

Sex Differences in Sports Interest and Motivation: An Evolutionary Perspective

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Although girls and women in many societies avidly participate in sports, they have been traditionally underrepresented compared with boys and men. In this review, we address the apparent sex differences in sports interest and motivation from an evolutionary perspective. First, we demonstrate that females' underrepresentation generally reflects lesser interest, not merely fewer opportunities for engagement. Moreover, there is mounting evidence that male and female athletes generally differ in their motivation, specifically their competitiveness and risk taking. Second, we examine the functional explanations for sports. We argue that the courtship display hypothesis applies mainly to females; the spectator lek hypothesis applies chiefly to males; and that 2 other hypotheses—the allying with coalitions hypothesis and the development of skills hypothesis—are important for both females and males. Third, we explore the proximate causes for the sex differences in sports interest and motivation. We show that although there is compelling evidence that prenatal hormones contribute, the evidence that socialization plays a role remains equivocal. We conclude by discussing key findings and identifying areas for further research.

Keywords: athletics, competitiveness, evolutionary psychology, gender differences, socialization

Competition among organisms is ubiquitous and manifest in many ways. For example, behavioral ecologists differentiate between con-

test and scramble competition: depending on the dispersal of resources, it may be beneficial to dominate competitors (contest or interference competition) or, instead, to simply consume resources before competitors can do so (scramble or exploitive competition; Sterck, Watts, & van Schaik, 1997). Among humans, the diversity of competitive modes seems especially pronounced because of our elaborate culture and language. Humans can compete, for instance, by driving a sports car, starting a false rumor, insulting a competitor's hairstyle, or eating all the cookies before a sibling has a chance to enter the kitchen.

Another important aspect of human competition is that men and women differ in their use of competitive modes, especially in intrasexual or same sex competition. Perhaps most notably, men are more likely than women to use high-stakes physical aggression (e.g., fighting), whereas women's aggression more frequently involves indirect or relational tactics, such as gossiping (Benenson, 2013; Campbell, 2002).

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Here, we use an evolutionary perspective to explore sex differences in another competitive mode, namely sports.

Sports are of interest because they occur in many societies, and sex differences have been explored by scholars from many fields, including law (Brake, 2010), economics (Stevenson, 2010), history (Guttman, 1991), sports science (Gill, 1988), psychology (Dietz-Uhler, Harrick, End, & Jacquemotte, 2001), communications (Whiteside & Hardin, 2011), and sociology and gender studies (Birrell & Cole, 1994). Nevertheless, only recently have scholars considered sex differences in sports from an evolutionary perspective (Apostolou, 2014b; Apostolou, Frantzides, & Pavlidou, 2014; Balish, Eys, & Schulte-Hostedde, 2013; Deaner, 2013; Deaner et al., 2012; Deaner & Smith, 2013; Lombardo, 2012). In this review, we extend these evolutionary contributions and provide the most comprehensive examination yet of sex differences in sports interest and motivation.

We first provide a definition of sports and, in the first major section, show that there is much evidence for a sex difference in sports interest, both in participation and spectating. In the next section, we show that there is substantial evidence for sex differences in sports motivation, particularly competitiveness and risk taking. We then turn to the possible causal explanations for these sex differences. In one section, we explore the four leading functional hypotheses for sports. We argue that the courtship display hypothesis appears crucial for explaining female sports interest, whereas the spectator lek hypothesis is vital for understanding male sports interest. Furthermore, two other hypotheses—the allying with coalitions hypothesis and the development of skills hypothesis—are likely important for both females and males. In the next section, we examine the proximate factors that might produce the sex differences in sports interest and motivation. We show that prenatal hormones clearly contribute whereas the evidence for socialization contributing is less compelling. We conclude by highlighting our key findings and identifying areas for further research.

Defining Sports

A game can be defined as an organized activity where two or more individuals or teams

compete to win, according to agreed-on rules (Chick, 1984; Roberts, Arth, & Bush, 1959). A sport can be defined as the subset of games that require physical skill (Deaner & Smith, 2013; see Chick, 1984; Guttman, 2004). This definition of sport therefore excludes noncompetitive physical activities (i.e., exercise), games of pure chance (e.g., roulette), and strategic games that depend solely on mental skill or decision making (e.g., chess). It is still a broad definition of sports, encompassing activities as varied as Formula 1 auto racing, World Cup cricket and football (or soccer), Olympic figure skating, recreational softball and basketball, and archery and wrestling in small-scale societies (e.g., agropastoral, and hunting and gathering).

