



## Review

## Evolutionary sport and exercise psychology: Integrating proximate and ultimate explanations

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## ABSTRACT

**Objectives:** This review aims to demonstrate the utility of integrating the insights of evolutionary psychology with sport and exercise psychology. Specifically, we offer a primer on evolutionary psychology that we then discuss in the context of several research avenues in sport and exercise. Next, we discuss how evolutionary psychology can inform our understanding of sporting culture.

**Design:** Review paper.

**Methods:** Theory and research are selectively reviewed in efforts to demonstrate the utility and limits of evolutionary psychology as an approach to sport and exercise psychology.

**Results and conclusions:** Evolutionary psychology offers researchers in sport and exercise psychology an improved capacity to produce proximate explanations (i.e., *how* psychological mechanisms interact with the environment to produce behavior) by generating productive and novel hypotheses from ultimate explanations (i.e., *why* a psychological mechanism evolved a particular design; [Tooby & Cosmides, 1992, 2005](#)). The worth of integrating proximate and ultimate explanations is demonstrated by the ensuing novel insights of popular avenues of sport and exercise psychology including (a) the interrelation between motivation and reasoning and their relative influence on exercise behavior, (b) sex differences in sport participation, (c) performance in sport, and (d) group dynamics in sport. Unlike specific fields of psychology, evolutionary psychology is a metatheoretical approach that can foster mutually productive linkages between currently disparate areas within sport and exercise psychology, and with neighboring disciplines.

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The origin of sport psychology can be traced back to [Scripture \(1895\)](#), [Triplett \(1898\)](#), and [Griffith \(1925\)](#) whose foundational work had notable significance in applied settings—a trend that still characterizes sport psychology. Several decades later, [Morgan \(1974\)](#) helped establish exercise psychology—a field with applied aims, historical ties, and theoretical overlap with sport psychology. Although these two fields are distinct, they have engineered a mutually beneficial relationship centered on understanding how specific behavioral outcomes are produced within a physical activity environment.

Whereas the fields of sport and exercise psychology continue to mature, the parent discipline of psychology is undergoing a paradigm shift brought about by evolutionary psychology.

Evolutionary psychology is built upon the fact that evolution via natural selection “designed” not only the architecture of the body, but also the architecture of the mind (i.e., the physiological, neurological, and psychological adaptations that enable learning and produce human behavior; [Buss, 1995](#); [Tooby & Cosmides, 1992, 2005](#)). Just as the majority of members of the human species reliably develop a similar functional bodily architecture (e.g., two eyes, two arms, a heart, lungs), evolutionary psychologists posit that the same is true for the brain in that it comprises reliably developing psychological mechanisms that evolved because they served an adaptive function in the ancestral past. By gathering evidence and building a task-analysis of the adaptive problems that occurred in the ancestral past, evolutionary psychologists generate hypotheses of psychological mechanisms that evolved to solve these adaptive problems ([Tooby & Cosmides, 1992, 2005](#)). These hypotheses are then tested experimentally against possible alternatives, including how the behavior should be distributed cross-culturally ([Tooby & Cosmides, 2005](#)).

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The insights of evolutionary psychology offer sport and exercise psychology an improved capacity to pursue their shared research aim (i.e., *how* a psychological mechanism interacts with the environment to produce behavior) by generating hypotheses from knowledge of *why* a psychological mechanism may have gained its design; that is, the ancestral selection pressures that caused its design (Tooby & Cosmides, 1992). Indeed, explanations of *how* a mechanism works and explanations of *why* a mechanism possesses a specific design are mutually informative; reaching one explanation generates worthwhile hypotheses about the other (Cosmides, Tooby, & Barkow, 1992). The general purpose of this article is to articulate the need to integrate evolutionary psychology with sport and exercise psychology. Accordingly, the specific objectives are to (a) provide a brief primer on evolutionary psychology, (b) highlight specific examples to illustrate the utility of an evolution-informed sport and exercise psychology, and (c) discuss how evolutionary psychology can inform our understanding of sporting culture.

### An evolutionary psychology primer

Evolutionary psychology is built upon the advances of cognitive science, which maintains that the mind is a “set of information-processing devices, embodied in neural tissue, that are responsible for all conscious and nonconscious mental activity, and that generate all behavior” (Tooby & Cosmides, 2005, p. 5). Although traditional approaches test hypotheses concerning how information-processing devices use information from the environment to regulate and produce behavior, evolutionary psychology advances this endeavor by recognizing that the design of these information-processing devices (often termed evolved psychological mechanisms) was crafted during human evolution by specific selection pressures in ancestral environments. Consider that the behaviors of a young athlete in the present are, of course, responses to information the athlete encounters in the present. Nevertheless, the relationships between (a) the information the athlete extracted from the environment, (b) how that information is processed, and (c) the athlete’s behavioral output were crafted by selection pressures in the ancestral environment (Tooby & Cosmides, 2005).

To grasp the relevant selection pressures in the ancestral environment, evolutionary psychologists use the “environment of evolutionary adaptedness” (EEA) concept. The EEA refers to the ancestral environment that possessed the adaptive problem that selected for a specific psychological adaptation. The EEA is generated by amassing knowledge of our shared ancestry from evidence gathered in relevant disciplines (e.g., anthropology, archeology, geology) and is used to generate predictions about the “design” of specific psychological adaptations. Underlying the application of the EEA is the principle that individuals who were most successful in surviving and producing offspring increased the frequency of their genes in the next generation (i.e., genetic fitness) relative to those less successful individuals. Thus, traits that conferred a reproductive and survival advantage proliferated in a population over generations. Seen through the lens of evolutionary psychology, there are two general types of explanations—*how* a psychological mechanism interacts with the environment to produce behavior, and *why* a psychological mechanism evolved to have a particular design.

