Social Issues and Policy Review

Social Issues and Policy Review, Vol. 8, No. 1, 2014, pp. 1–32

Naturally Green: Harnessing Stone Age Psychological Biases to Foster Environmental Behavior

Mark van Vugt*
VU University and University of Oxford

Vladas Griskevicius
University of Minnesota

P. Wesley Schultz
California State University

It is widely agreed that humans must reduce their environmental impact. We propose that an improved understanding of our evolved human nature can help to improve programs and policies to address environmental problems. Combining evolutionary and social psychological approaches, we argue that environmental problems are often caused or exacerbated by five evolutionarily adaptive psychological biases: Humans (1) value personal over collective outcomes (self-interest), (2) prefer immediate over delayed rewards (shortsightedness), (3) value relative over absolute status (status), (4) copy the behaviors of others (social imitation), and (5) ignore problems that we cannot see or feel (sensing). By considering how and why these five "Stone Age" biases continue to influence modern environmental practices, although acknowledging the role of individual and cultural differences, we present novel ways that human nature can be harnessed to develop intervention strategies to lessen resource depletion, restrain wasteful consumption, curb overpopulation, and foster green choices.

Easter Island is one of the most remote places on earth. The island lies in the Pacific Ocean about 2,000 miles off the west coast of South America, over a thousand miles from the nearest inhabitable land. Despite its relative

*Correspondence concerning this article should be addressed to Mark van Vugt, Professor of Psychology, Department of Social and Organizational Psychology, VU University, van der Boechorsstraat 1, Room 1B-57, Amsterdam, The Netherlands. Tel: +31205985323(8700); [e-mail: m.van.vugt@vu.nl]. www.professormarkvanvugt.com

insignificance in the modern world, Easter Island offers a grim lesson about human nature and environmental sustainability (Diamond, 2005). When the Dutch explorer Jacob Roggeveen visited the island on Easter Sunday in 1722, he found a barren landscape inhabited by a society on the verge of collapse. Yet only a few hundred years earlier, the island was covered with lush forests and had a thriving culture.

When the first settlers arrived on the island and the population began to grow, the islanders divided up into clans, whereby each clan established its own center for religious and cultural activity. At each ceremonial site, the clans erected massive stone statues to signal their status. To transport the colossal statues across the island, the inhabitants had to drag them using large tree trunks as rollers. So many trees were required for this task that by the time of Roggeveen's arrival, the island was almost completely deforested and statue construction had been brought to a halt. Deforestation caused dramatic ecological and social problems. The shortage of trees forced inhabitants to stop building wooden houses and canoes to fish the waters. Tree removal also produced soil erosion, leading to constant food shortages. Diminishing natural resources intensified conflicts between clans, resulting in a state of near-permanent warfare. Without trees for building canoes, the people were trapped on the island, unable to escape the consequences of their self-inflicted, environmental collapse.

The fate of Easter Island serves as a grim warning to the modern world. Like Easter Island, our planet has limited resources to support human populations and their demands. Like the islanders, we have no practical means to escape our self-inflicted fate. The Earth's natural resources such as land, fresh water, food, and gas and oil supplies are currently being depleted at unsustainable rates. A person living in the United States consumes over 100 kg of meat per year, compared to less than 15 kg in countries of the developing world. With unchanging demands for food, energy, and water we would need at least four planet Earths if every person in the world reached U.S. levels of consumption (OECD, 2012). In addition, human activities are causing immense pollution to air, land, and water as well as doing irreversible damage to eco-systems. The impact of these activities contributes to local and global environmental crises, creating novel ecological problems such as biodiversity losses and global climate change that may have devastating consequences for the health and well-being of future generations. This is nothing new, of course. The Easter Island tragedy suggests that humans are very capable of—and sometimes very willing to—destroy their own environment.

This article examines modern environmental practices—and potential interventions to foster green behaviors—by considering the evolutionary forces that have shaped human psychology and decision making. Evolutionary approaches are increasingly influencing diverse areas of applied psychology including management (Saad, 2011), marketing (Roberts, 2012), mental health (Nesse, 2005), and prejudice (Neuberg, Kenrick, & Schaller, 2010). Yet with some notable

exceptions (Gardner & Stern, 2002; Goldstein, Cialdini, & Griskevicius, 2008; Rees, 2010; van Vugt, 2009; Wilson, Daly, & Gordon, 2007), social scientists have been silent about the evolutionary bases of human environment interactions. Although social and environmental psychologists have done an excellent job in finding many proximate explanations for environmentally relevant behaviors such as attitudes, opinions, beliefs, values, emotions, and norms, a more complete understanding of human environmental activities may also consider the biological and evolutionary roots of such practices.

Our goal in this article is to show how we can better respond to environmental problems through an improved understanding of evolved human nature. The article contains three sections. First, we provide a short introduction to evolutionary psychology, the scientific study of underlying human nature, and how it may be relevant to understanding environmental behavior. Second, we review the primary reasons why evolved human psychology underlies the behaviors that cause environmental problems, highlighting why current efforts to foster greener practices are not always successful. In particular, we focus on a constellation of five evolved psychological biases that are key drivers of human behavior and may hinder sustainable action: (1) self-interest, (2) shortsightedness, (3) status-seeking, (4) social imitation, and (5) sensing. Third, we demonstrate how these five "Stone Age" biases, individually and in combination, could be harnessed to develop novel, better ways to spur a wide range of proenvironmental behaviors such as conserving natural resources, curtailing consumption, and reducing overpopulation (Table 1).

Evolutionary Psychology and Environmental Behavior

An evolutionary perspective to human behavior is inspired by the seminal work of Charles Darwin (1871). This perspective suggests that just as the forces of natural selection can shape the physical features of organisms—think of the giraffe's neck, bird's wings, or the upright stature of humans—so can those forces shape behavioral and psychological tendencies. An evolutionary psychological approach asserts that humans inherit brains and minds equipped to behave in ways that are adaptive—that are fitted to the demands of the environments within which their ancestors evolved. In particular, the human brain is designed to solve critical, recurrent problems in the ancestral world of the Pleistocene in which humans evolved (Buss et al., 1998; Neuberg, Kenrick, & Schaller, 2010; Tooby & Cosmides, 1992). This era is commonly referred to as the Stone Age period, which occupies 99% of human evolutionary history. By understanding the selection pressures operating on Stone Age humans we may be able to understand better how the mind operates and influences behavior. However, as we discuss next, people are usually not aware of the deep evolutionary causes for their behavior, and the psychological tendencies that were adaptive in ancestral environments are not always adaptive in the modern world.

Table 1. Stone Age Biases: An Evolutionary Psychology Framework for Environmental Conservation and Behavior Change

Evolved psychological bias underlying environmental practice	Constraints on behavior change	Obstacles for intervention	Opportunities for intervention	Examples of promising influence strategies
Self interest	People prioritize personal over collective interests	Persuading individuals to value the collective more than their own interests	People cooperate with kin and in reciprocal social relationships	Use of kinship cues to extract environmental donations Create programs where the environmental choice results in direct personal gain Create strong stable communities to foster conservation
Shortsighted	People value the present more than the future	Persuading individuals to value the future more than the present	People discount the future less in safe and predictable environments	Induce (perception of) stable environment in childhood Influence discount rates, especially among younger men Increase education opportunities
Status	People value relative over absolute status	Persuading individuals to accept a lower relative status associated with environmental conservation	People value environmental behaviors if they come with a status increase	Increase relative status of green products by making them more visible, of higher quality, and costly to obtain Publish ranking of greenest companies
Social imitation	People copy what others around them are doing	Persuading people to behave environmentally despite not many others behaving in this way	People copy sustainable behaviors if they are performed by the majority	Show the prevalence of certain common green behaviors Get prestigious individuals to perform green behaviors
Sensory mechanisms	People ignore threats and dangers they cannot see, smell or touch	Persuading individuals to be concerned about distant, global, and slow moving environmental problems	People respond to environmental threats that they can sense, and there is an innate love for nature (biophilia)	Use tangible and visceral stimuli to increase awareness of environmental threats (e.g., bad odors) Use positive nature experiences to promote conservation

Different Explanations for Human Behavior

An evolutionary approach is concerned about the adaptive functions of behavior. It asks: How might a given tendency have helped our ancestors survive and reproduce? When asking why people prefer sweet and fatty foods, one answer could be that it is more pleasant. An evolutionary approach, however, would also ask why humans find high-sugar and high-fat foods pleasant. In this case, one reason is because humans evolved in resource-poor environments—primarily the ancestral African Savannah—in which the intake of high-calorie foods such as honey and meat would have been critical to their survival and well-being. Thus, our bodies and brains signal to us that we need high-calorie meals to satisfy our hunger.

An evolutionary perspective draws an important distinction between proximate and ultimate behavioral causes (Kenrick et al., 2010; Tinbergen, 1963). Most psychological research is focused on proximate explanations, which concern the relatively immediate psychological triggers for behavior. When asking why adolescents engage in risky activities such as speeding, binge drinking or unsafe sex, proximate explanations are that they are impulsive, easily influenced, lack self-control, or that their prefrontal cortex is not yet fully developed. However, an evolutionary perspective highlights the importance to understand why adolescents might have inherited a particular psychology that leads them to make impulsive, risky choices. One answer to this question may be that it is evolutionarily adaptive to take risks when you are trying to climb up in the hierarchy of a group (Kenrick et al., 2010).

Proximate and ultimate evolutionary questions offer complementary explanations. For instance, one reason why individuals may want to purchase an expensive, gas-inefficient sports utility vehicle (SUV) is because it makes them feel good (a proximate reason). Yet an ultimate reason may be that possessing expensive luxury devices such as a SUV—or in ancestral times, a richly decorated spear—conveys wealth, status, and prestige. Both of these explanations can be correct, whereby each one explains the same behavior at a different level of analysis. The important point is that neglecting ultimate reasons limits the search for intervention strategies. If governments would want to curb the demand for gas-inefficient SUVs, ignoring ultimate reasons might lead to an intervention strategy that tries to persuade people that possessing a SUV—or any other high status good—should not make them feel good. This kind of strategy is likely to be fighting an uphill battle, in the same way that it is difficult to get people to change their eating habits by persuading them that sweet and fatty foods do not taste good.