A Sex Difference in Sports Interest

Although most scholars recognize that boys and men generally exhibit greater sports interest than girls and women, some dispute this or argue that differences in observed sports behavior do not represent differences in underlying interest (Brake, 2010; Hogshead-Makar & Zimbalist, 2007). In this section, we demonstrate that there is unambiguous evidence for a substantial sex difference in sports participation and spectatorship. We also review several lines of evidence indicating that these patterns reflect a sex difference in underlying sports interest, not merely differences in opportunities for engagement.

Participation

Historical reviews of sports demonstrate that many societies had substantial female participation. For instance, in ancient Sparta, girls trained and competed in several sports, including running and wrestling (Golden, 2008; Guttman, 1991). Nevertheless, it appears that males have been generally more involved than females in all historical societies (Craig, 2002; Guttman, 1991, 2004; Potter, 2012). Guttman's (1991) monograph, *Women's Sports: A History*, is telling. It is the most comprehensive review of this topic, and the first sentence of the book states, "There has never been a time, from the dawn of our civilization to the present, when women have been as involved in sports, as participants or spectators, as men have." Of course, on logical grounds, we cannot be com-

pletely confident that there have not been some historical societies that showed a different pattern, but no evidence for this has turned up so far.

Cross-cultural ethnographic studies of sports in small-scale societies have also documented unambiguous evidence of female sports participation. For example, in studies of North American Native Americans, there are many accounts of girls and women avidly playing double ball and shinny, both of which involve direct competition and coordinated team play (Craig, 2002; Oxendine, 1988). Nonetheless, ethnographers and anthropologists have ubiquitously focused on male sports participation, and this is apparently because of the greater frequency and societal significance of male sports (e.g., Chick, Loy, & Miracle, 1997; Roberts et al., 1959; Sipes, 1973). The first systematic attempt to assess the frequency of male and female sports across societies was recently undertaken, and it found more male sports than female sports in all 50 societies with relevant data in the Human Relations Area Files (HRAF) probability sample (Deaner & Smith, 2013). It is possible that exceptional societies exist, but given anthropologists' penchant for celebrating the exotic (Brown, 1991), it is probably safe to assume that such a society has never been observed by scholars.

Studies in large contemporary societies also support the claim of a consistent, possibly universal, sex difference in sports participation. These studies consistently report that males play sports more frequently than females, generally at least twice as much in terms of duration or frequency. This is true whether studies are based on behavioral observations (Deaner et al., 2012; Lever, 1978; Pellegrini, Blatchford, Kato, & Baines, 2004), experience sampling methods (Kirshnit, Ham, & Richards, 1989), or retrospective self-reports (Lunn, 2010), including time-use diaries (Deaner et al., 2012; Ferrar, Olds, & Walters, 2012; Stamatakis & Chaudhury, 2008).

The sex difference of this magnitude holds for both adults (Deaner et al., 2012; Lunn, 2010; Stamatakis & Chaudhury, 2008) and children (Deaner et al., 2012; Ferrar et al., 2012; Kirshnit et al., 1989; Lever, 1978; Lunn, 2010; Pellegrini et al., 2004). It has been well-documented in Australia (Ferrar et al., 2012), Ireland (Lunn, 2010), the U.K. (Stamatakis & Chaudhury,

2008), and the U.S. (Deaner et al., 2012; Kirshnit et al., 1989; Lever, 1978). The available data from Asia are also consistent with this difference (Larson & Verma, 1999).

The first large multicountry study of sports participation using standardized surveys was recently conducted, and it found that men participated more than women in all 37 countries (Apostolou, 2014b; see also Apostolou, 2014c). However, the sex difference was only statistically significant in 16 countries, and the overall effect size was small ($d = 0.11$). The small sex difference likely reflects that participants self-defined their sports participation, which could result in the conflation of sports and exercise (see above, "Defining Sports"). Supporting this, when participants specified their most common physical activity, men were 3.7 times more likely than women to list a sport rather than a noncompetitive activity. This sex difference was statistically significant in all 37 countries.