### Proximate and ultimate explanations

Nikolaas Tinbergen (1963) is credited with outlining an integrative framework of four distinct yet complementary types of explanations of behavior that can be categorized as either proximate (how) or ultimate (why). *Proximate* explanations specify (a)

how a psychological mechanism interacts with the environment to produce behavior and (b) how a psychological mechanism develops over an individual’s lifetime (ontogeny). *Ultimate* explanations specify (c) why a psychological mechanism is designed the way it is (i.e., the adaptive function) and (d) the evolutionary history of a psychological mechanism (Tinbergen, 1963). For example, consider “runner’s high”—the elation experienced after moderate to vigorous physical activity. On one hand, proximate explanations of runner’s high include how sufficient levels of physical activity induce positive elation or, more specifically, how exercise-induced endocannabinoid signaling causes positive elation (Raichlen, Foster, Gerdeman, Seillier, & Giuffrida, 2012). The second type of proximate explanation specifies how exercise-induced endocannabinoid signaling develops over an individual’s lifetime. On the other hand, ultimate explanations draw upon evidence suggesting that exercise-induced endocannabinoid signaling evolved to promote aerobic activity, which is vital for hunting moving prey (Bramble & Lieberman, 2004). The second ultimate explanation concerns the evolutionary history (phylogeny) of exercise-induced endocannabinoid signaling; that is, when it emerged in ancestral species.

### Recognizing human nature

To identify and understand the information-processing structure of evolved psychological mechanisms it is necessary to test the domain specificity of a hypothesized mechanism. In other words, an attempt is made to determine whether the mechanism is domain-specific (i.e., it inputs specific information and generates specific behavioral outputs because it evolved to solve specific adaptive problems) or domain-general (i.e., it inputs a variety of information and generates a variety of behavioral outputs because it evolved to solve a variety of adaptive problems; Barrett, 2008).

The question of whether the mind is mostly comprised of domain-specific or domain-general mechanisms is a point at which evolutionary psychology diverges from traditional approaches (Tooby & Cosmides, 1992). The suite of assumptions and arguments that evolutionary psychology critiques, often termed the standard social science model (SSSM; Tooby & Cosmides, 1992; 2005) or the “blank-slate” model (Pinker, 2002), maintains that the mind consists of a diminutive number of domain-general psychological mechanisms that enable infinite malleability. Although evolutionary psychologists recognize that domain-general mechanisms are possible, they reject the claim that the mind is completely domain-general and infinitely malleable. The rejection stems from the recognition that domain-general mechanisms would not have been consistently selected for because “jacks-of-all-trades are masters of none. They achieve generality only at the price of broad ineptitude” (Cosmides & Tooby, 2002, p. 170). Thus it is argued that the mind, like the body, is modular, comprised of many domain-specific psychological mechanisms that evolved for solving specific adaptive problems. However, the domain specificity of hypothesized mechanisms must be determined empirically, case-by-case (Barrett, 2008).

When generating and testing functional hypotheses of evolved psychological mechanisms (adaptations) it is necessary to test for design, the hallmark of an adaptation (Williams, 1966). Indeed, many organism traits are not themselves adaptations, but are by-products of adaptations. By-products are traits that serve no adaptive purpose and are causally coupled or produced by adaptations (Tooby & Cosmides, 2005). Physiological examples include the color of bones or the belly button. A psychological example would be reading and writing text. Given that text has only existed for several thousand years, and only in certain cultures, it is highly unlikely that reading/writing is an adaptation. Rather, this behavior

is likely a by-product enabled by adaptations for spoken language and perhaps others (Pinker & Bloom, 1990).

### *The mismatch hypothesis*

The process that crafted both psychological and physiological adaptations (i.e., natural selection) is relatively slow. It takes time to evolve complex mechanisms. Although it takes significantly less time to shape and mould them, and evidence does suggest humans have undergone selection within the last 10,000 years (Voight, Kudaravalli, Wen, & Pritchard, 2006), the majority of psychological mechanisms evolved to utilize aspects of an ancestral environment that preceded the last 10,000 years in which humans have grown in population, physical resources, and knowledge. The various mismatches between humans' evolved psychology and the current environment are reflected by the many problems that have developed in modern society, often described as the diseases of civilization (Pollard, 2008).

An example of this mismatch between modern society and our ancestral past is the competitive group dynamics observed in team sport. While identifying with a sport team/club (either as a player or fan) can often evoke positive experiences (e.g., satisfy the need to belong; Baumeister & Leary, 1995), it can also evoke inter-group rivalries and aggressive acts against members of rival groups (Wann, Haynes, McLean, & Pullen, 2003). In fact, the psychophysiological response to the success and failure of these groups (who are often located hundreds of miles away and are composed of individuals who many of these fans have never met in real life) can be quite substantial. For instance, the incidence of acute myocardial infarction and stroke increases the days after a national team is eliminated from the FIFA World Cup of soccer/football (Wilbert-Lampen et al., 2008) and decreases after winning the championship (Berthier & Boulay, 2003).

