must emphasize two important principles of EP here. First, and to reiterate, *evolved psychological mechanisms mostly operate unconsciously*. We do not consciously choose or decide to like sweets and fats. We just like them but otherwise don't know why; sweet and fatty foods just taste good to us. Humans (just like

[4] Excellent introductions to evolutionary psychology include Barkow, Cosmides and Tooby (1992), Buss (1999), Cartwright (2000), Ridley (1993), and Wright (1994).

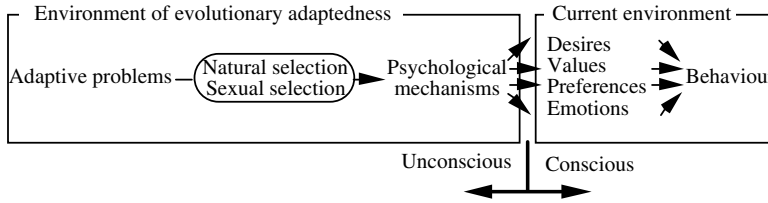

Figure 1 The basic theoretical structure of evolutionary psychology.

members of other species) are not always privy to the evolutionary logic behind our psychological mechanisms. We are, however, aware of the desires, values, preferences and emotions that our psychological mechanisms engender in us, and we consciously and rationally set about to pursue these goals within our constraints (Kanazawa, 2001*a*). Second, *evolved psychological mechanisms need only have been adaptive in the environment in which they evolved, called the environment of evolutionary adaptedness* (EEA or 'EEAs', to the extent that there were some important variations in the environments in which our ancestors lived).[5] For the most part, the EEA is the African savanna during the Pleistocene epoch about 200 000 to 50 000 years ago (Maryanski and Turner, 1992, pp. 69–90).[6] To the extent that our current environment is radically different from the EEA, our evolved psychological mechanisms might produce maladaptive behaviour (Eaton and Konner, 1985; Eaton, Konner and Shostak, 1988). Our preference for sweets and fats solved the adaptive problem of survival and reproduction in the EEA, where malnutrition and starvation were prevalent. However, we now live in an environment where sweets and fats are abundantly available; in other words, the original adaptive problem no longer exists. Yet we still possess the same psychological mechanism to compel us to consume sweets and fats. We therefore face a curious situation now where those

[5] I thank one anonymous reviewer for bringing up the concept of the EEAs.

[6] As a first approximation, it might be useful to think of the EEA as the African savanna during the Pleistocene epoch, because this is indeed where many psychological mechanisms evolved. Technically, however, the EEA 'is not a place or a habitat, or even a time period. Rather, it is 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' (Tooby and Cosmides, 1990, pp. 386–7). In other words, the EEA might be different for different adaptations.

For instance, in order to pinpoint the EEA for our taste for sweets and fats as an adaptation, we need to consider the entire period of evolution from the time when we did not have this taste (probably long before we were human) until the time when all humans had this psychological mechanism. This is probably the period during which malnutrition was a particular problem for survival. Further, we must emphasize the period during which malnutrition was more prevalent (weight by frequency) and during which those with this taste for sweets and fats had particularly greater reproductive success than those without it (weight by fitness-consequences).

who behave according to the dictates of the evolved psychological mechanism are *worse off* in terms of survival and reproduction. Obesity (to which overconsumption of sweets and fats leads) hinders both survival and successful reproduction. When the environment changes too rapidly for evolution to catch up (as human civilization has in the last 10 000 years), our evolved psychological mechanisms often produce maladaptive behaviour, due to the mismatch between the EEA and the current environment.

EP strongly rejects the view of the human mind as a *tabula rasa*, and avers instead that it is content-rich and biased (Pinker, 2002). The human brain, and all of its psychological mechanisms, are adapted to the EEA and are therefore biased in favour of viewing and responding to the world as if it were still the EEA (Kanazawa, 2004). For instance, because TV did not exist in the EEA, humans have difficulty distinguishing between their real friends and imaginary ones they see on TV, and as a consequence respond to both similarly (Kanazawa, 2002). It is not impossible to overcome this bias through conscious effort, but it is often difficult. This is why we still respond to sweets and fats today as if we still lived in the EEA, where such high-calorie foods were rare and malnutrition was an imminent problem for survival (even though many of us can consciously overcome the urge).