Finally, an evolutionary approach does not assume that people will always be consciously aware of the ultimate reasons for their decisions. The social psychological literature shows that ultimate motives often guide behaviors in automatic, unconscious ways (Kenrick et al., 2010). Because ultimate motives often operate

outside of awareness, an evolutionary perspective highlights that the same behavior could be altruistic at the proximate level: "I'm donating to Greenpeace because it is a worthy cause." Yet the same behavior can be entirely selfish at the ultimate gene level, because being "seen as green" provides reputation benefits that could be beneficial to the person in the long run (Griskevicius, Tybur, & Van den Bergh, 2010; Hardy & van Vugt, 2006).

Stone Age Biases

An evolutionary perspective further asserts that our brains have evolved to confront challenges in the past. Yet this does not mean that they always produce adaptive behavior in today's world. Biological evolution tends to be a painstakingly slow process. If the environment in which a trait evolved changes rapidly, then we can expect there to be some evolutionary mismatches. Indeed the environment in which our ancestors evolved has changed dramatically since the agricultural revolution some 11,000 years ago, which constitutes a period of less than 1% of human evolutionary history. This has led evolutionary psychologists to assert that humans are navigating the modern world with "Stone Age" minds (Tooby & Cosmides, 1992). For instance, our brains have evolved to respond adaptively to localized environmental threats that we can see or smell, such as a fire, famine, or flood, but not to global environmental changes that we cannot appreciate with our evolved sensory mechanisms (we return to this later). Tragically, humans have not only created mismatched environments for themselves, but also for other species with sometimes devastating consequences. Ecologists estimate that about 24% of mammals and 12% of bird species are globally endangered because of damaging human environmental practices such as hunting, pollution, and deforestation (UNEP, 2012).

An important insight from evolutionary psychology is that strategies aimed to change behavior may fail if those strategies are mismatched with our ancestral tendencies. However, influence strategies might be more effective when they are tailored to take advantage of our Stone Age biases. For example, consider the common strategies used to reduce meat consumption—a habit which takes a heavy toll on the environment in the form of green house gas emissions, deforestation, fuel and fresh water consumption (OECD, 2012). Some strategies use guilt to persuade meat eaters that eating meat is bad for the environment; others urge people to restrain their meat consumption, and still others inform people about the longer term health consequences of eating meat such as cardiovascular problems (Richardson, Shepherd, & Elliman, 1993). Although such strategies may be somewhat successful, an evolutionary perspective argues that these strategies may be suboptimal, because they work against our evolved psychological tendencies. In ancestral environments, just like in many traditional societies today, meat is a highly prized, high-status food because it is fatty and calorie rich, it is difficult to

obtain, and it is easily shared among many families (Hawkes, 1992). As a result, our bodies and brains evolved to get an intense feeling of pleasure from eating meat, and meat eating is a highly enjoyable social affair.

An evolutionary perspective suggests that strategies to change meat eating behavior could be more effective if they are directly matched to our evolutionary tendencies such that they "nudge" individuals into behaving sustainably (cf. Thaler & Sunstein, 2008). In the case of meat consumption, this means that as long as it tastes good, is reasonably affordable, does not cause immediate health problems, and carries social status, people will prefer it over healthier nonmeat options. However, people could be persuaded to try out alternatives for meat if these foods look and taste meaty, and are highly socially valued. These strategies are already being used by the food industry which has come up with vegetarian alternatives that look and taste like burgers or sausages, with salad dressings that make salads taste fattier and calorie rich and with highly prized vegetarian sushi rolls as an exotic alternative to meat.

Flexible Adapted Minds

Third and finally, an evolutionary perspective argues that the human mind is not a blank slate (cf. Pinker, 2002), meaning that an individual's preferences and behaviors are not determined solely by exposure to culture. A blank slate perspective implies that marketing campaigns can be equally effective in persuading people to behave in one way or in the exact opposite way. According to this view, it is equally difficult to persuade a person to be selfish or selfless, value the future as much as the present, aspire to low as much as to high status, and conform or deviate from local norms. Conversely, an evolutionary perspective maintains that there is a biologically based human nature—that we have a set of evolved dispositions reflecting adaptive psychologies that helped solve recurring challenges in our ancestral past. This means that humans are not infinitely malleable. Across cultures, people are likely to care more about some things than others, and to learn some things easier than others—so-called human universals (Brown, 1991).

An evolutionary perspective does not imply genetic determinism. Our minds and behaviors are highly responsive to environmental contingencies that were recurrent in ancestral environments (Rees, 2010; Tooby & Cosmides, 1997). Evolved dispositions always require environmental inputs to produce adaptive behavior. These inputs can be provided by local environmental, social, or cultural factors. For instance, Ostrom's research on resource management (1990) shows that in communities with strong social norms against free-riders, people are more likely to conserve resources than in the absence of social sanctions. Whether or not people conserve energy or water within their households is critically dependent upon what they believe their neighbors are doing (Nolan et al., 2008; van Vugt,

2001). Finally, people growing up in rural environments respond more strongly to appeals to donate to environmental charities than people growing up in urban environments (Van der Wal, Schade, Krabbendam, & van Vugt, 2013). These examples show that people respond adaptively and contingently to local cultural and environmental cues by behaving in more, or less, sustainable ways depending upon the context. An evolutionary perspective does not prioritize nature over nurture, and we suggest that this is in fact a false dichotomy. Social and environmental cues trigger evolved psychological tendencies to produce adaptive behaviors: *Nature operates via nurture* (Ridley, 2003).

Thus, instead of viewing human nature as a constraint that should be overcome it is more productive to better understand the nature of human nature so that we can help promote new conservation behaviors and address environmental challenges. As noted by evolutionary ecologists Penn and Mysterud (2007, p. 2): "Sustainability is an admirable goal but our policies need to be sustainable themselves, and therefore we need policies that are compatible with human nature." By considering that deep evolutionary forces continue to shape many modern behaviors, insights from evolutionary psychology can be applied to understand and intervene in pressing environmental problems related to pollution, resource depletion, biodiversity loss, overconsumption, and overpopulation (Gardner & Stern, 2002; Rees, 2010).

Why Human Nature May Cause Environmental Problems

There is a popular notion that humans are naturally inclined to show restraint in using environmental resources and that bad environmental practices are products of modern, wasteful Western culture. Although this idea of an ecological "noble savage," coined by the 18th century French Philosopher Rousseau, continues to be influential, it turns out that traditional societies are not the conservationists they were once believed to be (Smith & Wishnie, 2000). Many traditional societies have stories about the sacredness of nature, yet there is no association between the presence of such stories and a low ecological impact (Low, 1996). The evidence suggests that the lower ecological impact of traditional societies has more to do with low population densities and lack of technology than with conservation ethics (Smith & Wishnie, 2000). Consider that there have been many reports of mass extinctions of mega fauna at the hands of indigenous people. For example, when the British arrived in New Zealand in the 18th century, there were no large animals on the islands yet they discovered hundreds of archaeological sites with the bones and skeletons of many thousands of giant birds that had been killed, eaten, and hunted to extinction by the local people. Instead of being ecological noble savages, humans have had a long history of causing ecological destruction (Diamond, 2005; Penn, 2003).

The Stone Age Biases Framework

Based on an evolutionary analysis, we suggest that environmental problems are caused or exacerbated by five key evolved psychological biases that aided the survival and reproductive interests of our human ancestors: (1) a proclivity for self-interest; (2) preference for immediate over delayed rewards (temporal discounting), (3) concerns about relative rather than absolute status, (4) propensity to socially imitate, and (5) tendency to disregard impalpable consequences. These five "Stone Age" biases can be summarized as: self-interest, shortsightedness, status, social imitating, and sensing. For each of these biases, there is wealth of empirical data showing that they (1) have a strong influence on human decision making, (2) are likely to be part of an evolved human nature, (3) are particularly relevant for understanding environmental behaviors, and (4) provide opportunities for sustainability interventions (Fiske, 2004; Gardner & Stern, 2002; Griskevicius, Cantu, & Van Vugt, 2012; Penn, 2003; Steg & Vlek, 2009; Van Vugt, 2009; Wilson, 2006).

Nevertheless, we do not claim this list of adaptive psychological biases is exhaustive. People also have fundamental needs for trust, safety, belongingness, identity, justice, and uncertainty avoidance that may also be innate and impact the environment (Fiske, 2004; Kenrick, Griskevicius, Neuberg, & Schaller, 2010; Lerner & Clayton, 2011; van Vugt, 2009). Yet, these motives do not necessarily predict poor environmental outcomes, which is what we try to explain here. Furthermore, some of these motives fit nicely into the Stone Age Bias framework. For instance, a concern with justice can be entirely selfishly motivated, and uncertainty avoidance is an integral aspect of temporal discounting. Finally, we do not suggest that there are no other theoretical frameworks to understand the reasons why humans cause environmental problems. The values framework (Schwartz, 1992), the Value-Belief-Norm framework of environmentalism (Stern, 2000), self-determination theory (Deci & Ryan, 2002), social norm theory (Cialdini et al., 1990), the BUC(K)ET-model (Fiske, 2004), the theory of planned behavior (Ajzen, 1991), and nudge theory (Thaler & Sunstein, 2008) also provide key insights into relevant psychological drivers of environmental behavior. Yet these theories focus on the proximate reasons such as how particular needs, values, or norms influence environmental outcomes. Each of these models could ultimately turn to evolutionary theory to try and explain its own assumptions, for instance, why people care about autonomy or what norms they internalize. An evolutionary framework provides an integrative theory for understanding the ultimate reasons why we do the things we do and is therefore not in competition with these models.[1]

[1] Evolutionary theory provides a meta-theoretical framework to understand the origins of all living matter. Since its initial development more than 150 years ago, science has uncovered overwhelming

Below we provide concise reviews from research programs in evolutionary and social psychology, and other disciplinary fields, showing converging evidence for each of these Stone Age biases. We discuss the barriers posed by these evolved psychological biases to engage in successful environmental management. For each Stone Age bias we also highlight various opportunities—or nudges—to harness these tendencies and foster environmental conservation and change.