Identifying with and defending a sport team or club are not purely social constructions—these dynamics are by-products of psychological mechanisms that evolved due to the high prevalence of tribal warfare in the EEA; it is estimated that many hunter-gatherer societies had upwards of a 30–40% male death rate due to tribal warfare (Keeley, 1996; Pinker, 2011). As Van Vugt and Park (2009) highlighted: “Upon encountering a group of strangers, it would be crucial for our ancestors to know—and know quickly—whether they were members of the same or a different clan...Inappropriate responses could have been lethal” (p. 10). Tribal warfare and raiding are hypothesized to have selected for mechanisms that motivate individuals to identify with, form, and defend one's in-group, and also the cognitive capacity to discriminate “us” versus “them” (Van Vugt, 2009; Van Vugt & Park, 2009; Winegard & Deaner, 2010).

### *Issues with evolutionary psychology*

When proposing an overarching approach such as evolutionary psychology there are often apt critiques; indeed, such is the healthy progress of science (Lakatos, 1970). However, there are often straw-man critiques (i.e., arguments made against distorted interpretations) that impede real progress and result in the need to clarify mischaracterizations (Lakatos, 1970). One fallacy often associated with evolutionary psychology is termed the naturalistic fallacy—attempting to derive an “ought” from an “is” (Buss, 1990; Gaulin & McBurney, 2004; Hagen, 2005). For example, youth have evolved mechanisms that underlie play behavior (Geary, 2010), but this does not exclusively mean play behavior is good, just as the existence of evolved mechanisms underlying aggressive behavior does not mean aggressive behavior is good. Just because something is natural, does not make it morally acceptable (Gaulin & McBurney, 2004).

Evolutionary psychology is also mischaracterized as being situated on the nature side of the nature–nurture dichotomy. On the contrary, evolutionary psychology calls into question the validity of this dichotomy (Tooby & Cosmides, 1992; 2005). Converging evidence from cognitive science, behavioral genetics, evolutionary biology, artificial intelligence, behavioral economics, anthropology, and similar fields have rendered many aspects of the nature–nurture debate obsolete (Davids & Baker, 2007; Hagen, 2005; Pinker, 2002; Tooby & Cosmides, 1992). As Tooby and Cosmides (2005) highlighted, a foundation of evolutionary psychology is that nature and nurture are not opposed. In contrast, they exhibit a non-zero sum relationship (i.e., more nature means more nurture). From this view, learning is only possible because the human species reliably develops numerous evolved psychological learning mechanisms that are specialized for solving specific problems (e.g., grammar acquisition or kin recognition). Pinker (2004) clarified that “learning itself must be accomplished by innate circuitry, and what is innate is not a set of rigid instructions for behavior but rather programs that take in information from the senses and give rise to new thoughts and actions” (p. 2). The term “learning” is regularly used throughout the social sciences as an explanation for some type of human change, yet such explanations are vacuous (Hagen, 2005). Learning is not an explanation, but a description that itself requires explanation. An evolutionary approach does not downplay the human capacity for variable behavior, nor does it downplay humans' powerful capacity to change. Rather, it merely aims to develop explanations of behavior and learning that are biologically plausible.

Those critiquing evolutionary psychology for supposedly neglecting the role of learning often exploit the accusation of genetic determinism. However, these accusations are mainly built upon the genetic fallacy—the mistaken belief that evolved traits are inflexible (Buss, 1990; Gaulin & McBurney, 2004; Hagen, 2005). What is often overlooked is that genetically “determined” evolved mechanisms, including those both below and above the neck, do not imply genetically determined behavior (Hagen, 2005). Consider the immune system and the capacity for language. Both are genetically determined in one sense (i.e., practically every human reliably develops an immune system and the capabilities to learn language) yet the possible languages and word combinations that can be learned, and the possible pathogens that the immune system can detect and neutralize, are seemingly infinite.

In sum, the human brain is an evolved organ consisting of adaptations that evolved to solve specific adaptive problems in the ancestral past. To understand *how* specific psychological adaptations “work” it helps to understand *why* they evolved via natural selection. Psychological adaptations are computational; in that information is inputted, processed, and results in behavioral output. As these adaptations evolved in ancestral environments they may not be biologically adaptive in current environments. When viewing the mind as a suite of information-processing adaptations it is also important to recognize that (a) just because something is “natural” does not make it morally acceptable, and that (b) genes are not destiny. An evolutionary approach to sport and exercise recognizes the numerable learning capacities of the human species while also recognizing the necessity of biologically plausible explanations.

### **Evolutionary sport and exercise psychology**

Unlike the fields of social psychology or developmental psychology, evolutionary psychology is an overarching theoretical approach to the study of psychology (i.e., a metatheory). Many researchers in the field anticipate that the *evolutionary* component of evolutionary psychology will eventually become redundant as all of

psychology will be evolutionary (Buss, 2005). As a metatheoretical approach, evolutionary psychology can benefit sport and exercise psychology in four ways. First, it offers ultimate explanations of already established proximate level evidence. Second, by converging on ultimate explanations, it offers novel and fruitful hypotheses of undiscovered evolved psychological mechanisms or reinterpretations of proximate level evidence. Third, it can foster mutually productive linkages between currently disparate avenues of research within sport and exercise psychology. Fourth, it can foster mutually productive linkages between sport/exercise psychology and other disciplines, such as anthropology. The following review discusses specific avenues of research in evolutionary psychology that add to sport and exercise psychology.