Phobias provide another example. Most humans have deep-seated and innate phobias in respect of spiders and snakes (Marks, 1987; Nesse, 1990). This is because spiders and snakes, many species of which are poisonous, represented genuine threats to human survival in the EEA. That is why humans have innate physical mechanisms (either freezing or fleeing) to deal with these threats. Humans have been selected to have the psychological mechanism to fear spiders and snakes and the physical mechanisms to freeze or flee to avoid the danger.

This is true even today. Even though very few of us, living in cities, ever encounter poisonous spiders and snakes, we still have phobias about them. For most of us, cars and guns represent far greater dangers for survival than spiders and snakes; far more people in the United States die in car accidents and from gunshot wounds than from spider or snake bites. However, most of us still have an innate and strong fear of spiders and snakes, rather than cars and guns, because our brain and its psychological mechanisms are biased to perceive our environment as if it were the EEA, where there were no cars and guns (Buss, 1999, pp. 62–3). This fundamental observation, that *our brain and its psychological mechanisms are strongly biased to view and respond to the world as if it were still the EEA*, helps us solve some of the empirical puzzles in social sciences.

3. Puzzles: wage penalty for motherhood, wage reward for fatherhood (and bigger reward from boys than girls)

In a recent study, Budig and England (2001) find that mothers earn less than non-mothers with similar characteristics. The negative effect of motherhood on

wages is greater for married mothers than for unmarried mothers. Their finding is in stark contrast to Lundberg and Rose's (2000) discovery that fathers earn more than non-fathers with similar characteristics. In other words, there appears to be a wage penalty for motherhood and a wage reward for fatherhood.

Both Budig and England (2001) and Lundberg and Rose (2000) use a statistical technique called the fixed-effect model. By using two data points for each individual, before and after parenthood, the fixed-effect model controls for all unobserved heterogeneity, and allows these authors to rule out the possibility of selection bias. In other words, Budig and England (2001) demonstrate that it is *not* because women with lower earning capacities are more likely to become mothers that mothers earn less than non-mothers, and Lundberg and Rose (2000) demonstrate that it is *not* because men with higher earning capacities are more likely to become fathers that fathers earn more than non-fathers. It is motherhood itself that reduces wages, and it is fatherhood itself that increases them.

Further, Lundberg and Rose (2002) find, once again using the fixed-effect model, that such 'wage reward' for fatherhood is greater if the men have boys than if they have girls. Men earn more, and work longer hours, in response to the birth of sons than to that of daughters. What accounts for these peculiar patterns? What explains the puzzling fact that motherhood carries a wage penalty but fatherhood carries a wage reward, and that such wage reward for fatherhood is greater if the men have sons than if they have daughters?

The traditional social sciences, which set themselves apart from biology and conceive of men and women as the interchangeable unitary actor, as *Homo economicus*, may have difficulty accounting for this exact patterns of empirical findings. These empirical puzzles may begin to make sense once we realize that men and women are nothing but biological organisms, subject to all the laws and principles of evolutionary biology.

4. The meaning of life from the evolutionary psychological perspective

From the biological perspective, the meaning of life is equivalent to its evolutionary function: reproductive success (Dennett, 1995). We are designed by evolution by natural and sexual selection to reproduce. The fact that many of us don't think that's the ultimate meaning of life or that some of us choose not to reproduce is irrelevant. We are not privy to the evolutionary logic behind our design, and, no matter what we choose to do in our own lifetimes, we are all descended from people who chose to reproduce. None of us inherited our psychological mechanisms from our ancestors who remained childless.

Whether we like it or not, whether we know it or not, reproductive success, creating as many copies of our genes as possible, is the ultimate purpose of life for all living organisms, and everything else, even survival, is a means toward it (Dawkins, 1989).

For humans, a *K*-strategy species,[7] this means that they reproduce a small number of children and invest heavily in them so that they will all reach the age of sexual maturity and reproduce themselves. Having children in itself does not necessarily guarantee reproductive success. If many or most of them die before they can reproduce themselves, then the parents have managed to leave very few copies of their genes. Parents instead must make sure that their children themselves will have children.