Managing Self-interest: Social Dilemmas

Many environmental problems result from a conflict between personal and collective interests, whereby narrow self-interests often prevail against the common good of the group. This tension is famously captured by the Tragedy of the Commons story (Hardin, 1968), which describes a social dilemma in which a small pasture is shared by multiple herders. Although the herders desire sustainable levels of grazing by all, each herder quickly realizes that if he adds just a little extra cattle to the pasture, he receives a net personal benefit, although the costs are shared among all herdsmen. Corroborated by evidence from multiple fields including environmental, anthropological, and social psychological sciences, the result is an accidental tragedy: Most individuals increase their herd size, thereby unintentionally causing the destruction of the commons (Dietz, Ostrom, & Stern, 2003; Hawkes, 1992). Hardin suggested that the only way out of this dilemma was "mutual coercion, mutually agreed upon by the majority of the people affected" (p. 1247).

The cause of this oft-repeated tragedy is rooted deep in human nature. Humans have evolved to prioritize their personal interests over collective interests because natural selection favors individuals who can gain a personal benefit at the expense of unrelated others (Hardin, 1968). Natural selection does not care about the survival of the species. What matters is the replication of one's genes, which often comes at the expense of the survival of others' genes (Dawkins, 1976). A key indicator that the human mind is shaped to prioritize self-interest comes from evidence from social dilemmas research showing that most individuals make selfish choices when they interact with other people in one-shot encounters (Fehr & Gaechter, 2002; Komorita & Parks, 1994; Van Lange, Balliet, Parks, & van Vugt, 2013).

Importantly, an evolutionary perspective does not suggest that everyone prioritizes self-interest to the same extent across all situations. There are important

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evidence in support of evolutionary theory from research on animals, fossils, and DNA. Yet this does not mean that lower level evolutionary hypotheses cannot be refuted. For instance, the hypothesis that the purchase of conspicuous luxury devices such as a sports car serves as a costly signal can be dismissed if it turns out that (i) people do not attribute status to sports car owners, (ii) people drive sports cars regardless of their wealth, (iii) men and women show equal preferences for purchasing a sports car, (iv) single men and married men do not differ in sports car ownership.

individual differences in the tendency to exploit others that could be shaped by cultural and developmental inputs (Van Lange et al., 1997). For example, humans behave less selfishly interacting with members of in-groups than out-groups (De Cremer & van Vugt, 1999), and fairness considerations constrain the pursuit of narrow self-interest (Lerner & Clayton, 2011). Nevertheless, evolutionary considerations highlight that it is human nature to be tempted by—and occasionally act upon—opportunities to benefit one at the expense of others, which has direct implications for environmental practice.

Obstacles for Intervention

Because environmental campaigns have not always recognized the deep-seated nature of humans' tendency to prioritize their own interests over the public good (Penn, 2003), this has resulted in the perpetuation of some relatively ineffective proenvironmental strategies (Gardner & Stern, 2002). Strategies that try to persuade people to value abstract societal goals (e.g., with slogans like "Save the environment and you will save life"), more than concrete personal outcomes, are fighting an uphill battle. Similarly, persuading people to engage in self-restraint purely for ecological reasons is unlikely to work either (Schultz, 2011). Voluntary environmental cooperation often fails because of the opportunities to free-ride on others' efforts, which breeds greed and paranoia (van Vugt, 2009). A campaign to persuade households to conserve during a water shortage in the United Kingdom failed because the households did not incur a penalty for overuse. Facing a resource crisis, many households actually started to consume more water than usual for fear that the resource would soon collapse (van Vugt, 2001). An evolutionary perspective suggests that interventions aimed at eradicating people's evolved selfish biases may be doomed. Such biases need to be harnessed, and redirected, to promote sustainable behaviors (Schultz & Zelezny, 2003).

Opportunities: Harnessing Self-interest

Although narrow personal interests often coincide with individuals' genetic interests, this is not always true (Dawkins, 1976). Applying insights from an evolutionary perspective highlights that under certain conditions, a proclivity for genetic self-interest can lead individuals to cooperate with each other to achieve environmental goals. We next discuss the theories of kin selection, reciprocal altruism, indirect reciprocity, and multilevel selection, each of which offers a unique perspective on how environmental conservation can be fostered through appeals to genetic self-interest.

Kinship. Kin selection theory (also known as inclusive fitness theory) asserts that humans, like any other organism, are designed to ensure the survival and

replication of their genes, which are shared with kin (Hamilton, 1964). We share 50% of our genes with our children and siblings, 25% with our grandchildren, 12.5% with our first cousins, and so forth. Kin selection has important implications for environmental outcomes. Consider a family group of parents and children, brothers and sisters, confronting a local tragedy of the commons. Because they share roughly 50% of the genes with each other, they have a strong shared interest to preserve the commons and show individual restraint compared to a group of genetic strangers. Across cultures, individuals are more likely to share resources with relatives than with nonrelatives and with close relatives more than with distant relatives (Burnstein, Crandall, & Kitayama, 1994; Ostrom, 1990).

Kin selection theory suggests that proenvironmental appeals should be more effective if they emphasize the interests of relatives. A message urging people to conserve gas or water may be more persuasive if it highlights that there might not be enough resources left for one's children, grand children, nieces, and nephews—someone's "genetic" future. A recent study found that messages to conserve the environment are more effective if they stress the benefits for kin (Neufeld et al., 2013). Another implication of kin selection theory is that the use of fictitious kin labels in slogans like "helping Mother Nature" may foster sustainable behavior through activating a psychological sense of kinship. Finally, humans often use indirect cues such as familiarity, co-residence, and facial resemblance to indicate genetic relatedness (Park, Schaller, & van Vugt, 2008). This suggests that messages to save the environment may be more persuasive if they come from individuals who look like, speak like, and share similarities with the target audience (van Vugt, 2009).

Direct reciprocity. Another key insight for proenvironmental interventions comes from reciprocal altruism theory, which highlights that people help others in order to receive their assistance in return (Trivers, 1971). The evolution of reciprocity came about in humans because the social networks in which our ancestors interacted consisted of kin and nonkin, and these groups were relatively small and stable with high degrees of social control (Boehm, 2012). A long tradition of research on commons management shows that communities that resemble these kinds of Pleistocene bands with relative dense social networks and informal rules and sanctions do better in preserving environmental resources (Ostrom, 1990). For instance, small fishery communities with strong reciprocal networks have more sustainable fishing practices than large villages in part because they exchange catch information more frequently and punish over-users (Palmer, 1991; cited in Gardner & Stern, 2002). Although it may be a challenge to induce environmental change in today's global world, it may be possible to create small virtual social networks to help spread good environmental practices.

At first glance, the idea of reciprocity might appear to imply that people might be more willing to donate money to environmental causes if they get something in

return. For instance, electrical appliance giant Samsung donates $2 to the Nature Conservancy for every reclaimed phone that has been purchased by customers. Some hotels chains implore their guests to reuse towels by promising to make a small financial donation to an environmental charity for each towel that has been re-used. However, research finds that these kinds of tit-for-tat strategies are actually suboptimal at spurring conservation (Goldstein, Griskevicius, & Cialdini, 2011). Instead, insights from reciprocal altruism theory suggest that a reversal of this procedure should be more effective, whereby the company should first make a donation to a proenvironmental cause and then ask the target to partake in a proenvironmental act. By making an environmental donation first, companies can invoke the psychology of reciprocity. This donate-first technique has been shown to be more effective than promising to donate in return for an action. For example, when hotels informed guests that they had already donated to environmental charities and now expected guests to cooperate this increased towel reuse by as much as 26% (Goldstein et al., 2011).

Indirect reciprocity. Theories of indirect reciprocity explain why humans evolved to cooperate in larger groups because by showing restraint, they establish a positive reputation which gives them a return on their group investments (Nowak & Sigmund, 2005). Consistent with this idea, research shows that people are less likely to deplete a communal resource when their reputation is at stake, and people who get status as conservationists are more often selected as collaboration partners and even group leaders (Hardy & van Vugt, 2006; Milinski et al., 2006). These reputation or self-presentation motives can entice customers to purchase green products and induce businesses to invest in sustainable practices (Griskevicius et al., 2010). As a case in point, a naming-and-shaming campaign in the early 1990s, set up by a grass roots movement, forced McDonalds to bin their plastic packaging of hamburgers (Gardner & Stern, 2002).

The power of reputations and self-presentation tendencies can be subtly activated. Research shows that even a pair of eyes displayed on a poster or computer screen can activate reputation concerns and make people behave more cooperatively (Bateson et al., 2006; Haley & Fessler, 2005). An implication of these findings is that in public places in which people litter (such as parks) or use electricity or water (such as in public buildings), signs or stickers with eyes displayed on them can encourage people to be more environmentally friendly.

Intergroup competition. Finally, evolutionary theorizing suggests that people may be inclined to cooperate if their genetic interests are aligned with that of their community. Some evolutionary scientists argue that genetic selection at the level of groups has been an important force in human evolution—this is called multilevel selection theory (Boehm, 2012; Wilson et al., 2008). This groupishness may be the result of fierce competition between ancestral groups of humans for scarce

resources. Consistent with this idea, the social psychological literature shows that humans are capable of forming strong emotional attachments to ingroups especially when they are in competition with other groups (Tajfel & Turner, 1979). Intergroup competition can be used for promoting proenvironmental behaviors. Research shows that people cooperate more with in-group members than out-group members (De Cremer & van Vugt, 1999). High group identifiers also compensate for the unsustainable practices of others in their community by showing more restraint especially when in competition with other groups (Brewer & Kramer, 1986).

In sum, whether by activating kinship, inducing direct or indirect reciprocity or creating intergroup competition, an evolutionary perspective suggests that people will be more willing to engage in conservation if they see benefits for themselves, their kin or their community or organization.

Overcoming Shortsightedness: Temporal Discounting

Many environmental problems result from a conflict between people's desire for immediate rather than delayed rewards, whereby today's desires prevail over tomorrow's needs. The tendency to discount future outcomes is sometimes considered to be a pathology of modern Western culture (Penn, 2003), yet it had enormous benefits in ancestral human environments, suggesting it is an evolved psychological trait (Wilson & Daly, 2005). If early humans would have spent too much effort on satisfying their future needs rather than their immediate needs, they would have been less likely to survive and pass on their genes in a sometimes harsh and unpredictable natural environment (Boehm, 2012). Neuroscience data show that the salience of immediate rewards activates evolutionary ancient brain systems (McClure et al., 2004).