#### *Motivation, reasoning, and physical activity behavior*

The behaviorist tradition led by Skinner, Watson, and Donald viewed motives as either innate or learned. Innate motives were thought to be limited in number and functioned to acquire fundamental resources such as food, water, and mating partners, whereas motives such as jealousy and parental attachment were supposed to be learned via conditioning and reinforcement. However, the majority of psychologists have since rejected the behaviorist paradigm (Miller, 2003) on the basis of philosophical, theoretical, and empirical advances.

An evolutionary approach to motivation posits that humans should possess multiple motivational mechanisms that have specific information processing characteristics. Although these motivational mechanisms are also hypothesized to be universal aspects of human nature, their behavioral outputs are shaped by one's cultural milieu and are contingent on the local social and physical ecology. For example, children's rough-and-tumble play is found across cultures, is more prevalent in males, and there is accumulating evidence that such behaviors are, in part, due to levels of prenatal androgen exposure (Berenbaum & Beltz, 2011). Yet while universal, the prevalence and intensity of rough-and-tumble play is culturally variable. For example, in societies that regularly involve intra-group and inter-group physical aggression (e.g., fighting, tribal warfare), anthropologists have documented relatively more intense rough-and-tumble play, including physically competitive sports. In their analysis of Native American warrior societies of the central plains, Loy and Hesketh (1995) noted that "all Plains Indian tribes were, to greater or lesser degrees, involved in a wide range of warring activities" (p. 80) and that within these societies youth sports were designed to promote physical endurance and aggressive physical competition between individuals and groups.

An evolutionary approach suggests that psychological mechanisms evolved to produce locally adaptive behavior, and certain motives in certain contexts should take precedence over others, altogether resembling a hierarchy (Kenrick, Griskevicius, Neuberg, & Schaller, 2010). An early proposal of such a hierarchy was Maslow's pyramid of human needs (Maslow, 1954). Maslow proposed that all humans reliably develop multiple independent sets of motivational mechanisms that are hierarchal in nature. Although the early popularity of Maslow's pyramid faded as the cognitive revolution oriented psychology toward higher-level cognitive processes, its fundamental proposition that humans have multiple motivational mechanisms has remained. In particular, research employing an evolutionary approach has unearthed a variety of specific motivational mechanisms including sex-differences in the elicitation of anger (Buss, 1989), social dominance (Sidanius, Levin, Liu, & Pratto, 2000), resistance and noncontact with infectious pathogens (Schaller & Duncan, 2007), mate selection (Botwin, Buss, & Shackelford, 1997), in-group cooperation and out-group enmity (Winegard & Deaner, 2010), and the need to belong (Baumeister &

Leary, 1995). Recently, Kenrick et al. (2010) proposed a renovated pyramid of needs (based on Maslow's) that captures a wealth of contemporary research suggesting the existence of a variety of motivational mechanisms that can be grouped into hierarchal systems.

Although an evolutionary approach has begun to reinvigorate the study of motivation in general, theories of behavior change in exercise and sport psychology mainly concern higher-level reasoning processes (e.g., intentions, contemplations, expectations; for reviews of prevailing theory in exercise psychology see Mack, Sabiston, McDonough, Wilson, & Paskevich, 2011). The focus on higher-level executive constructs may be attributed to the cognitive revolution that paralleled the emergence of the field of exercise psychology. During this time, theories concerning higher-level executive constructs dominated mainstream psychology, with the majority arguing that most behavior is under conscious volitional control and can therefore be changed by rational argument. This proposition is integral to exercise psychology's current focus on reasoning. For example, anticipating outcomes of exercise behavior (i.e., outcome expectations) and perceiving one's capability to perform exercise behavior in a specific context (i.e., efficacy beliefs) are conceptualized as determinants of exercise behavior (and seem reasonable on the surface). However, attempting to develop ultimate explanations of these higher-level constructs may advance proximate explanations, including flaws in reasoning and, importantly, how they coincide with overriding affective processes.

In contrast to the rational model of reasoning, which predicts that reasoning helps to achieve correct beliefs and conclusions, research led by Kahneman (2011) has exposed various irrational flaws. However, when looking through an evolutionary lens, irrational flaws in reasoning become ecologically rational; that is, flaws are seen as aspects of functional design that were once adaptive in ancestral environments (Tooby & Cosmides, 1992). For example, the argumentative theory put forth by Mercier and Sperber (2011) proposes that conscious reasoning evolved to win arguments (to convince others of one's position and to evaluate and criticize opposing positions as a lawyer would) rather than seeking accurate conclusions (as a scientist would). This theory integrates a variety of relevant and previously unaccounted for phenomena such as the universally found confirmation bias and reasoned-based choice bias (Mercier & Sperber, 2011).

In terms of physical activity, it is telling that individuals, at least in technologically developed societies, seem to know exercise behavior is healthy (e.g., Crombie et al., 2004) and yet across the world inactivity is highest among more technologically developed societies (Dumith, Hallal, Reis, & Kohl, 2011). Indeed, this poses an important and often-ignored question for exercise psychologists: how useful is conscious rational arguments (i.e., "physical activity is healthy, so be physically active!") for increasing exercise behavior? Is reasoning "the slave of the passions" (1739/2007, p. 295) as philosopher David Hume claimed?