Throughout the human evolutionary history, the attainment of reproductive success most often required *biparental care*. In other words, unlike most species in nature, where male parental investment in the offspring is limited to the sperm deposited inside the female during copulation, men invest heavily in their children to ensure their survival to sexual maturity (even though male parental investment even among humans is never as high as female parental investment) (Trivers, 1972). The more the father invests in the children, the greater the likelihood of their survival to sexual maturity.

Throughout evolutionary history, offspring of men of higher social status and greater political power have had much better chance of survival to sexual maturity, because their fathers could use their status and power to protect them (Betzig, 1986). Women therefore competed to mate with men of higher status and power, and men competed to attain status and power to attract women. Throughout evolutionary history, status and power were men's means of reproductive success, the ultimate goal of all biological organisms, whereas physically taking care of their children was women's. In the current environment of capitalist market economy, however, both men's quest for status and their investment in their offspring often involve material resources (such as money) because status and power often correlate positively with resources. I suggest that this is why men earn more and work longer hours when they become fathers, so that they can invest more in their children and attain greater reproductive success. By the same token, women earn less when they become mothers because accumulating material resources was not their means to reproductive success and women cannot physically take care of the children and earn as much as they did before motherhood, given their time and energy constraints. This is probably also why Budig and England's (2001) analysis shows that married mothers earn less than unmarried mothers. Unlike unmarried mothers, married mothers can depend on their husbands to earn the material resources to invest in their children.

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[7] *K*-strategy species, such as humans and other great apes, reproduce a few offspring, and care for and invest in them heavily to ensure that most or all of them will grow to sexual maturity. In contrast, *r*-strategy species, such as most fish species, reproduce millions of offspring at a time but do not care for or invest in them at all (MacArthur and Wilson, 1967). Even humans with the largest number of children (say, 20) still find themselves on the extreme *K*-strategy end of the continuum, relative to species that reproduce millions of offspring.

Recall that evolved psychological mechanisms mostly operate beneath and behind conscious thinking. I am *not* necessarily arguing that this is how men and women think consciously. Whether they are consciously aware of the evolutionary logic behind their desires and preferences is immaterial to EP. I am arguing that men *feel like* working longer hours and earning more money after they become fathers, and women *feel like* spending more time taking care of their children. They are not necessarily privy to the evolutionary logic behind their desires and preferences. All the 'thinking' has already been done by evolution, so to speak, and it simply 'equips' humans with certain desires and preferences. Men and women simply do what they feel like doing or want to do.

Now what about the fact that boys produce greater 'wage reward' for fatherhood than girls do? Unbeknownst to social scientists, who have operated in total isolation from biology, evolutionary biologists have known this for over a quarter of a century. They could have easily predicted this pattern 27 years before Lundberg and Rose (2000) discovered it.

Trivers and Willard (1973) argue that, for all species for which male fitness variance exceeds female fitness variance, such as all mammalian species, male offspring of parents in better material and nutritional conditions are expected to have greater reproductive success than their female siblings, because their greater size allows them to outcompete their intrasexual rivals and monopolize available reproductive opportunities. The converse is true of offspring of parents in poorer material and nutritional conditions, because the smaller males, who are not intrasexually competitive, are excluded from the mating opportunities. Parental conditions affect the reproductive prospect of female offspring to a much lesser extent because almost all of them get to reproduce.

Since males have a greater variance in reproductive success, good material and nutritional condition of the parents can translate into a reproductive windfall for a male offspring, as the advantaged male offspring may hope for reproductive success in the higher range of the male distribution. Thus it pays parents in good condition to bet on male rather than female offspring. Since females have much lower variance in reproductive success, parents in poor material and nutritional condition prefer to produce females as a safe bet because most females eventually produce some offspring, even though no female can produce a very large number because of greater female parental investment in each offspring (Trivers, 1972).[8]

Trivers and Willard (1973) thus hypothesize that parents in better conditions should produce more male than female offspring and those in poorer conditions should produce more female than male offspring. Their parental investment in male and female offspring should be similarly biased. These predictions have been supported by data from a large number of species.

[8] I thank one anonymous reviewer for the correct interpretation of the Trivers–Willard hypothesis.