Natural selection has shaped human psychology to maximize outcomes in the here and now rather than in the uncertain future. Temporal discounting benefited our early nomadic ancestors because they could not save for the future. But after the agricultural revolution some 11,000 years ago, this trait impulsivity was put to test. Whereas hunter-gatherers' primary activities such as hunting and gathering are often rewarded the same day, farmers must wait several months until they can harvest and eat. It is unclear whether biological evolution has altered our immediate reward psychology sufficiently in the 400+ generations since the agricultural revolution. Research shows that although there are important individual and cultural differences in temporal discounting, people in modern societies still weigh immediate outcomes much more heavily than distant ones (Green & Myerson, 2004). In addition, our sense of optimism, another likely evolved bias (Hardin, 1995), causes us to underestimate the severity and probability of future environmental challenges (Ornstein & Ehrlich, 1989).

Obstacles for Intervention

Because it is human nature to discount the future and ignore low probability ecological hazards, environmental policies that fail to take these predispositions into account are not likely to succeed. Calls for people to value the needs of future generations as much as their own needs are not realistic. Evidence from field studies shows that public appeals to consider the future consequences of poor environmental practices are generally ineffective in producing behavior change (Gardner & Stern, 2002; Goldstein & Cialdini, 2007). Nevertheless, although zero discounting is unrealistic, an evolutionary analysis suggests that specific types of interventions can lead people to place more weight on the future in making environmental decisions.

Opportunities: Valuing the Present and the Future

Although some discounting of the future is individually adaptive, an evolutionary perspective posits that people's discounting rates are not fixed. Evolutionary scientists note that the extent to which people weigh the present versus the future is explained by their life history (Kaplan & Gangestad, 2005). Life history theory posits that all organisms face trade-offs in deciding between investing in current versus future reproduction. Prioritizing current reproduction—known as a fast life history strategy—means having as many children as early as possible in one's lifetime. In contrast, prioritizing future reproduction—a slow life history strategy—means having fewer children later in life (Ellis, 2004). These life history strategies are reflected psychologically in the extent to which people value the present over the future. Life history notions may have important implications for a range of environmental problems, most notably the problems of overpopulation and overconsumption as we discuss below.

Predictable and safe environments. Life history theory assumes that whether individuals prioritize current versus future reproduction varies in response to specific environmental inputs. When environments are dangerous or unpredictable, people adopt a faster strategy and thus discount the future more (Ellis, Figueredo, Brumbach, & Schlomer, 2009). Consistent with this idea, research shows that mortality rates are strongly related to the average age of getting a first child across cities and countries—the lower the average age when people die, the earlier they start having children (Low, 1996; Wilson & Daly, 1997). Furthermore, across nations and neighborhoods, higher violent crime rates predict an earlier age of getting one's first child (Griskevicius, Delton, Robertson, & Tybur, 2011). This means that in environments that are unpredictable or unsafe, people tend to have more children, adding to problems of overpopulation.

An implication of life history theory is that making environments more predictable and safer should delay the age at which people get their first child and hence such environments will lead to fewer offspring in total. Because childhood environments are particularly important in setting life-history parameters, these time preferences could be altered through early-age interventions that make neighborhoods more stable and predictable. This means that environmental strategies emphasizing that life today will be the same as it was in the past and will be in the future are more successful in tackling a range of environmental threats such as overpopulation, overconsumption, and waste production. When people believe they are living in a predictable world and will be around for a long time, they have more incentive to contribute to a more sustainable future. Yet, when environmental campaigns stress that the future is uncertain and natural resources may run out this should increase their valuation of present pay-offs.

Different discount rates. An evolutionary perspective suggests that there are individual differences in temporal discounting. For instance, men (and especially younger men) have steeper discount rates than women have due to a lower parental investment. This means that men are, on average, more concerned about their current outcomes and less concerned about the future. An implication is that men are more likely to overconsume environmental resources and ignore environmental threats. This is borne out by environmental surveys showing that on average men are less concerned about environmental degradation than women are (Wilson et al., 2007).

Combining insights from life history theory with the evolutionary theory of sexual selection theory offers novel ideas for interventions. Sexual selection theory suggests that the choice of women for sexual partners might influence environmental outcomes through influencing the behavior of men: Young men become less concerned about the future if they are presented with visual images of attractive women (Griskevicius et al., 2012; Wilson & Daly, 2005). This suggests that billboard and poster advertisements displaying young attractive women might increase men's unsustainable preferences for excessive consumption and luxury goods. Yet research also shows that women find men sexually more attractive when they engage in specific environmental activities that signal physical quality such as riding a sport bike to work (Gotts & van Vugt, 2014). The lesson here is that women's mate preferences provide opportunities to influence men's environmental practices. There are also relatively stable differences in people's discount rates as a function of age, education, income, socioeconomic status, and having children. Older, wealthier, and more educated individuals, individuals with children and from higher socioeconomic backgrounds tend to have lower discount rates meaning that they value the future more.

Taken together, an evolutionary perspective suggests that people could be persuade to value the future more if they perceive their environment as relative

safe and stable. In addition, there are individual differences in temporal discounting as a result of sex, age, education, or socioeconomic status that suggests a tailored marketing approach might work best.

Status Needs: Prioritizing Relative over Absolute Outcomes

Various environmental challenges result from a conflict between having enough resources versus wanting to have more than others. Excessive consumption, especially of expensive, conspicuous goods that have no benefit to survival, contributes significantly to the production of waste and the depletion of nonrenewable resources (Penn, 2003). The desire to "Keep up with the Joneses" is often believed to be a product of Western thinking. Thorstein Veblen's classic book "Theory of the Leisure Class" (1899) shows that conspicuous consumption has roots deep in human history, from the Egyptian pharaohs to the Indian maharajahs and European monarchies. Such conspicuous status displays have also been documented in traditional societies as diverse as Polynesian Islanders, Amazonian foraging tribes, the Melanesian people of Australia, and North West Pacific Indians (Bird & Smith, 2005; Godoy et al., 2007). The potlatch is a showy display among the North-West Pacific native tribes in which tribal leaders give away—and sometimes burn—large quantities of valuable goods such as canoes and clothes to signal their prestige and resource holding powers (Bird & Smith, 2005; van Vugt & Hardy, 2010).

An evolutionary analysis suggests that such conspicuous displays are rooted in the evolved thirst for status and power (Miller, 2009; Saad, 2007). Because success in evolution is always relative, an evolutionary psychological analysis highlights that individuals are more concerned with relative status than absolute status. An increase in relative wealth makes people happier than their absolute wealth (Diener & Suh, 2000). Consider the following: Would you rather work for a company (i) in which you earn $60,000 and the average salary is $40,000 or (ii) you earn $80,000, and the average salary is $100,000. When presented with these kinds of options, most people choose the first option (Frank, 1985). This is surprising because it means people are happy to have less, but only as long as they have more than their peers.

Obstacles for Intervention

Strategies to reduce consumption rates are unlikely to show much on an effect if they fail to consider the importance of relative status. An evolutionary perspective highlights the fact that it will be an uphill fight to persuade people to be content with what they currently have, or act in ways that lower their status compared to their peers. Urging Americans to consume less, because they are wealthier than most of the people in the rest of the world is not the solution. Rather than trying

to eradicate our thirst for status, more optimal strategies will harness and redirect such status motivations to produce proenvironmental behavior.

Opportunities: Improving the Relative Status of Green Behaviors

Evolutionary theorists regard conspicuous consumption as a costly signal of someone's status, much like a peacock's tail (Griskevicius et al., 2007; Bird & Smith, 2005; Iredale & van Vugt, 2012; Miller, 2009; Sundie et al., 2011). Costly signaling theory posits that natural selection encourages individuals to engage in activities involving significant amounts of resources to signal important yet unobservable qualities. The peacock's tail is a classic costly signal in the animal kingdom. This elaborate, ornamental tail is costly to grow and difficult to maintain, yet it has evolved as an honest signal of the peacock's fitness (Zahavi & Zahavi, 1997). In the same way, people who buy a Ferrari or Aston Martin signal to their peers that they have enough money to spend on luxury goods, and this raises their prestige (Sundie et al., 2011).

Could status tendencies also produce conspicuous forms of helping and proenvironmental behavior? Research shows that generous individuals are not only seen as more trustworthy (Barclay, 2004), but that they are also more desirable as friends and as romantic partners (Iredale, van Vugt, & Dunbar, 2008). Furthermore, people who are careful in using communal resources have more social prestige than people who are wasteful (Hardy & van Vugt, 2006; Milinski et al., 2006; van Vugt & Hardy, 2010). Costly signaling can explain many conspicuous helping displays in society such as philanthropic donations, charity auctions, and bystander emergency interventions (Bird & Smith, 2005; van Vugt, Roberts & Hardy, 2007).

Competitive environmentalism. People's desire for relative status can be harnessed, and redirected, for status competition in the environmental domain. Because our evolved status psychology motivates us to acquire a good reputation it may encourage us to invest in buying expensive, greener devices such as the Toyota Prius car or the Scott Foil Premium racing bike (Griskevicius et al., 2010). A key component of this strategy is to make the proenvironmental choice visible to others (Hardy & van Vugt, 2006). Green organizations are therefore well advised to give their benefactors visible signs, tags, or badges so that benefactors can clearly display their self-sacrificing green acts. We refer to this as competitive environmentalism—the idea that people compete to be seen as green.

An effective strategy is the publication of a green list of companies in a country, or a black list with the most polluting companies (Powers et al., 2008). Ted Turner once criticized the Forbes 400 rich list, declaring that it discourages the wealthiest individual in society from giving away their money. In response he created the public philanthropy list—the Slate 60—and immediately pledged a billion dollars to good causes. Considering environmentalism as a costly signal

also has implications for the pricing and marketing of green products. Increasing the price of green products might make them more desirable, because it signals that people are prepared to incur costs. Consistent with this, after the U.S. tax credits for the Toyota Prius expired sales went up by almost 70% (Toyota Reports, 2008). When green products are relatively cheaper, they incur a status loss which affects their popularity and desirability (Griskevicius et al., 2010). Thus, a counterintuitive implication of competitive environmentalism is that making green products cheaper and easier to purchase actually undermines their value as a signal of environmental concern.

In summary, the costly signaling perspective suggests that people can be motivated to engage in environmental behavior if it increases their relative status. Whereas competition for status is often seen as a social bad, under the right conditions it can produce environmental benefits. Encouraging people to compete on achieving a proenvironmental status might motivate more people to adopt a greener strategy.