Both reasoning and affective processes are necessary to form any comprehensive model of behavior change. However, a recent meta-analysis by Webb and Sheeran (2006) suggested that conscious reasoning generally has a small to moderate influence on behavior. In fact, consensus seems to have shifted to one side of this long-standing debate: affective processes have a relatively stronger influence than reasoning (Haidt, 2001). In a heavily cited synthesis, Haidt (2001) concluded that "the affective system has primacy in every sense: it came first in phylogeny, it emerges first in ontogeny, it is triggered more quickly in real-time judgments, and it is more powerful and irrevocable when the two systems yield conflicting judgments" (p. 819). Aligning with Haidt's position, evidence suggests most cognition occurs outside of consciousness (Bargh & Chartrand, 1999), and in many situations individuals cannot

rationalize why they make certain value judgments (Haidt, Bkorklund, & Murphy, 2012). If conscious reasoning is in fact “the slave of the passions” (Hume, 1739/2007, p. 295), and if exercise psychology aims to find the most viable and efficient ways to increase exercise behavior, then a research agenda with a more balanced focus on both conscious reasoning and affective processes may be warranted. On this view, specific hypotheses provided by an evolutionary approach to motivation will be a valuable resource for those aiming to increase exercise behavior. The following discussion of sport participation and sex differences is an example of how the study of motivation may be informed by an evolutionary approach.

### *Sex differences in sport participation*

Across the world, in practically all societies and at all ages (where measures exist), males exhibit higher rates of sport participation than females (e.g., Craig, 2002; Deaner & Smith, 2012; Guttmann, 2004; Ifedi, 2008; Larson & Verma, 1999; Lunn, 2010; Stamatakis & Chaudhury, 2008). A seemingly popular hypothesis put forth by sport psychologists and sociologists is that this disparity is a result of socially constructed oppressive forces that produce, for example, unequal opportunities for sport participation. This hypothesis has merit. In 1972, the United States enacted a federal law known as Title IX, which prohibits any form of sexual discrimination within education programs or activities receiving federal funding. Included under this law, as a consequence, were high school and collegiate sport programs, which resulted in a more equal number of athletic scholarships and actual participation opportunities for women at both levels (Brake, 2010). In the subsequent years, and in parallel with the feminist movement, high school female sport participation grew six-fold, from 7% of all high school athletes in 1972 to 42% in 2010 (National Federation of State High School Associations, 2010). Intercollegiate female sport participation also grew from 30% in 1982 to 43% in 2009 (NCAA Research, 2010).

Unfortunately, this steady increase in female sport participation seems to be limited to secondary and post-secondary institutions. A recent analysis of the American Time Use Survey, which between 2003 and 2010 interviewed 112,000 participants regarding their activities during one day, found that while females accounted for 51% of time spent in exercise activities they only accounted for 24% percent of all time spent in sport participation and only 20% in team sport participation (Deaner et al., 2012). Deaner et al. (2012) also conducted systematic observations of 41 public parks and recreational areas, and documented participation in intramural sports across 34 institutions, both of which revealed similar participation patterns to those found using the American Time Use Survey.

There is also evidence that women and men approach sport in different ways. For example, males report higher competitive and ego orientations (Kavussanu & Ntoumanis, 2003). In 2005, a nation wide survey of sport participation in Canada found that men reported a lack of time as the primary reason for not participating in sport while women reported a lack of interest (Ifedi, 2008). In addition, males and females also participate in different sports. Four of the five most popular sports Canadian men participate in are largely tribal in nature and involve physical contact: hockey, basketball, baseball, and soccer. In contrast, four of the five most popular sports for Canadian women are relatively more individualistic and involve less physical contact: swimming, golf, volleyball, and skiing. Males also exhibit significantly more sport fandom (Dietz-Uhler, Harrick, End, & Jacquemotte, 2000) and experience sport fandom differently (James & Ridinger, 2002).

An evolutionary approach is radically at odds with the hypothesis that sex differences are *entirely* socially constructed—that males and females are born with identical blank slates. While

socialization certainly shapes gender differences (e.g., Eccles, Jacobs, & Harold, 1990), the blank slate hypothesis that predicts *all* sex differences are due to socialization fails to explain the wealth of evidence of sex differences among children (Geary, 2010). For example, one of the most established and consistent finding across cultures is the tendency for youth to form same-sex play and social groups, and to engage in different play styles (Geary, 2010). Young males, on average, often engage in rough and tumble play and form small coalitions during early development, whereas females tend to engage more in dyadic relationships and form long-term bonds with other females (Geary, 2010). Sex differences in children’s toy play are also robust across cultures and, in fact, have parallels in other primates (Hassett, Siebert, & Wallen, 2008). In addition, females with congenital adrenal hyperplasia—an uncommon condition that involves heightened prenatal androgen exposure—are more likely than typical females to have interest in stereotypically masculine activities, including sports (Berenbaum, 1999).

### *Evolved sex differences*

A specific form of natural selection, sexual selection, refers to selection that acts on an organism’s ability to obtain or attract a mate, and is a selective force through which many sex differences are crafted (Geary, 2010). Sexual selection theory argues that males tend to compete amongst themselves for access to mates (intra-sexual selection), and that females tend to be more selective of their mates than males (intersexual selection) (Andersson, 1994). These sex differences are the result of the asymmetry in reproductive investment between the sexes (Trivers, 1972). The production of male gametes is considered to be relatively cheap, and generally males in most non-human animals provide little or no parental care. Female investment in reproduction, however, is generally costly because they produce large, energy rich gametes and often are the sole providers of parental care. Thus, females can increase genetic fitness by carefully selecting mates that provide good genes for their offspring or material benefits such as high quality parental care or resources that can be used to aid in raising offspring (Andersson, 1994; Trivers, 1972). In humans, the resources a male must expend to sire an offspring is the relatively low cost of producing the ejaculate and the metabolic costs of intercourse. However, women must invest nine months of gestation and an extended period of lactation to produce offspring. Although men can (and do) invest in parental care, the majority of the physiological costs of parental investment are borne by women. Differences in parental investment lead to differences in reproductive strategies that evolve to maximize genetic fitness.