Evolutionary social scientists have since applied the original formulation of the Trivers–Willard hypothesis to humans, and derived further hypotheses specific to humans from Trivers and Willard's original insight. Sons' expected reproductive success depends largely on the parents' wealth, so that sons from wealthy families are expected to attain much greater reproductive success than sons from poor families. This is because sons from wealthy families typically inherit the wealth from their fathers, and can in turn invest the resources in their offspring. Women prefer men with greater resources, and thus wealthy men throughout human evolutionary history have been able to attract a large number of high-quality mates (Betzig, 1986).

In contrast, daughters' expected reproductive success is largely orthogonal to parents' wealth, because it mostly depends on their youth and physical attractiveness. Men in general prefer younger and physically more attractive women, not wealthy women, for their mates (Buss, 1989; Kanazawa, 2003). The Trivers–Willard hypothesis has been supported with data from a wide variety of human societies, including the contemporary United States (Betzig and Weber, 1995; Gaulin and Robbins, 1991; Kanazawa, 2001*b*), although Freese and Powell (1999) and Keller, Nesse and Hofferth (2001) offer counterevidence. Cronk (1991) provides a comprehensive review of the empirical evidence in support of the hypothesis.

I suggest that this is why sons produce a greater reward for fatherhood than do daughters. Fathers with sons can increase their reproductive success if they accumulate more resources because they can then pass them on to their sons so that they can attract more mates. Fathers with daughters cannot similarly increase their reproductive success because their daughters' (and thus their own) reproductive success hinges on factors largely independent of wealth (youth and physical attractiveness). The Trivers–Willard effect also explains why couples with sons are less likely to divorce than couples with only daughters (Morgan, Lye and Condran, 1988; Katzev, Warner and Acock, 1994). Fathers' parental investment is far more important for sons' future reproductive success than daughters'. Once again, all of this happens largely unconsciously. Fathers *feel like* working longer hours and making more money, or staying longer in marriage, when they have a son than when they have a daughter, but they usually don't know why.

5. What makes us happy?

If this biological view of humans is correct, then attaining reproductive success should increase our subjective happiness. Throughout evolutionary history, finding a mate has always been a significant adaptive problem for our ancestors (Buss, 1994), and many men, in particular, ended their lives without finding any mate. Once our ancestors found a mate and 'got married' (by forming a long-term pair-bond), however, reproductive success (having children) followed as a necessary

and immediate consequence of regular mating. In the absence of reliable means of contraception, regular copulation and reproduction in the ancestral environment were essentially the same thing (Kanazawa, 2003), except for the few who were biologically infertile, but we are not descended from them and thus have not inherited their psychological mechanisms.

Evolutionary psychological logic thus predicts that both men and women should be much happier if they are married than if they are not, because marriage (finding and keeping a regular mate) signifies the solution of the most difficult obstacle toward reproductive success. Further, the same logic would predict that, because high social status is an effective means to men's reproductive success, the accumulation of material resources, which highly correlates with and predicts men's social status in the capitalist market economy, should increase men's happiness. In contrast, since social status is not an effective means to women's reproductive success, the accumulation of material resources should not increase women's happiness. Men should be far more single-minded in their pursuit of material resources than women are (Browne, 2002). Of course, income and economic welfare are prerequisite for health, which is crucial for motherhood and the subsequent health of the baby. However, in advanced societies like the contemporary United States, from which my data come, virtually everyone, even the poorest person, meets the minimum requirement for physical health and welfare. Very few Americans today have health problems because they are too poor.

Table 1 presents an analysis of data from the General Social Survey (1972–98). I present the empirical data here only for illustrative purposes, not as a rigorous empirical test of competing hypotheses. Because the dependent variable measuring happiness is ordinal (1 = 'not too happy', 2 = 'pretty happy', 3 = 'very happy'), I use ordinal regression (McCullagh, 1980). The results in Table 1 show that, controlling for age, race (black = 1), education and survey year, being currently married significantly (ps < 0.001) increases both men's and women's happiness. This finding is consistent with earlier reports of the strong positive effect of marriage on happiness (Waite and Lehrer, 2003). The interaction between being currently married and having children is also significant for both men ($p < 0.01$) and women ($p < 0.001$), suggesting that being married with children significantly increases the respondent's happiness.

In addition, the respondent's income (measured in 12 ordinal categories) significantly ($p < 0.001$) increases men's happiness, but it has no effect on women's happiness. Both of these patterns are consistent with the evolutionary psychological predictions. Incidentally, the strongly significantly ($p < 0.001$) negative effect of survey year on women's happiness demonstrates that women have gradually become less and less happy in the United States over the last quarter-century, when men's happiness has marginally significantly ($p < 0.10$) increased over the same period.