A crucial question is whether the sex difference in sports participation truly reflects a difference in motivation to participate. This question arises because in many societies girls and women enjoy much less free time than do boys and men (Chick, 2010; Whiteside & Hardin, 2011) or are discouraged or prohibited from participating in sports (Birrell & Cole, 1994; Guttman, 1991). Although such factors merit attention, for several reasons, they are insufficient to fully explain the sex difference, at least in contemporary societies. First, if girls and women played sports less often because they had less free time than boys and men, then one might expect they would also engage in less noncompetitive exercise; however, this generally is not the case (Deaner et al., 2012; Ham, Kruger, & Tudor-Locke, 2009; Van Tuyckom, Scheerder, & Bracke, 2010). Similarly, studies of students' recreational and extracurricular activities indicate that females' lesser participation in sports largely reflects their higher prioritizing of other activities, such as schoolwork (George, 2010; Sax, 2008; see also Apostolou, 2014c).

Second, if girls and women played sports less often because they had fewer formal opportunities, then one would expect that the sex difference in sports participation would be nonexistent or smaller in informal settings; however, the sex difference is considerably larger in these contexts (Deaner et al., 2012; Kirshnit et al.,

1989). For example, in the U.S., boys and men play informal sports in public parks (e.g., “pick-up” games) roughly 10 times as frequently as do girls and women, despite that sex differences in organized school settings are slight (Deaner et al., 2012). A third reason we can be confident that females are, on average, truly less interested than males, is that numerous surveys find that they report less desire to participate and excel in sports (Evans, Schweingruber, & Stevenson, 2002; Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002) and a systematic search of the literature indicates no exceptions (Ellis et al., 2008).

Spectatorship

The evidence for a sex difference in sports spectatorship from historical and small-scale societies is similar to the evidence for a sex difference in sports participation in these societies. That is, although we cannot rule out the possibility of exceptional cases, the available information indicates that males were more likely than females to be spectators in every society (Guttman, 1986). The extent to which this truly reflects greater male interest, however, is unclear because girls and women were frequently discouraged or prohibited by men from attending sporting events (Guttman, 1986, 1991; Potter, 2012).

The data on sports spectatorship from large contemporary societies, where there are fewer prohibitions, are therefore especially relevant. At first glance, it may be tempting to draw the conclusion there is no major sex difference because differences are often slight in terms of attendance at major sporting events (Apostolou, 2014b; Dietz-Uhler et al., 2001), self-classification as being a sports fan (Dietz-Uhler et al., 2001), and motives for sport spectating (Robinson & Trail, 2005). Nonetheless, detailed studies of sports spectatorship reveal many differences (Apostolou et al., 2014; Gantz & Wenner, 1991; James & Ridinger, 2002). For example, a study of undergraduates in the U.S. found that, compared with females, males identified more strongly as sport fans, possessed greater sports knowledge, and reported greater sports interest and desire to acquire information about professional teams; by contrast, women’s spectatorship was more likely to reflect social motives, such as wanting to watch or attend a sporting

event with family or friends (Dietz-Uhler et al., 2001).

Such differences translate into large sex differences in sports consumption: in the U.S., men spend roughly twice as much time watching televised sports (Dietz-Uhler et al., 2001; Gantz & Wenner, 1991; Guttman, 1986), discussing sports (Dietz-Uhler et al., 2001), and seeking sports related information (Gantz & Wenner, 1991; Ruihley & Billings, 2013); in Germany, men spend twice as much time watching sports programming (Meier & Leinwather, 2012); and in Australia men are three times as likely to watch televised sports on a daily basis and to follow sports on the Internet at least three times per week (Melnick & Wann, 2011). In the recent multicountry study, men were roughly three times more likely to indicate that they watch sports on TV, and the sex difference was significant in 34 of 37 countries (Apostolou, 2014b).

Although this evidence indicates that men generally possess greater interest than women in monitoring sports, one might argue that this pattern merely reflects that there are far more sporting events featuring men than women and people prefer watching the play of same-sex individuals (Guttman, 1986). If this account were true, then, when they do occur, women’s elite or professional sporting events should attract audiences similar in size to those of men’s sporting events. However, this is not the case, at least for team sports, which generally attract the largest sports audiences (Guttman, 1986; Meier & Leinwather, 2012). For example, the premier men’s professional basketball league in the U.S., the National Basketball Association (NBA), has sponsored a women’s league (WNBA) since 1997, and the attendance and TV viewership is a small fraction of the NBA’s and has not grown (Berri & Krautmann, 2013; Whiteside & Hardin, 2011). There have also been numerous attempts to sustain women’s professional play in other sports, including soccer (Congdon-Hohman & Matheson, 2013) and softball (McGrath, 2013), and none has yet succeeded in turning a profit or attracting audiences similar in magnitude to men’s professional leagues.