Intrasexual competition can occur through two different strategies. One is to physically dominate competitors, which aligns with the wealth of evidence suggesting that human males (i.e., the sex with the higher reproduction potential) are far more prone to instances of physical aggression (Daly & Wilson, 1988; Kruger & Nesse, 2006). Females also exhibit intrasexual competition, but they often use less physical forms of dominance, such as derogating a competitor’s reputation through gossip or exclusion (Hess & Hagen, 2006). The second strategy for obtaining mates is to attract them, which for males primarily occurs through increasing social status and primarily for females by increasing physical beauty (Geary, 2010). Lombardo (2012) hypothesized that sport may serve as both a context to gain status and to display attractive qualities. Specifically, Lombardo proposed that sport functions as a biological lek—a context where individuals not only compete to gain status and dominance, which involves learning about rivals and allies, but also allows individuals to display attractive qualities. However, functions of status striving, learning about rivals and allies, and displaying attractive qualities does not account for the tribal nature of sport. The most popular sports in which males tend

to be over-represented involve significant intergroup competition (Deaner & Smith, 2012; Ifedi, 2008).

Once again, differences in ancestral selective forces between sexes may provide insight, specifically with respect to cooperative hunting and tribal warfare (Lombardo, 2012; Van Vugt, 2009; Van Vugt & Park, 2009; Winegard & Deaner, 2010). Across the vast majority of hunter-gatherer societies, males predominantly participated in group-based cooperative hunting, an activity that not only provides heightened status to skilled hunters—and in turn reproductive opportunities—but also influences the genetic fitness of local kin-groups via nutritional resources (Marlowe, 2007). In addition, males were (and still are) substantially more likely to participate in intergroup warfare and raiding type activities (Gat, 2006; Keeley, 1996). It follows that males should be more inclined to form competitive coalitional groups than females (Van Vugt, 2009).

Research offering proximate evidence and explanations largely supports these ultimate hypotheses. For example, sexual selection theory predicts that intrasexual competition among males may be more intense as they have elevated motivation to best their peers. Supporting this prediction, evidence suggests that males consistently report greater ego-orientation (i.e., perceiving success as winning or possessing superior ability relative to peers; Kavussanu & Ntoumanis, 2003; Li, Harmer, & Acock, 1996; White, Duda, & Keller, 1998). Moreover, Deaner (2006) demonstrated that there are three times as many males than females in the United States who run fast relative to sex-specific world-class standards even though there is negligible, if any, sex differences in participation rates in distance running. Taken together (i.e., self-report questionnaires and distance running times) the above evidence provides indirect, yet objective support for the hypothesis that males have greater competitive orientations. In terms of the popularity of tribal team sports, the selection pressures for males to successfully navigate cooperative hunting and intergroup warfare and raiding predict males to have elevated preferences for coalitional competition. Supporting this hypothesis, across cultures males consistently score higher on preferences for between group dominance hierarchies (Sidanius et al., 2000). Evolved sex-differences in social preferences may influence sex differences in participation between sports and overall rates of sport participation.

Although we anticipate male-biased sex differences to remain (due to the aforementioned evolved sex differences), the flexibility of the magnitude of these sex differences is still unknown. Ultimately, interventions to increase sport participation must affect the fit between the environment and individual. Rather than focusing on manipulating the individual to fit the environment, an evolution-informed approach better aligns with interventions that aim to shape the environment to fit the individual. It should also be noted that an evolved basis for sex differences in sport participation does not justify oppression of female sport, nor that in all cultures female sport participation will forever be relatively lower than male sport participation (recall the naturalistic and genetic fallacies). The evolution-informed hypothesis described here simply aims to converge on the most accurate model of psychological sex differences, which can then be incorporated into the decision-making process for sport participation interventions. Indeed, if evolved sex differences become firmly established by a wealth of scientific literature and there are widespread moral arguments for equalizing sex differences, then implementing interventions to increase participation in sports that are best suited to male-specific and female-specific psychology—not a blank slate—may be warranted.

#### *Performance in sport*

Athletic performance has been a long-standing topic within the study of sport psychology and, over time, has hosted numerous

nature–nurture debates. Although emerging evidence suggests both genes and environment significantly contribute to sporting aptitude (Vinkhuyzen, Van der Sluis, Posthuma, & Boomsma, 2009) and sport and exercise participation (Stubbe, Boomsma, & De Geus, 2005), evolutionary psychologists primarily focus on panhuman evolved psychological mechanisms, not genes. The following represent only a few of many possibilities.