Table 1 What makes us happy? (ordinal regression)

	Women	Men
Reproductive success		
Currently married	0.750***	0.775***
	(0.062)	(0.063)
Parenthood	−0.356***	−0.500***
	(0.046)	(0.058)
Interaction	0.210**	0.324***
	(0.071)	(0.079)
Money		
Income	0.006	0.020***
	(0.004)	(0.004)
Controls		
Age	0.008***	0.011***
	(0.001)	(0.001)
Race (black = 1)	−0.518***	−0.378***
	(0.041)	(0.051)
Education	0.063***	0.030***
	(0.005)	(0.005)
Year	−0.007***	0.004
	(0.002)	(0.002)
Threshold (Y = 1)	−15.265	6.742
	(3.848)	(4.285)
(Y = 2)	−12.393	9.695
	(3.847)	(4.285)
Pseudo R^2 (Cox and Snell)	0.074	0.065
Number of cases	19 885	15 610

Notes: Link function = logit.
Main entries are unstandardized coefficients.
Numbers in parentheses are standard errors.
*$p < 0.05$; **$p < 0.01$ ***$p < 0.001$.

There is one anomaly in the ordinal regression results presented in Table 1, however. While, consistent with my evolutionary psychological prediction, both being currently married (the main term) and being married with children (the interaction term) have significantly positive effects on happiness, for both men and women, the main term for parenthood has an equally significantly negative effect for both men and women (ps < 0.001). The negative coefficient for the main term for parenthood is slightly larger than the positive coefficient for the interaction term for both men and women, suggesting that, whether they are married or not,

having children actually reduces the respondents' *absolute* levels of happiness. How could this be? If, as I argue, the ultimate goal of all biological organisms is reproductive success, and if emotions are designed to induce organisms to engage in behaviour that helps them achieve this goal, how can individuals with children be less happy than their childless counterparts?

I believe that this anomalous finding may point to the potential limits of EP as an explanation of human behaviour in the current environment. As I note above (in section 2), all evolved psychological mechanisms are adapted to (and thus assume that we still live in) the EEA (Kanazawa, 2002, 2004). To the extent that our current environment is different from the EEA, our evolved psychological mechanisms often malfunction and misfire.

Parents today must raise their children in a radically different environment from the EEA. They must drive them to and from daycare centres and soccer practices, they must put them through compulsory schooling and pay for their higher education, they must feed, clothe and shelter them in their adolescence and early adulthood (when they would have been economically independent in the EEA soon after puberty), they must purchase computers, cars and other expensive gadgets for them, etc. The list is endless. I suspect that having to raise children in an evolutionarily novel environment might suspend the operation of evolved psychological mechanisms (and the preferences, desires and emotions they engender) and allow other mechanisms to kick in and influence their happiness. Economic and sociological theories are indispensable in explaining these other mechanisms that might overtake and supersede evolved psychological mechanisms in the current environment.

For instance, Becker (1991, pp. 135–78) presents a microeconomic model of the demand for children which not only provides alternative explanations for phenomena that EP can also explain, such as why mothers spend more time and effort taking care of their children than fathers do (see above), but can also explain phenomena for which, to my knowledge, EP has not been able to provide satisfactory explanations, such as why rural fertility is typically higher than urban fertility or why there has been a steady decline in fertility throughout the world in the last couple of centuries. (In fact, what the demographers call the 'demographic transition' and the current apparent equilibrium on the two-child family are two of the great mysteries to EP.) Becker's microeconomic model can offer satisfactory explanations to these phenomena from a rational-choice, cost–benefit perspective, with only four independent variables: price, income, demand and supply.

Given all of this, and in the current state of development of EP, it is difficult to refute Becker's contention that 'To be sure, the Darwinian theory is highly relevant to nonhuman species and, modified to include cultural selection, may also be relevant to some primitive human societies . . . However, the analysis developed here is far more suited to explaining fertility changes in Western countries during the last few centuries and in developing countries during this century' (Becker,

1991, p. 137). What Becker is unwittingly yet very presciently pointing to may be the distinction between the EEA and the current environment.