Using Social Imitation: Copying Others' Behaviors

An often underappreciated contributor to environmental problems results from a conflict between what people believe they ought to do versus what they actually see others doing (Cialdini, Reno, & Kallgren, 1990). A recent survey (Environics Research Group, 2009) shows that although the overwhelming majority of Americans supported environmental causes, when they were probed about their actual behaviors, only a handful actually engaged in domestic water and electricity conservation practices. When asked about this discrepancy, the respondents reported that they did not believe that many other people were making these savings either.

Social psychologists have long recognized that humans have a tendency to copy what others are doing (Asch, 1956), and this tendency may be adaptive (Simon, 1990; Sundie, Cialdini, Griskevicius, & Kenrick, 2006). Imitating others and following what the majority does have been found to be common strategies in any group living species because the costs of individual learning, through trial and error, are substantial (Gigerenzer & Todd, 1999; Richerson & Boyd, 2006). In ancestral environments with high levels of uncertainty it would pay to follow what others were doing rather than finding out for yourself (Kameda et al., 2003). Research on behavioral mimicry suggests that imitating others is an unconscious process, triggered by mirror neurons in the brain (Chartrand & Van Baaren, 2009).

The psychological tendency to conform has important consequences for the environment. Findings show that home residents' energy conservation is more strongly influenced by the behaviors of their neighbors than by their personal attitudes toward conservation, even though people often deny this fact when asked about it (Nolan et al., 2008). And, when people learn that their neighbors are not conserving, they increase their own energy consumption even when they had

been conserving energy in the past (Schultz, Nolan, Cialdini, Goldstein, & Griskevicius, 2007). Hence, conformity tendencies can produce local environmentally unfriendly social norms.

Obstacles for Intervention

Because of this copying instinct, interventions that attempt to motivate proenvironmental behavior by highlighting the fact that most people do the wrong thing are likely to fail. Messages such as "100 million plastic bags thrown away every day" or "76% of people do not switch off the lights when they leave the house" may backfire because they convey the powerful message that the majority is not getting engaged in environmental behavior. When signs were placed at the Petrified National Forest in Arizona informing visitors about the high number of thefts of petrified wood, the amount of stealing went up threefold (Cialdini, 2003). Informing people what others are doing is only really sensible if there is a critical mass of people who already show the desired behavior—that is when a tipping point has been reached (Gladwell, 2002). Research shows that messages to discourage bad environmental practices can have exactly the opposite effect when there are contextual cues that most people do not comply (Keizer et al., 2008; Keizer & Schultz, 2012).

Opportunities: Copying Others to Spur Green Behaviors

In persuading people to engage in proenvironmental behavior, there are two types of messages frequently used in environmental campaigns. One involves informing people about the state of our natural environment, and the other involves appealing to financial self-interest. Many hotels in the world urge guests to reuse their towels by either appealing to the environment (e.g., "Please help to save the environment!") or to money (e.g., "Please reuse towels to keep your costs low"). Although such messages intuitively seem persuasive, field research shows that either type of message is no more effective than a simple message to "Please reuse your towels" (Goldstein et al., 2008; Schultz, Khazian, & Zaleski, 2008). Educating people about the state of the environment does little to motivate behavior change (Schultz, 2011). Financial incentives can motivate conservation, but such incentives need to be substantial, making such programs prohibitively expensive to run. Finally, monetary incentives sometimes backfire because they crowd out people's intrinsic motivations to save the environment (cf. Tenbrunsel & Messick, 1999). A better method for supporting proenvironmental behaviors might be through social means rather than financial instruments (Schultz, 2010).

Cultural evolution and social norms. Theories of gene-culture coevolution (Henrich et al., 2010; Richerson & Boyd, 2006) suggest that the tendency to imitate

others could be harnessed to spur environmental action. According to this theory, humans have an adaptive bias toward social learning and one of these copying biases is to do whatever the majority of people around them do. Knowledge of these evolved biases can be used to convey information about local environmental norms, especially to newcomers. For instance, hotel cards persuading guests to reuse towels could indicate whether this behavior is relatively common. Research shows that when hotel guests are informed that the majority of guests are reusing their towels at least once during their stay, towel reuse went up by more than 30% (Goldstein et al., 2008). Providing majority feedback has also been used, with some success, in campaigns to reduce littering (Cialdini et al., 1990), domestic energy use (Nolan et al., 2008), and foster recycling behaviors (Schultz, 1999).

Yet what if the majority of people are not yet engaging in the desired green behavior. Say only 8% of residents in a large city cycle to work? Cultural evolution theories suggest that in such instances, reframing the information from relative to absolute numbers might be useful. For instance, the information that 25,000 bike to work each week may be more effective than saying that only a small percentage of people cycle in to work. Equally problematic is that people copy anti-environmental behaviors if these are the local norm. When residents learn that they are using less energy than their neighbors, their energy consumption goes up (Schultz et al., 2007). Fortunately, this can be reversed by providing residents who already conserve energy with feedback that other people approve of their efforts (Schultz et al., 2007). This type of moralizing works because people want to do what they believe is morally right (Cialdini, 2003).

One success story concerning the application of evolutionarily informed social norms strategies is OPOWER (Cuddy & Doherty, 2010). OPOWER provides home residents with feedback about how much energy they are using compared to their neighbors, and include smiley faces on the bills of those residents who are energy efficient (cf. Schultz et al., 2007). In just the first few years of operation, this company saved the equivalent to removing 150,000 homes from the electricity grid. This result was so impressive that President Obama recently held a public press conference at OPOWER headquarters in Arlington, Virginia, showing his enthusiasm for this project.

Follow the leader. Although people are hardwired to follow the majority, cultural evolution theories also suggest that people are biased to imitate certain successful individuals (Richerson & Boyd, 2006). This prestige bias is adaptive because in learning new strategies it pays to imitate successful models more than unsuccessful ones. Imitating these leaders can help in the transmission of environmental practices (Rogers, 1995; van Vugt et al., 2008). One example is the Toyota Prius. Experts have argued that Prius sales went up after news emerged in the media that Hollywood stars such as Cameron Diaz, Leonardo DiCaprio, and Harrison Ford were driving this hybrid car. Research also shows that people

are more inclined to imitate individuals who are most similar to them in terms of features such as age, gender, culture, and social class. In an evolutionary sense, it is adaptive to follow successful individuals with a similar background who have faced the same adaptive challenges. Indeed, similar looking role models have been used with some effect in campaigns to reduce domestic energy use (Gardner & Stern, 2002).

In addition to using celebrities to induce normative environmental change, research also suggests that people are more likely to copy individuals who have the physical features of ancestral leaders, the so-called Big Men: fit and healthy looking individuals with masculine features, including a low voice pitch, and dominant authoritative personalities (van Vugt & Ahuja, 2011). Such ancestral tendencies should not be overlooked when selecting models to advertise sustainable products or lifestyles.

In summary, an evolutionary perspective suggests that in adopting green practices people could be persuaded by what the majority does (and perhaps in particular if they are ingroup members). In addition, because it is evolutionarily adaptive to follow prestigious individuals and leaders, these could be used as role models to promote environmentally firmly behaviors. Such role models are more persuasive to the extent that they look like and speak like the target of environmental interventions.

Sensing Mechanisms: Disregarding Impalpable Consequences

Many environmental challenges are made worse by a general lack of public interest in the issue (Swim et al., 2011). Not everyone is alarmed by the current and future environmental threats that the world is facing, such as global climate change, pollution of the oceans, and the loss in biodiversity. Such apathy may be a product of our evolutionary past too. Because early humans did not face distant, slow-moving environmental problems, our brain simply has not evolved to be alarmed when confronted with novel dangers that we cannot see, hear, or feel with our senses. In the ancestral human world, there was a tangible link between behavior and the environment. If band members collected all of the food in an area, they became hungry and moved on; if they urinated in the water hole, they became sick. A critical difference between the modern world and our ancestral environment is that we rarely see, feel, touch, hear, or smell how our behaviors impact the environment (Gifford, 2011; Uzzell, 2000).

Social scientists have long been puzzled as to why people are so poor at comprehending environmental risks and ignore low probability global environmental hazards (Hardin, 1995; Slovic, 1987). An evolutionary perspective suggests that such judgments may reflect a deeper ecological rationality meaning that the human mind is optimized to solve problems the way they presented themselves in the ancestral environment (Haselton & Nettle, 2006). Human decision making appears

to be much better when problems are presented in a natural ecological context (Cosmides, 1989). Consider that statistical information in the modern world is often presented in probabilistic terms. Whereas our ancestors would have encountered information as frequencies—it rained on 1 out of the last 5 days—this information is now presented in probabilistic terms: A 20% probability of rain today. Rather than being error-prone decision-makers, research shows that people are excellent intuitive statisticians as long as information is presented in an ecological relevant manner (Gigerenzer & Todd, 1999).

Obstacles for Intervention

Given that the mind has evolved to respond to information in the way it would have appeared in ancestral environments it suggests that humans are slow to respond to evolutionary novel threats that they cannot detect with their own senses. This suggests that people are not easily persuaded by environmental threats that they cannot feel, hear, smell, touch, or see such as global warming or the loss in biodiversity. In addition, people react less to environmental risks stated in probabilistic than frequentist terms. Similarly, because humans evolved in relatively small and simple societies we are not adept at comprehending large numbers. Although a million, billion, and trillion represent vastly different quantities such concepts did not exist in the ancestral environment, and they are unlikely to stick. Here is a test: "Do you know what the current world population number is?"

Opportunities: Using Our Sensory Mechanisms to Appreciate the Environment

Knowledge about our evolved sensory mechanisms suggests that people may be more responsive to environmental challenges that they can hear, smell, touch, or see. Furthermore, positive experiences with nature can be used as a leverage to increase environmental concerns and foster environmental action.

Visceral stimuli. Environmental interventions must harness our evolved psychological tendencies to respond to tangible and visceral stimuli. How do you know if there is a gas leak in your house? Natural gas has no odor, so gas companies intentionally scent gas with a smell to make sure that people immediate feel that they are being poisoned, which urges immediate action. How do you know if your environment is being polluted? Almost everyone "knows" at some level that our water today is scarcer and more polluted than ever, that the earth is warming up, and that biodiversity is being threatened. Some of us have even visited places where we have seen the tangible and visceral evidence that these things are actually happening. But at the end of the day, there is water coming out of the tap in our houses, the water tastes fine, the local park is full of trees, and there is snow falling in winter. Our minds are not designed to respond to environmental

problems when such problems are distant, global, and presented in abstract terms. Drawing on data from 18 countries, researchers found a strong tendency among people to belief that environmental problems were more severe globally than they were locally. One interpretation of this finding is that modern people do not get the visceral experiences associated with local environmental problems anymore unless they are really severe.