Even in cases where women’s team sports do attract large audiences, there is little evidence that spectators are predominantly female, as this explanation assumes. For instance, from 1995

to 2011, the German men's national soccer team attracted six times as many TV viewers as did the women's national team, and men constituted 58% of the audience for the men's games and 64% for the women's games (Meier & Leinwather, 2012). The general lack of female interest in women's sports is underscored by the failure of *Sports Illustrated (SI) Women* and similar magazines focusing on elite women's sports; all have been unable to attract sufficient readerships to sustain publication (Sheaffer, 2005).

As is the case for sports participation, some have suggested that girl's and women's lesser spectatorship and consumption of sports is attributable to a lack of free time (Gantz & Wenner, 1991), especially time that is genuinely free from domestic responsibilities (Whiteside & Hardin, 2011). Although time constraints must be relevant in many cases, this is implausible as a general explanation, at least in large contemporary societies. This is because women are far less likely than men to report in surveys that sports are their favorite genre of TV programming (Gantz, Wang, Paul, & Potter, 2006; Ruihley & Billings, 2013). This difference in preferences is confirmed by viewing patterns: although males watch sports about twice as much as do females (see above), there is no consistent sex difference in overall TV consumption (Meier & Leinwather, 2012; Sabo & Veliz, 2008). In fact, many popular contemporary nonsports programs cater to a predominantly female audience (Consoli, 2012).

Caveats

Although this section demonstrates the existence of a reliable sex difference in sports interest, several caveats should be kept in mind. First, although males play and consume sports at least twice as much as females do, female sports interest is still considerable. In Germany, for instance, women watch an average of 15 minutes of sports programming on TV each day (Meier & Leinwather, 2012). A second caveat is that the sex difference applies at the population level, not the individual level. In other words, there are many women who show strong sports interest and many men who do not.

A final caveat is that the sex difference in sports interest documented here is based on generalizing about all sports in each society,

and some sports do not show a sex difference in interest or are even more popular among females. In some cases, this is because "women's" sports are developed as deliberate analogs to "men's" sports. Netball, for instance, emerged from early versions of basketball, still shares many similarities with basketball, and is played far more often by women than by men (Taylor, 2001). Other sports, however, have specific characteristics that apparently make them more appealing to girls and women. Gymnastics and figure skating, for example, are considered stereotypically feminine sports (Koivula, 1999; Lauriola, Zelli, Calcaterra, Cherubini, & Spinelli, 2004), and they are played and watched more by women than men (Apostolou et al., 2014; Guttman, 1986; Sargent, Zillmann, & Weaver, 1998). In these and other "stylistic" sports, outcomes are based exclusively on the evaluation by judges, the style or form of the athlete's movements is central to the evaluation, and the competitors do not perform simultaneously. Below, in the "Functional Hypotheses" section, we consider why stylistic sports might be especially appealing to females.

Sex Differences in Sports Motivation

Many studies outside the domain of sports have reported sex differences in motivation, including competitiveness, responses to competition, and risk-taking, a correlate of competitiveness (Croson & Gneezy, 2009; Wilson & Daly, 1985). It is not surprising, therefore, that researchers have also tested for such sex differences within sports settings. Apparently, however, there has been no previous attempt to summarize this research.

Competitiveness

Male athletes are, on average, more likely than female athletes to endorse competition and winning as motives for participating in sports, whereas goal orientation is endorsed similarly by females and males or even more by females. This pattern has been reported in Iran (Jamshidi, Hossien, Sajadi, Safari, & Zare, 2011), Norway (Hellandsig, 1998), Canada (Findlay & Bowker, 2009), and the U.S. (Gill, 1988; but see Gill & Kamphoff, 2010). One exception comes from a study of professional tennis players, where women reported greater competitiveness than

men (Houston, Carter, & Smither, 1997). This might suggest that the sex difference in competitiveness disappears within selective or elite populations. However, the first study designed to directly address this hypothesis found that the sex difference in competitiveness did not decrease in more selective populations of U.S. collegiate distance runners (i.e., Division I vs. Division III student-athletes) (Deaner, Lowen, Rogers, & Saksa, 2015).