Of course, Becker himself is an unabashed reductionist like me, and thus socio-economists who are critical of reductionism may have other objections to or concerns with my call to subsume social sciences under evolutionary biology and psychology. In particular, such critics may point to the inherent difficulty in figuring out precisely what the EEA was like, tens and hundreds of thousands of years before the present, and what its implications are for human behaviour today. I welcome theoretical and empirical challenges to my argument presented here from critics of all perspectives and orientations.

6. Conclusion

If social scientists are ever to understand and explain as much variance in human behaviour as physicists are able to explain elementary behaviour, they need to commit to the scientific principles of reductionism and generality. As a practical matter, it means that whatever theories of human behaviour and social system they propose may not contradict established laws and principles of biology, just as whatever observations physicists make of hydrogen may not violate the established laws and principles of physics. One of the fundamental principles of evolutionary biology is that the ultimate goal of all living organisms is reproductive success, and humans are no exception. Conceptualizing men and women as male and female animals in pursuit of reproductive success helps us explain some otherwise puzzling empirical phenomena, such as why motherhood carries a wage penalty while fatherhood carries a wage reward, and why the wage penalty for fatherhood is greater if the men have sons than if they have daughters.

References

Abell, Peter (2003) 'On the Prospects for a Unified Social Science: Economics and Sociology', *Socio-Economic Review*, **1**, 1–26.

Alcock, John (2001) *The Triumph of Sociobiology*, New York, Oxford University Press.

Bagemihl, Bruce (2000) *Biological Exuberance: Animal Homosexuality and Natural Diversity,* New York, St Martin's Press.

Barash, David P. (1982) *Sociobiology and Behaviour*, 2nd edn, New York, Elsevier.

Barkow, Jerome H., Cosmides, Leda and Tooby, John (editors) (1992) *The Adapted Mind: Evolutionary Psychology and the Generation of Culture*, New York, Oxford University Press.

Becker, Gary S. (1991) *A Treatise on the Family,* enlarged edn, Cambridge, MA, Harvard University Press.

Betzig, Laura L. (1986) *Despotism and Differential Reproduction: A Darwinian View of History*, New York, Aldine.

Betzig, Laura and Weber, Samantha (1995) 'Presidents Preferred Sons', *Politics and the Life Sciences*, **14**, 61–4.

Browne, Kingsley R. (2002) *Biology at Work: Rethinking Sexual Equality*, New Brunswick, NJ, Rutgers University Press.

Budig, Michelle J. and England, Paula (2001) 'The Wage Penalty for Motherhood', *American Sociological Review*, **66**, 204–25.

Buss, David M. (1989) 'Sex Differences in Human Mate Preferences: Evolutionary Hypotheses Tested in 37 Cultures', *Behavioural and Brain Sciences*, **12**, 1–49.

Buss, David M. (1994) *The Evolution of Desire: Strategies of Human Mating*, New York, Basic Books.

Buss, David M. (1995) 'Evolutionary Psychology: A New Paradigm for Psychological Science', *Psychological Inquiry*, **6**, 1–30.

Buss, David M. (1999) *Evolutionary Psychology: The New Science of the Mind*, Boston, MA, Allyn and Bacon.

Byrne, Richard W. and Whiten, Andrew (1988) *Machiavellian Intelligence: Social Expertise and the Evolution of Intellect in Monkeys, Apes, and Humans*, Oxford, Oxford University Press.

Campbell, Anne (2002) *A Mind of Her Own: The Evolutionary Psychology of Women,* Oxford, Oxford University Press.

Cartwright, John (2000) *Evolution and Human Behaviour: Darwinian Perspectives on Human Nature,* Cambridge MA, MIT Press.

Cosmides, Leda and Tooby, John (1992) 'The Psychological Foundations of Culture', pp. 19–136 in *The Adapted Mind: Evolutionary Psychology and the Generation of Culture*, New York, Oxford University Press.

Crittenden, Danielle (1999) *What Our Mothers Didn't Tell Us: Why Happiness Eludes the Modern Women*, New York, Touchstone.

Cronk, Lee (1991) 'Preferential Parental Investment in Daughters Over Sons', *Human Nature*, **2**, 387–417.