For information about environmental problems to "stick" and motivate people to take immediate action such information must be presented in simple, concrete, and affective terms (Heath & Heath, 2007). As in the poisonous gas example, industries could be required to color their invisible but harmful emissions, and city governments might consider altering the taste and smell of public drinking water according to the level of pollutants detected. If poor environmental practices active a disgust response this might motivate people to undertake action. It may also work in reverse. Research shows that the smell of cleaning products in train wagons decreases public littering (De Lange, Debets, Ruitenburg, & Holland, 2012). Finally, displaying green information on products with simple visual instructions may work much better than the use of complex written directions—writing is not a biological adaptation (Pinker, 2002).

Biophilia cues. Campaigns might also exploit the evolved psychological tendency to appreciate nature. Humans spent much of their evolutionary history living in natural environments rather than in urban environments. Evolving in and with nature may have endowed humans with biophilia, the love for nature (Wilson, 2006). There is much evidence to suggest that our environmental aesthetics—what we like about nature—has been shaped by our ancestral past (in the same way did humans inherit a fear for certain aspects of nature such as for snakes and spiders; Öhman & Mineka, 2001). Around the world humans are attracted to the same kinds of landscapes indicating resource-rich environments with grassy fields, meandering rivers, hills, and forests. Exposure to nature also increases recovery from stressful experiences such as postoperative surgery (Ulrich, 1984), and people growing up in rural environments show less amygdale response after performing a stressful task (Lederbogen et al., 2011). It may not be surprising from an evolutionary perspective that many people living in modern, urban environments do as much as they can to make their modern living spaces to be more like our ancestral environments by filling them with nature (Kaplan & Kaplan, 1989). Equally unsurprising, in cities across the United States and Europe more people visit their local zoos than they attend professional sports matches (Wilson, 2006).

This sensory biophilia mechanism could be activated to promote green behaviors in various ways. Research shows that after city folks have watched pictures and videos with beautiful natural scenery they donate more money to environmental causes (Steentjes & van Vugt, 2013). Recent studies show that priming

people with scenes of nature versus urban scenery increases their self-control and decreases future discounting (Van der Wal et al., 2013). The lesson is that with an increasing percentage of the world population living in large urban areas, we must find creative ways to unleash these biophilia needs to promote more sustainable lifestyles (Schultz, 2002). For instance, we need to ensure that children who grow up in city environments get regular exposure to trees, animals, and enjoyable outdoor experiences such as camping or scouting because this could promote lifelong environmental awareness (van Vugt, 2009).

Taken together, an evolutionary perspective suggests that interventions should employ our evolved sensory mechanisms to motivate environmental action. If we can develop creative interventions that make people see, smell, hear, or touch the environmental problems they cause, this might work. In addition, positive sensory experiences of nature could also help to promote environmental changes with sometimes long-lasting beneficial effects.

Conclusions, Limitations, and Future Directions

Evolutionary psychological considerations suggest that many modern environmental problems are caused, or exacerbated, by specific psychological biases emanating from human nature. Interventions designed to promote sustainable behaviors have not always been successful, because they tend to ignore important facets of human evolved psychology. Some key Stone Age biases that we focused on include our tendency to (i) prioritize self-interest, (ii) be shortsighted, (iii) seek relative status, (iv) socially imitate, and (v) care about sensory information (Table 1). Although we believe that these are the key psychological drivers of current unsustainable practices, they are unlikely to be the only ones. Optimism, confirmation, loss aversion, and status quo biases also play a role in ignoring current environmental problems and they are also likely to be innate (Haselton & Nettle, 2006). Considering that deeply rooted psychological biases continue to shape current environmental practices, we have argued that human nature can be harnessed, or nudged, to create more optimal strategies to lessen resource depletion, restrain wasteful consumption, curb overpopulation, and spur sustainable behaviors. Although we have offered many practical suggestions based on our evolutionary framework, much work is still needed.

Although an evolutionary psychology perspective on conservation offers many novel suggestions for both research and policy-making, there are various limitations to our approach. First, we have largely ignored the role of individual differences in these Stone Age psychological biases. It is entirely consistent with evolutionary theorizing that not all people are born identical. Rather human behavior is the product of a complex interplay between genetic, developmental, social, and cultural factors (Buss, 2009). For instance, some people may have a stronger genetic predisposition to discount the future, but whether they are able

to control their impulses is likely to be influenced by developmental inputs such as parental role models and social-cultural inputs such as poverty, class, or the country they grew up in (Uzzell & Raethzel, 2009). Individuals and even cultures are likely to vary in their sensitivity to different environmental interventions, and this suggests that a diversified, market-segmented approach might work best. In addition, because the research that we reported has been conducted primarily with samples from Western societies (so-called WEIRD people, Henrich et al., 2010), we do not know to what extent the conclusions can be generalized to non-Western cultures.

Second, we acknowledge the role of structural barriers toward environmental change. People may be motivated to change but if the financial costs of new environmental practices are substantial or there is no infrastructure it will be difficult to persuade people to voluntarily change their behavior (Black et al., 1985). Third, interventions in which a combination of evolved psychological biases are being tackled simultaneously may be most effective in inducing change. For instance, compulsory installation of domestic water meters across neighborhoods provides residents with both a financial incentive (self-interest) and a social incentive to conserve because it assures them that many neighbors will conserve water too (van Vugt, 2001). Similarly, riding an expensive racing bike might increase an individual's reputation in various ways: It conveys that this person is both wealthy, healthy, and is concerned with the environment—a great combination of traits in any romantic partner (Iredale et al., 2008).

Fourth, it is important to consider important political and institutional barriers toward environmental change (Uzzell & Raethzel, 2009). Many politicians and government officials have high discount rates themselves, especially when they are elected for short periods. The same applies to business leaders who are often concerned primarily with shareholder value. Their focus on the present, or on the next election, may prevent them from making long-term investments in valuable environmental causes such as sustainable product technology, wind-turbine parks, or cycle lanes. How governments and businesses can be persuaded to discount the future less is a project for political and organizational scientists, and goes beyond the scope of this article.

Finally, many environmental problems involve different stakeholders with sometimes conflicting interests, for instance, a freshwater resource being shared among several communities (Steg & Vlek, 2009). Research suggests that natural resources accessed by different user groups are in greatest danger of collapse (Ostrom, 1990). Inducing competition between groups can be a double-edged sword for solving environmental dilemmas. It would be more beneficial in such cases to foster super-ordinate goals, for instance, saving the local tourist economy or recategorizing individuals as being members of the same overarching local community (Gaertner, Dovidio, Anastasio, Bachman, & Rust, 1993).

Much research is still needed on the Stone Age Bias framework for fostering environmental conservation and behavioral change. Complementing evolutionary and psychological research on the environment with data from anthropology, environmental sciences, human behavioral ecology, behavioral genetics, behavioral economics, and neuroscience may yield a more complete picture of the way humans interact with the environment. Anthropological research may tell us more about the role of environmental destruction in the collapse of traditional societies (Diamond, 2005; Smith & Wishnie, 2000). Behavioral economics research can show the conditions under which groups manage common resources efficiently (Fehr & Gaechter, 2002; van Lange et al., 2013). Finally, neuroscience data can tell us more about what brain regions are involved in the reaction to environmental threats as well as the appreciation of nature (Lederbogen et al., 2011). Human nature has caused many environmental problems, yet human nature can also be leveraged to tackle them by applying the principles, methods, and findings from evolutionary and social psychology.

References

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*, 179–211.

Asch, S. (1956). Studies of independence and conformity. *Psychological Monographs*, *70*, 1–70.

Barclay, P. (2004). Trustworthiness and competitive altruism can also solve the "tragedy of the commons." *Evolution and Human Behavior*, *25*, 209–220.

Bateson, M., Nettle, D., & Roberts, G. (2006). Cues of being watched enhance cooperation in a real-world setting. *Biology Letters*, *3*, 412–414.

Bird, R., & Smith, E. A. (2005). Signaling theory, strategic interaction, and symbolic capital. *Current Anthropology*, *46*, 221–248.

Black, S. J., Stern, P. C., & Ellworth, J. T. (1985). Personal and contextual influences on household energy adaptations. *Journal of Applied Psychology*, *70*, 3–21.

Boehm, C. (2012). *Moral origins*. London: Basic Books.

Brewer, M. B., & Kramer, R. M. (1986). Choice behavior in social dilemmas: Effects of social identity, group size and decision framing. *Journal of Personality and Social Psychology*, *3*, 543–549.

Brown, D. (1991). *Human universals*. Boston: McGraw-Hill.

Burnstein, E., Crandall, C., & Kitayama, S. (1994). Some neo-Darwinian decision rules for altruism: Weighing the cues for inclusive fitness as a function of the biological importance of the decision. *Journal of Personality and Social Psychology*, *67*, 773–789.

Buss, D. M. (2009). How can evolutionary psychology successfully explain personality and individual differences? *Perspectives on Psychological Science*, *4*, 359–366.

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.

Chartrand, T., & Van Baaren, R. (2009). Human mimicry. *Advances in Experimental Social Psychology*, *41*, 219–274.

Cialdini, R. B. (2003). Crafting normative messages to protect the environment. *Current Directions in Psychological Science*, *12*, 105–109.

Cialdini, R. B., Reno, R. R., & Kallgren, C. A. (1990). A focus theory of normative conduct: Recycling the concept of norms to reduce littering in public places. *Journal of Personality and Social Psychology*, *58*, 1015–1026.

Cosmides, L. (1989). The logic of social exchange. *Cognition*, *31*, 187–276.

Cuddy, A. J. C., & Doherty, K. T. (2010). OPOWER: Increasing energy efficiency through normative influence. Harvard Business School Case N9-911-16.

Darwin, C. (1871). *The descent of man*. London: Appelton & Co.