#### *Implicit and explicit learning*

A prominent line of research in the study of skill acquisition has concerned two main types of learning processes: (a) *explicit learning* characterized by controlled, usually declarative processes in which perceived patterns are encoded consciously; and (b) *implicit learning* involving a more automatic non-declarative learning process in which perceived patterns are encoded mostly non-consciously (Masters & Maxwell, 2004). Although the literature concerning each type of learning process, and how they interact, requires more discussion than this article provides, a major finding emerging from research in this area suggests that skills learned through implicit processes are generally more resilient under times of conscious duress than are skills learned explicitly. For example, Masters (1992) developed individuals' skill in golf putting either implicitly or explicitly and, in turn, placed them in a situation that evoked conscious duress. Implicit training consisted of individuals practicing in the absence of a teacher while simultaneously performing a random-letter-generation task that was assumed to use conscious attentional resources. Explicit training consisted of the individuals following a detailed set of instructions on skilled putting. Masters (1992) found performance between the last training session and the experimental high-duress session continued to increase for the implicit group but decreased for the explicit group.

Endeavoring to explain why skills learned implicitly may be more resilient under duress, Reber (1992) developed an ultimate level hypothesis proposing that the continual process of adaptation and degree of functional integration of phylogenetically older systems results in an implicit learning process that may be less error prone than phylogenetically younger explicit learning processes (Reber, 1992). Poolton, Masters, and Maxwell (2007) found empirical support for this ultimate level hypothesis and concluded that “We have inherited motor processes from our pre-declarative ancestors that have potential to be both resilient to fatigue and to the passage of time ... an evolutionary perspective has provided us useful insight” (p. 466).

#### *Color*

Darwin was one of the first to recognize that red coloration may have evolved in primates as a signal to attract females and of dominance. Subsequent research has largely supported this insight. Red coloration signals biological traits such as testosterone levels, physical dominance, and emotional states such as anger, arousal, and embarrassment (for an overview see Wiedemann, Barton, & Hill, 2012). In the current sporting environment, the color red has been implicated in performance differences across sports (although it is worth noting that more recent research has failed to establish this relationship; Furley, Dicks, & Memmert, 2012). For example, Hill and Barton (2005) analyzed boxing, taekwondo, freestyle wrestling, and Greco-roman wrestling in the 2004 Olympic Games. Their evidence suggested that wearing red provides an advantage in close contests. More recent research by Attrill, Gretsny, Hill, and Barton (2008) reviewed English football data in which they found an association between red team colors and long-term success.

Wiedemann et al. (2012) identified two mechanisms that may explain the proposed influence of red coloration on sporting success. One potential mechanism is perceiver effects; that is, those

who perceive their opponents wearing red may consciously or unconsciously perceive them as more dominant and/or that red coloration may have more psychological resonance and act as a distractor. Perhaps the strongest evidence for perceiver effects comes from research on judging bias. Hagemann, Strauß, and Leifing (2008) digitally reversed the coloring of taekwondo uniforms in a competition video and found that while the footage of the competition was the same (except for colors), judges consistently allotted more points to the athletes in red uniforms. Another mechanism may be adornment effects in that those wearing the color red may experience an endocrine response that improves performance. For example, Hill and Barton (2005) proposed that testosterone may be increased in those who wear red, which in turn, may influence physiological and behavioral performance. However, rigorous research investigating this hypothesis is lacking (Wiedemann et al., 2012).

#### *Group dynamics and sport*

Group dynamics is another general area of sport/exercise that could benefit from considering the principles of evolutionary psychology. 'Groups' are very prevalent in physical activity settings; a recent summary noted that over 80% of youth participants take part in team oriented sports (Canadian Fitness and Lifestyle Research Institute, 2009). Furthermore, even though many activities are viewed as 'individual' in nature, the majority are conducted in settings characterized by a high degree of interdependence (e.g., running groups, golf foursomes; Evans, Eys, & Bruner, 2012). We echo Van Vugt and Schaller (2008) who, in a special issue of the journal *Group Dynamics: Theory, Research, and Practice*, argued that "By applying the logical tools provided by evolutionary psychology, we have the potential to strengthen groups and foster beneficial group dynamics" (p. 1).

Hazing practices, as a specific example, offer a context with which to apply evolutionary psychology that is relevant to sport psychology. Hazing is defined as "any activity expected of someone joining a group that humiliates, degrades, abuses or endangers, regardless of the person's willingness to participate" (Hoover, 1999, p. 8). However, hazing is a relatively modern classification of a much more common and historically consistent practice: initiation rituals. From the perspective of evolutionary psychology, the prevalence of hazing across cultures (Allan & Madden, 2008; Groves, Griggs, & Leflay, 2012; Hamilton & Scott, 2012) and more generally of initiation rituals throughout history (Glucklich, 2003) raises several questions: If initiation rituals are detrimental, why are they so prevalent cross-culturally and historically? What is the ultimate explanation of these costly initiation rituals? Are these practices by-products of psychological mechanisms that evolved to solve other adaptive tasks, or are these behaviors actually adaptive?

Humans benefit from cooperation—cooperating with a group often affords individuals more fitness benefits than what could be acquired alone. However, a significant threat to group cooperation is free riding or social loafing (i.e., a potential reduction in effort and/or productivity by individuals who join groups). Although newcomers to a group could increase the fitness of group members, they could also free ride and thereby increase their own fitness at the expense of the fitness of group members, which if sustained would extinguish the benefits of cooperation. Several researchers have hypothesized that initiation rites are 'honest signals' of group members' commitment—their willingness to pay the costs necessary for group cooperation (Irons, 2001; Sosis, Kress, & Boster, 2007). Honest signals (e.g., enduring physical beatings, humiliation) are an evolutionarily stable strategy because they are by definition costly, and thus cannot be faked. Dishonest signals are evolutionarily unstable because they are unreliable and thus cannot

be used to enhance fitness over the long term (for an in-depth discussion of signaling theory see Zahavi & Zahavi, 1997).