Daly, Martin and Wilson, Margo I. (1999) 'Human Evolutionary Psychology and Animal Behaviour,' *Animal Behaviour*, **57**, 509–19.

Darwin, Charles (1859) *On the Origin of Species by Means of Natural Selection*, London, John Murray.

Darwin, Charles (1871) *The Descent of Man, and Selection in Relation to Sex*, London, John Murray.

Dawkins, Richard (1989) *The Selfish Gene,* 2nd edn, Oxford, Oxford University Press.

Dennett, Daniel C. (1995) *Darwin's Dangerous Idea: Evolution and the Meanings of Life*, New York, Touchtone.

de Waal, Frans B. M. (1992) 'Intentional Deception in Primates', *Evolutionary Anthropology*, **1**, 86–92.

de Waal, Frans B. M. (1995) 'Bonobo Sex and Society', *Scientific American*, **272** (3), 82–8.

de Waal, Frans (1996) *Good Natured: The Origins of Right and Wrong in Humans and Other Animals*, Cambridge, MA, Harvard University Press.

Eaton, S. B. and Konner, M. (1985) 'Paleolithic Nutrition: A Consideration of Its Nature and Current Implications', *New England Journal of Medicine*, **312**, 283–9.

Eaton, S. B., Konner, M. and Shostak, M. (1988) 'Stone Agers in the Fast Lane: Chronic Degenerative Diseases in Evolutionary Perspective', *American Journal of Medicine*, **84**, 739–49.

Ellis, Lee (1996) 'A Discipline in Peril: Sociology's Future Hinges on Curing its Biophobia,' *American Sociologist*, **27**, 21–41.

Freese, Jeremy and Powell, Brian (1999) 'Sociobiology, Status, and Parental Investment in Sons and Daughters: Testing the Trivers–Willard Hypothesis', *American Journal of Sociology*, **106**, 1704–43.

Gaulin, Steven J. C. and Robbins, Carole J. (1991) 'Trivers–Willard Effect in Contemporary North American Society', *American Journal of Physical Anthropology*, **85**, 61–9.

Goodall, Jane (1986) *Chimpanzees of Gombe: Patterns of Behaviour*, Cambridge, MA, Harvard University Press.

Hirshleifer, Jack, (1977) 'Economics from a Biological Viewpoint', *Journal of Law and Economics*, **20**, 1–52.

Hirshleifer, Jack (1978) 'Natural Economy Versus Political Economy', *Journal of Social and Biological Structures*, **1**, 319–37.

Kanazawa, Satoshi (2001*a*) 'De Gustibus *Est* Disputandum', *Social Forces*, **79**, 1131–63.

Kanazawa, Satoshi (2001*b*) 'Why We Love Our Children', *American Journal of Sociology*, **106**, 1761–76.

Kanazawa, Satoshi (2002) 'Bowling with Our Imaginary Friends', *Evolution and Human Behaviour*, **23**, 167–71.

Kanazawa, Satoshi, (2003) 'Can Evolutionary Psychology Explain Reproductive Behaviour in the Contemporary United States?' *Sociological Quarterly*, **44**, 291–301.

Kanazawa, Satoshi (2004) 'The Savanna Principle', *Managerial and Decision Economics*, **25**, 41–54.

Katzev, Aphra R., Warner, Rebecca L. and Acock, Alan C. (1994) 'Girls or Boys? Relationship of Child Gender to Marital Stability', *Journal of Marriage and the Family*, **56**, 89–100.

Keller, Matthew C., Nesse, Randolph M. and Hofferth, Sandra (2001) 'The Trivers–Willard Hypothesis of Parental Investment: No Effect in the Contemporary United States', *Evolution and Human Behaviour*, **22**, 343–60.

Leighton, Donna Robbins (1987) 'Gibbons: Territoriality and Monogamy', pp. 135–45 in *Primate Societies*, ed. Barbara Smuts, Dorothy L. Cheney, Robert M. Seyfarth, Richard Wrangham and Thomas T. Struhsaker.

Lundberg, Shelly and Rose, Elaina (2000) 'Parenthood and the Earnings of Married Men and Women', *Labour Economics*, **7**, 689–710.

Lundberg, Shelly and Rose, Elaina (2002) 'The Effects of Sons and Daughters on Men's Labor Supply and Wages', *Review of Economics and Statistics*, **84**, 251–68.