Dawkins, R. (1976). *The selfish gene*. Oxford: Oxford University Press.
Deci, E., & Ryan, R. (Eds.), (2002). *Handbook of self-determination research*. Rochester, NY: University of Rochester Press.
De Cremer, D., & Van Vugt, M. (1999). Social identification effects in social dilemmas: A transformation of motives. *European Journal of Social Psychology*, *29*, 871–893.
De Lange, M. A., Debets, L. W., Ruitenburg, K., & Holland, R. W. (2012). Making less of a mess: Scent exposure as a tool for behavioral change. *Social Influence*, *7*, 90–97.
Diamond, J. (2005). *Collapse: How societies choose to fail or succeed*. London: Allen Lane.
Diener, E., & Suh, E. M. (2000). *Culture and subjective wellbeing*. Boston: MIT Press
Dietz, T., Ostrom, E., & Stern, P. C. (2003). The struggle to govern the commons. *Science*, *302*, 1907–1912.
Ellis, B. J. (2004). Timing of pubertal maturation in girls. *Psychological Bulletin*, *130*, 920–958.
Ellis, B. J., Figueredo, A. J., Brumbach, B., & Schlomer, G. L. (2009). Fundamental dimensions of environmental risk: The impact of harsh versus unpredictable environments on the evolution and development of life history strategies. *Human Nature*, *20*, 204–268.
Fehr, E., & Gaechter, S. (2002). Altruistic punishment in humans. *Nature*, *415*, 137–140.
Fiske, S. (2004). *Social beings: Core motives in social psychology*. New York: Wiley and Sons.
Frank, R. (1985). *Choosing the right pond: Human behaviour and the quest for status*. New York: Oxford University Press.
Gaertner, S. L., Dovidio, J. F., Anastasio, P. L., Bachman, B. A., Rust, M. C. (1993). The common ingroup model: Recategorization and the reduction of intergroup bias. *European Review of Social Psychology*, *4*, 1–26.
Gardner, G., & Stern, P. C. (2002). *Environmental problems and human behavior*. London: Pearson.
Gifford, R. (2011). The dragons of inaction: Psychological barriers that limit climate change mitigation and adaptation. *American Psychologist*, *66*, 290–302.
Gigerenzer, G., & Todd, P. M. (1999). *Simple heuristics that make us smart*. Oxford: Oxford University Press.
Gladwell, M. (2002). *Tipping point: How little things can make a big difference*. New York: Back Bay
Godoy, R., Reyes-García, V., Leonard, W. R., Huanca, T., McDade, T., Vadez, V., & Tanner, S. (2007). Signaling by consumption in a native Amazonian society. *Evolution and Human Behavior*, *28*, 124–134.
Goldstein, N. J., & Cialdini, R. B. (2007). Using social norms as a lever of social influence. In A. Pratkanis (Ed.), *The science of social influence: Advances and future progress* (pp. 167–192). Philadelphia, PA: Psychology Press.
Goldstein, N. J., Cialdini, R. B., & Griskevicius, V. (2008). A room with a viewpoint: Using social norms to motivate environmental conservation in hotels. *Journal of Consumer Research*, *35*, 472–482.
Goldstein, N. A., Griskevicius, V., & Cialdini, R. B. (2012). Reciprocity by proxy: Harnessing the power of obligation to foster cooperation. *Administrative Science Quarterly*, *56*, 441–473.
Gotts, J., & van Vugt, M. (2014). *Environmental behavior as mate quality signal*. VU University, submitted.
Green, L., & Myerson, J. (2004). A discounting framework for choice with delayed and probabilistic rewards. *Psychological Bulletin*, *130*, 769–792.
Griskevicius, V., Delton, A. W., Robertson, T. E, & Tybur, J. M. (2011). The influence of mortality and socioeconomic status on risk and delayed rewards. *Journal of Personality and Social Psychology*, *100*, 241–254.
Griskevicius, V., Tybur, J. M., Ackerman, J. A., Delton, A. W., Robertson, T. E., & White, A. (2012). The financial consequences of too many men: Sex ratio effects of saving, borrowing, and spending. *Journal of Personality and Social Psychology*, *102*, 69–80.
Griskevicius, V., Tybur, J. M., Sundie, J. M., Cialdini, R. B., Miller, G. F., & Kenrick, D. T. (2007). Blatant benevolence and conspicuous consumption: When romantic motives elicit strategic costly signals. *Journal of Personality and Social Psychology*, *93*, 85–102.
Griskevicius, V., Tybur, J. M., & Van den Bergh, B. (2010), Going green to be seen: Status, reputation, and conspicuous conservation. *Journal of Personality and Social Psychology*, *98*, 392–404.

Haley, K., & Fessler, D. (2005). Nobody's watching: Subtle cues affect generosity in an anonymous economic game. *Evolution and Human Behavior*, *26*, 245–256.
Hamilton, W. D. (1964). The genetical evolution of social behavior, I, II. *Journal of Theoretical Biology*, *7*, 1–52.
Hardin, G. (1968). Tragedy of the commons. *Science*, *162*, 1243–1248.
Hardin, G. (1995). *Living with limits: Ecology, economics, and population taboos*. Oxford, UK: Oxford University Press.
Hardy, C. L., & Van Vugt, M. (2006). Nice guys finish first: The competitive altruism hypothesis. *Personality and Social Psychology Bulletin*, *32*, 1402–1413.
Haselton, M. G., & Nettle, D. (2006). The paranoid optimist: An integrative evolutionary model of cognitive biases. *Personality and Social Psychology Review*, *10*(1), 47–66.
Hawkes, K. (1992). Sharing and collective action. In E. Smith & B. Winterhalder (Eds.), *Evolutionary ecology and human behavior* (pp. 269–300). New York: Aldine de Gruyter.
Heath, C., & Heath, D. (2007). *Made to stick: Why some ideas survive and others die*. New York: Random House.
Henrich, J., Heine, S. J., & Norenzayan A. (2010). Most people are not WEIRD. *Nature*, 466.
Iredale, W., & Van Vugt, M. (2012). Altruism as showing off: A signaling perspective on promoting green behaviors and other acts of kindness. In S. C. Roberts (Ed.), *Applied evolutionary psychology*. Oxford: Oxford University Press.
Iredale, W., Van Vugt, M., & Dunbar, R. I. M. (2008). Showing off in humans: Male generosity as a mating signal. *Evolutionary Psychology*, *6*, 386–392.
Kameda, T., Takezawa, M, Hastie, R. (2003). The logic of social sharing: An evolutionary game analysis of adaptive norm development. *Personality and Social Psychology Review*, *7*, 2–19.
Kaplan, H. S., & Gangestad, S. W. (2005). Life history and evolutionary psychology. In D. M. Buss (Ed.), *Handbook of evolutionary psychology* (pp. 68–95). New York: Wiley.
Kaplan, R., & Kaplan, S, (1989). *The experience of nature: A psychological perspective*. Cambridge, MA: Cambridge University Press.
Kenrick, D. T., Griskevicius, V., Neuberg, S. L., & Schaller, M. (2010). Renovating the pyramid of needs: Contemporary extensions built upon ancient foundations. *Perspectives on Psychological Science*, *5*, 292–314.
Keizer, K., Lindenberg, S., & Steg, L. (2008). The spreading of disorder. *Science*, *322*, 1681–1685.
Keizer, K., & Schultz, P. W. (2012). The role of social norms in understanding and changing pro-environmental behaviour. In L. Steg, A. van den Berg, & J. de Groot (Eds.), *Environmental psychology* (pp. 153–164). Oxford, UK: Wiley-Blackwell.
Komorita, S., & Parks, C. D. (1994). *Social dilemmas*. Madison, WI: Brown & Benchmark.
Lederbogen, F., Kirsch, P., Haddad, L., Streit, F., Tost, H., Schuch, P., ... Meyer-Lindenberg, A. (2011). City living and urban upbringing affect neural stress processing in humans. *Nature*, *474*, 498–501.
Lerner, M. J., & Clayton, S. (2011). *Justice and self-interest: Two fundamental motives*. Cambridge, MA: Cambridge University Press.
Low, B. S. (1996). Behavioral ecology of conservation in traditional societies. *Human Nature*, *7*, 353–379.
McClure, S. M., Laibson, D. I., Loewenstein, G., & Cohen, J. D. (2004). Separate neural systems value immediate and delayed monetary rewards. *Science*, *306*, 503–507.
Milinski, M., Semmann, D., Krambeck, H., & Marotzke, J. (2006). Stabilizing the earth's climate is not a losing game: Supporting evidence from public goods experiments. *Proceeding of the National Academy of Sciences*, *103*, 3994–3998.
Miller, G. F. (2009). *Spent: Sex, evolution, and consumer behavior*. New York: Viking.
Nesse, R. M. (2005). Evolutionary psychology and mental health. In D. Buss (Ed.), *Handbook of evolutionary psychology* (pp. 903–927). Hoboken, NJ: Wiley.
Neuberg, S. L., Kenrick, D. T., & Schaller, M. (2010). Evolutionary social psychology. In S. T. Fiske, D. T. Gilbert & G. Lindzey (Eds.), *Handbook of social psychology*, 5th ed. (pp. 761–796). New York: John Wiley & Sons.

Neufeld, S. L., Griskevicius, V., Ledlow, S. E., Li, Y. J., & Neel, R. (2013). *Going green to help your genes: The use of kin-based appeals in conservation messages*. Working paper, Global Institute for Sustainability, Arizona State University.

Nolan, J. P., Schultz, P. W., Cialdini, R. B., Goldstein, N. J., & Griskevicius, V. (2008). Normative social influence is underdetected. *Personality and Social Psychology Bulletin*, *34*, 913–923.

Nowak, M. A., & Sigmund, K. (2005). Evolution of indirect reciprocity. *Nature*, *437*, 1291–1298.

OECD (2012). *OECD environmental outlook to 2050*. Paris, France.

Öhman, A., & Mineka, S. (2001). Fears, phobias, and preparedness: Toward an evolved module of fear and fear learning. *Psychological Review*, *108*, 483–522.

Ornstein R., & Ehrlich P. (1989). *New world, new mind: Moving toward conscious evolution*. New York: Touchstone Books.

Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. Cambridge: Cambridge University Press.

Palmer, C. T. (1991). Kin-selection, reciprocal altruism, and information sharing among Maine lobstermen, *Ethology and Sociobiology*, *12*, 221–235.

Park, J., Schaller, M., & van Vugt, M. (2008). The psychology of human kin recognition: Heuristic cues, erroneous inferences, and their implications. *Review of General Psychology*, *12*, 215–235.

Penn, D. J. (2003). The evolutionary roots of our environmental problems: Toward a Darwinian ecology. *Quarterly Review of Biology*, *78*, 275–301.