If initiation rites are honest and costly signals of an individual's willingness to commit to group cooperation, then as Sosis et al. (2007) highlighted "groups that confront the most significant challenges of collective action ... will require the most demanding rituals of their community members in order to deter free-riders from exploiting the benefits attained through collective action" (p. 236). Although this prediction has yet to be examined in sport or exercise psychology, supportive evidence has been found in other contexts. Sosis et al. (2007) demonstrated cross-culturally that societies that engage in higher levels of warfare request costlier rites. Similar studies have also demonstrated that participation in costly rites is correlated with an individual's level of cooperation (Ruffle & Sosis, 2007; Sosis, 2000; Sosis & Ruffle, 2003), and that communes with costlier rites tend to exist for a longer period of time than those with less costly rites (Sosis & Bressler, 2003).

Is the severity of hazing practices positively associated with sporting contexts where success is more dependent on collective action, such as in competitive team sports? Do initiation rituals promote ingroup cooperation in sport, as they seem to do in other contexts? Perhaps a more nuanced approach that considers proximate explanations in the context of ultimate explanations will allow individuals to design initiation rituals to minimize negative aspects and maximize those that are positive. The above discussion considers both proximate and ultimate explanations of hazing, and is evidence of Van Vugt and Schaller's point that considering group dynamics from an evolutionary perspective highlights novel concepts and questions to pursue. Other topics that may also benefit include the provision of leadership, intra-team competition and cooperation, cohesion, role differentiation, conformity to group norms, in addition to inter-group rivalry.

#### *Linking psychology and culture*

Evolutionary psychology, as an overarching metatheoretical approach, is largely reductionist in so far as it pertains to evolved psychological mechanisms. It is also, fundamentally, an interdisciplinary approach as it converges on the causal connections between psychology and neighboring disciplines such as sociology or anthropology (Barkow, 2006). For example, evolutionary psychologists argue that culture is not opposed to biology, but rather culture is fundamentally biological because it is biology (psychological adaptations) that allows individuals to "enter", edit, transmit, and accumulate culture. As Barkow highlighted, our "evolved psychology is infrastructural to culture" (p. 59).

Although evolutionary psychology is conceptually situated at the individual level, the human environment consists of complex levels of organization and there is growing consensus that important determinants of sport and exercise behavior reside at multiple analytic levels (Spence & Lee, 2003). Accordingly, ecological approaches have been proposed to account for this suggestion. Evolutionary psychology strengthens ecological approaches because it makes specific predictions concerning how "upstream" factors such as the social ecology, culture, or material environment interact with the individual.

One way that evolutionary psychology contributes to the understanding of population level variation in sport and exercise behavior is through decomposing the concept of culture into two types: (a) transmitted culture and (b) evoked culture (Tooby & Cosmides, 1992). Transmitted culture (sometimes termed epideiological culture) refers to mental representations that are acquired through social transmission (Nettle, 2009). Transmitted culture is acquired via psychological mechanisms that evolved to learn specific information from specific individuals in one's local

social milieu. However, while most behavioral differences across cultures are likely not due to differences in genotype, this does not necessarily mean these differences are due to social learning. Rather, some local behavioral differences may be “evoked” by psychological adaptations that are dependent on cues in the local social and physical ecology (Nettle, 2009). Certain behavioral strategies were adaptive in certain contexts and, over deep time, ‘facultative’ mechanisms evolved to produce behavioral strategies in response to cues that reliably correlate with certain environments. Thus, members of the same species can display radically different behavior simply because of different contexts (for a discussion see Nettle, 2009). Tooby and Cosmides (1992) develop the metaphor of a jukebox to describe evoked culture: the tracks (behavioral strategies) are stored in the machine, and the environment presses the buttons.

Consider intergroup rivalries in sport such as that between the Boston Red Sox and New York Yankees. These rivalries can be considered a cultural phenomenon and have been studied through sociological and anthropological lenses. However, to meaningfully explain how culture “socializes” an individual to partake in a rivalry, one must identify the involved psychological mechanisms. Is rivalry simply copied from peers, or is it evoked via evolved mechanisms relying on specific cues? Likely both. The specific attributes of a group (e.g., name, location, team colors) are transmitted culture, yet the defining features of intergroup rivalry—ingroup cooperation and out-group enmity—are evoked culture. They are products of psychological mechanisms that evolved due to recurrent tribal warfare in the EEA (Winegard & Deaner, 2010).

## Conclusion

Sport and exercise psychology—as applied social sciences—are fueled by value-laden motives to change society for the better. Rather than working against such motives, an evolutionary approach empowers them by generating and integrating explanations that can inform intervention. Indeed, evolutionary psychology is fundamentally interdisciplinary and has established an impressive quantity of novel insights and explanations to which an evolutionary sport and exercise psychology should only add. In this article we sketched a view of the relative worth of an evolution-informed approach to affective processes and reasoning, sex differences in sport participation, performance in sport, and group dynamics. However, all areas of sport and exercise psychology should benefit (e.g., aggression, anxiety, parental behavior, positive youth development, etc.). Finally, evolutionary psychology informs our understanding of sporting and exercise culture and makes novel predictions of how behavior should be distributed across different environments.

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