MacArthur, Robert H. and Wilson, Edward O. (1967) *The Theory of Island Biogeography*, Princeton, NJ, Princeton University Press.

Marks, I. M. (1987) *Fears, Phobias, and Rituals*, New York, Oxford University Press.

Maryanski, Alexandra and Turner, Jonathan H. (1992) *The Social Cage: Human Nature and the Evolution of Society*, Stanford CA, Stanford University Press.

McCullagh, Peter (1980) 'Regression Models for Ordinal Data', *Journal of the Royal Statistical Society, Series B*, **42**, 109–42.

McGrew, W. C. (1992) 'Culture in Nonhuman Primates?' *Annual Review of Anthropology*, **27**, 301–28.

Miller, Geoffrey F. (2000) *The Mating Mind: How Sexual Choice Shaped the Evolution of the Human Mind*, New York, Doubleday.

Morgan, S. Philip, Lye, Diane N. and Condran, Gretchen A. 1988. 'Sons, Daughters, and the Risk of Marital Disruption', *American Journal of Sociology*, **94**, 110–29.

Nesse, Randolph M. (1990) 'Evolutionary Explanations of Emotions', *Human Nature*, **1**, 261–89.

Parker, Sue Taylor, Mitchell, Robert W. and Boccia, Maria L. (1995) *Self-Awareness in Animals and Humans: Developmental Perspectives*, New York, Cambridge University Press.

Pinker, Steven (2002) *The Blank Slate: The Modern Denial of Human Nature*, London, Penguin.

Ridley, Matt (1993) *The Red Queen: Sex and the Evolution of Human Nature*, New York, Penguin.

Ridley, Matt (1999) *Genome: The Autobiography of a Species in 23 Chapters*, New York, Perennial.

Savage-Rumbaugh, Sue and Lewin, Roger (1994) *Kanzi: The Ape at the Brink of the Human Mind*, New York, Wiley.

Smuts, Barbara (1985) *Sex and Friendship in Baboons*, New York, Aldine.

Thornhill, Randy (1980) 'Rape in *Panorpa* Scorpionflies and a General Rape Hypothesis', *Animal Behaviour*, **28**, 52–59.

Tooby, John and Cosmides, Leda (1990) 'The Past Explains the Present: Emotional Adaptations and the Structure of Ancestral Environments', *Ethology and Sociobiology*, **11**, 375–424.

Trivers, Robert L. (1972) 'Parental Investment and Sexual Selection', pp. 136–79 in *Sexual Selection and the Descent of Man 1871–1971*, ed. Bernard Campbell, Chicago, IL, Aldine.

Trivers, Robert L. and Willard, Dan E. (1973) 'Natural Selection of Parental Ability to Vary the Sex Ratio of Offspring', *Science*, **179**, 90–92.

van den Berghe, Pierre L. (1990) 'Why Most Sociologists Don't (and Won't) Think Evolutionarily', *Sociological Forum*, **5**, 173–85.

van Lawick-Goodall, Jane (1964) 'Tool-Using and Aimed Throwing in a Community of Free-Living Chimpanzees', *Nature*, **201**, 1264–66.

van Lawick-Goodall, Jane (1968) 'Tool-Using Bird: The Egyptian Vulture', *National Geographic*, **133**, 630–41.

Waite, Linda J. and Lehrer, Evelyn L. (2003) 'The Benefits from Marriage and Religion in the United States: A Comparative Analysis', *Population and Development Review*, **29**, 255–75.

Weinberg, Steven (1992) *Dreams of a Final Theory*, New York, Pantheon.

Weinberg, Steven (2001) *Facing Up: Science and Its Cultural Adversaries*, Cambridge, MA, Harvard University Press.

Wilson, Edward O. (1998) *Consilience: The Unity of Knowledge*, New York, Knopf.

Wrangham, Richard W., McGrew, W. C. de Waal, Frans B. M. and Heltne, Paul G. (1994) *Chimpanzee Cultures*, Cambridge, MA, Harvard University Press.

Wrangham, Richard and Peterson, Dale (1996) *Demonic Males: Apes and the Origins of Human Violence*, Boston, MA, Mariner.

Wright, Robert (1994) *The Moral Animal: The New Science of Evolutionary Psychology*, New York, Vintage.