Penn, D., & Mysterud, J. (2007). *Evolutionary perspectives on environmental problems*. London: Transaction Publishers.

Pinker, S. (2002). *The blank slate*. London: Penguin Classics.

Powers, N., Blackman, A., Lyon, T. P., & Narain, U. (2008). Does disclosure reduce pollution? Evidence from India's Green Rating Project. Discussion Paper, Resources for the Future, RFF 08-38. Downloaded January 12, 2013 from http://www.rff.org/RFF/Documents/RFF-DP-08-38.pdf.

Rees, W. (2010). *The human nature of unsustainability*. Post-Carbon Reader Series. Santa Rosa, CA: Post-Carbon Institute.

Richardson, N. J., Shepherd, R., & Elliman, N. A. (1993). Current attitudes and future influence on meat consumption in the UK. *Appetite*, *21*, 41–51.

Richerson, P. J., & Boyd, R. (2006). *Not by genes alone: How culture transformed human evolution*. Chicago: Chicago University Press.

Ridley, M. (2003). *Nature via nurture*. London: Penguin.

Roberts, S. C. (2012). *Applied evolutionary psychology*. Oxford: Oxford University Press.

Rogers, E. (1995). *Diffusion of innovations*. New York: The Free Press.

Saad, G. (2007). *The evolutionary bases of consumption*. New York: Lawrence Erlbaum Associates.

Saad, G. (2011). *Evolutionary psychology in the business sciences*. Heidelberg, Germany: Springer.

Schultz, P. W. (1999). Changing behavior with normative feedback interventions: A field experiment of curbside recycling. *Basic and Applied Social Psychology*, *21*, 25–36.

Schultz, P. W. (2002). Inclusion with nature: Understanding the psychology of human-nature interactions. In P. Schmuck & P. W. Schultz (Eds.), *The psychology of sustainable development* (pp. 61–78). New York: Kluwer.

Schultz, P. W. (2010). Making energy conservation the norm. In K. Ehrhardt-Martinez & J. Laitner (Eds.), *People-centered initiatives for increasing energy savings*. Washington, DC: American Council for an Energy-Efficient Economy. Online book available at: http://www.aceee.org/people-centered-energy-savings.

Schultz, P. W. (2011). Conservation means behavior. *Conservation Biology*, *25*, 1080–1083.

Schultz, P. W., Khazian, A., & Zaleski, A. (2008). Using normative social influence to promote conservation among hotel guests. *Social Influence*, *3*, 4–23.

Schultz, P. W., Nolan, J. P., Cialdini, R. B., Goldstein, N. J., & Griskevicius, V. (2007). The constructive, destructive, and reconstructive power of social norms. *Psychological Science*, *18*(5), 429–434.

Schultz, P. W., & Zelezny, L. (2003). Reframing environmental messages to be congruent with American values. *Human Ecology Review*, *10*, 126–136.

Schwartz, S. (1992). Universals in the content and structure of values. *Advances in Experimental Social Psychology*, *25*, 1–65.

Simon, H. (1990). A mechanism for social selection and successful altruism. *Science*, *21*, 1665–1668.

Smith, E., & Wishnie, J. (2000). Conbservation and subsistence in small scale societies. *Annual Review of Anthropology*, *29*, 493–524.
Slovic, P. (1987). Perception of risk. *Science*, *236*, 280–285.
Steg, L., & Vlek, C. (2009). Encouraging prosocial behavior: An integrative review and research agenda. *Journal of Environmental Psychology*, *29*, 309–317.
Stern, P. C. (2000). Toward a coherent theory of environmentally significant behaviour. *Journal of Social Issues*, *56*, 407–424.
Steentjes, K., & M. van Vugt (2013). Exposure to nature promotes cooperation in social dilemmas. Working paper. Department of Social and Organisational Psychology, VU Amsterdam.
Sundie, J. M., Cialdini, R. B., Griskevicius, V., & Kenrick, D. T. (2006). Evolutionary social influence. In M. Schaller et al. (Eds.), *Evolution and social psychology* (pp. 287–316). New York: Psychology Press.
Sundie, J. M., Kenrick, D. T., Griskevicius, V., Tybur, J. M., Vohs, K. D., & Beal, D. J. (2011). Peacocks, Porsches, and Thorstein Veblen: Conspicuous consumption as a sexual signaling system, *Journal of Personality and Social Psychology*, *100*, 664–680.
Swim, J. K., Stern, P. C., Doherty, T., Clayton, S., Reser, J., Weber, E, Gifford, R., & Howard, G. S. (2011). Psychology's contributions to understanding and addressing global climate change. *American Psychologist*, *66*, 241–250.
Tajfel, H., & Turner, J. C. (1979). An integrative theory of intergroup conflict. In H. Tajfel (Ed.), *The social psychology of intergroup relations* (pp. 33–47). Monterey, CA: Brooks-Cole.
Tenbrunsel, A. E., & Messick, D. M. (1999). Sanctioning systems, decision frames and cooperation. *Administrative Science Quarterly*, *44*, 684–707.
Thaler, R. H., & Sunstein, C. R. (2008). *Nudge*. New Haven, CT: Yale University Press.
Tinbergen, N. (1963). On the aims and methods of ethology. *Zeitschrift für Tierpsychologie*, *20*, 410–433.
Tooby, J., & Cosmides, L. (1992). The psychological foundations of culture. In J. Barkow, L. Cosmides, and J. Tooby (Eds.), *The adapted mind: evolutionary psychology and the generation of culture* (pp. 19–136). New York: Oxford University Press.
Trivers, R. L. (1971). The evolution of reciprocal altruism. *Quarterly Review of Biology*, *46*, 35–57.
Ulrich, R. S. (1984). View through a window may influence recovery from surgery. *Science*, *4647*, 420–421.
UNEP (United Nations Environment Programme) (2012). Downloaded June 12, 2013 from http://www.unep.org/geo/geo3/english/221.htm.
Uzzell, D. L. (2000). The psycho-spatial dimension of global environmental problems. *Journal of Environmental Psychology*, *20*, 307–318.
Uzzell, D. L., & Raethzel N. (2009). Transforming environmental psychology. *Journal of Environmental Psychology*, *29*, 340–350.
Van der Wal, A., Krabbendam, A. C., Schade, H., & van Vugt, M. (2013). Do natural landscapes reduce future discounting in humans? Proceedings of the Royal Society-B, 280, no. 1773 20132295.
Van Lange, P. A. M., Balliet, D. P., Parks, C. D., & van Vugt, M. (2013). *Social dilemmas: The psychology of human cooperation*. Oxford: Oxford University Press.
Van Lange, P. A. M., De Bruin, E., Otten, W., & Joireman, J. A. (1997). Development of prosocial, individualistic, and competitive orientations: Theory and preliminary evidence. *Journal of Personality and Social Psychology*, *73*, 733–746.
Van Vugt, M. (2001). Community identification moderating the impact of financial incentives in a natural social dilemma: Water conservation. *Personality and Social Psychology Bulletin*, *25*, 731–745.
Van Vugt, M. (2009). Averting the tragedy of the commons: Using social psychological science to protect the environment. *Current Directions in Psychological Science*, *18*, 169–173.
Van Vugt, M., & Ahuja, A. (2011). *Naturally selected: the evolutionary science of leadership*. New York: Harper.
Van Vugt, M., & Hardy, C. (2010). Cooperation for reputation: Wasteful contributions as costly signals in public goods. *Group Processes and Intergroup Relations*, *13*, 101–111.
Van Vugt, M., Hogan, R., & Kaiser, R. (2008). Leadership, followership, and evolution: Some lessons from the past. *American Psychologist*, *63*, 182–196.

Van Vugt, M., Roberts, G., & Hardy, C. (2007). Competitive altruism: Development of reputation-based cooperation in groups. In R. Dunbar & L. Barrett (Eds.) *Handbook of evolutionary psychology* (pp. 531–540). Oxford: Oxford University Press.

Wilson, E. O. (2006). *The creation: An appeal to save life on earth*. New York: Norton.

Wilson, M., & Daly, M. (1997). Life expectancy, economic inequality, homicide, and reproductive timing in Chicago neighborhoods. *British Medical Journal*, *314*, 1271–1274.

Wilson, M., & Daly, M. (2005). Carpe diem: Adaptation and devaluing the future. *Quarterly Review of Biology*, *80*, 55–60.

Wilson, M., Daly, M., & Gordon, S. (2007). The evolved psychological apparatus of human decision-making is one source of environmental problems. In D. Penn & I. Mysterud, (Eds.) *Evolutionary perspectives on environmental problems*. New Brunswick, NJ: Transaction Publishers.

Wilson, D. S., Van Vugt, M., & O'Gorman, R. (2008). Multilevel selection theory and major evolutionary transitions: Implications for Psychological Science. *Current Directions in Psychological Science*, *17*, 6–9.

Zahavi, A., & Zahavi, A. (1997). *The handicap principle: a missing piece of Darwin's puzzle*. New York: Oxford University Press.

MARK VAN VUGT is Professor of Psychology at the VU University, the Netherlands, and a research fellow at the University of Oxford. He obtained his PhD in health education from Maastricht University. His research expertise is in the areas of evolutionary and social psychology, group dynamics, and behavior change. He has a keen interest in applications of evolutionary social psychology to issues regarding sustainability, environmental conservation, nature and well-being. His research has been published in top journals in psychology and biology, including Nature, Psychological Science, American Psychologist, Current Biology, and Psychological Bulletin and he is co-author of a textbook on applying social psychology.

VLADAS GRISKEVICIUS is Associate Professor of Marketing and Psychology at the University of Minnesota's Carlson School of Management. He studies green marketing and the evolutionary roots of modern consumer behavior. Griskevicius has published extensively on motivation and sustainability. He is also the author of the book The Rational Animal: How Evolution Made Us Smarter than We Think, which looks at how modern choices are influenced by deep-seated ancestral needs, albeit rarely in obvious or conscious ways.

P. WESLEY SCHULTZ is Professor of Psychology at California State University, San Marcos. His research interests are in applied social psychology, particularly in the area of sustainable behavior. Recent studies have examined energy and water conservation, residential and workplace recycling, litter prevention, and climate change education. He is published extensively in these areas, with books on applied social psychology, the psychology of sustainable development, attitudes and opinions, and most recently social marketing to protect the environment.