Additional data come from the multicountry study of sports, which included items addressing respondents' motives for participating. Men were more likely than women to endorse the competition item ("to compete against others") as a reason to participate, and the sex difference was significant in all 37 countries (Apostolou, 2014b; see also Apostolou, 2014c).

Several studies have also examined sex differences in ego-orientation (e.g., perceiving success as winning) and task orientation (e.g., perceiving success as improvement). These studies typically find that male athletes report greater ego-orientation than female athletes (e.g., U. S.: White & Duda, 1994; U. K.: Nien & Duda, 2008; U.S., Australia, New Zealand: Weinberg et al., 2000). However, a study of American and Korean adolescents indicated no sex difference (Kim, Williams, & Gill, 2003), and a study of Thai undergraduates found that females had greater ego-orientation (F. Z. Li, Harmer, Acock, Vongjaturapat, & Boonverabut, 1997). The reason(s) for the conflicting findings is unknown.

Further data on sex differences in sports competitiveness can be found in distance running. Distance running is an excellent domain for assessing competitiveness because the motivation to run varies substantially among participants (Ogles & Masters, 2003), and unlike many other physical activities, it is generally accessible, acceptable, and popular for both men and women (Deaner, 2013). There is considerable evidence for a sex difference. First, more male than female runners report that competition motivates them to run (Deaner, Lowen, et al., 2015; Johnsgard, 1985; Ogles & Masters, 2003). Second, there is a large sex difference in performance depth. For example, in a typical 5-km road race held in the U.S., for every woman that finishes within 125% of the female world record, there are roughly three men that finish within 125% of the male world record

(Deaner & Mitchell, 2011). The best supported explanation for this pattern is that more men are motivated to engage in the training necessary for faster performances, and this motivation is related to greater competitiveness (Deaner, 2006, 2013). Third, male runners are more likely to choose to participate in competitive contexts. Among masters runners (age 40+) in the U.S., male and female participation in road races is roughly equal, yet at track meets, where runners are at least 20 times as likely to run fast (relative to sex-specific, age-specific standards), men participate about three times as often as women (Deaner, Addona, & Mead, 2014). Similarly, a study reported that when they have the option of entering a single-sex competitive road race or a single-sex noncompetitive road race held in the same location on the same day, men were significantly more likely than women to select the competitive race (Garratt, Weinberger, & Johnson, 2013).

Responses to Competition

Studies have tested for sex differences in responses to competition in several sports including golf, tennis, and figure skating. Unfortunately, the results of such studies are generally inconclusive (Leeds & Leeds, 2013). For example, a study of professional tennis players' tournament entry decisions reported that men show a "hot hand" effect that can last for several tournaments. That is, after playing well in one tournament male players were more likely to seek entry into additional tournaments (Wozniak, 2012). Females' entry decisions, by contrast, were affected only by their performance in their last tournament. Nevertheless, determining whether these differences are specific to sex is difficult because the institutional structures in men's and women's professional tennis differ; there are, for instance, fewer women's tournaments. Another example is that one study reported that female professional golfers do not respond to incentives in the same way that their male counterparts do (Matthews, Sommers, & Pechiera, 2007) (Matthews et al., 2007). However, the sex difference was not consistently significant, and the study was based on a small sample (Leeds & Leeds, 2013).

Risk Taking

Risk taking has been studied in several sports, and a common finding is that, when completing surveys, men are more likely than women to report taking risks. This has been found for rock climbing (Llewellyn & Sanchez, 2008), skiing (Ružić & Tudor, 2011) and snowboarding (Thomson & Carlson, 2015). In addition, a recent study reported behavioral evidence, albeit indirect, of a sex difference in risk taking in running marathons. Specifically, men were roughly three times more likely than women to slow dramatically, a result consistent with the hypothesis that men are more likely to undertake a “risky pace,” where a runner begins at a pace that could result in a superb performance (given their own talent and training) but also increases their chances of slowing dramatically because of physiological failure (Deaner, Carter, Joyner, & Hunter, 2015).

Functional Hypotheses

Games occur in most or all societies, and sports are by far the most common type of game (Chick, 1984; Deaner & Smith, 2013; Roberts et al., 1959). It is not surprising, therefore, that scholars have offered a wide variety of explanations for their existence (Chick, 1984; Guttman, 2004; Lombardo, 2012). For example, Baker (1982) posits that sports function to enable spiritual transcendence, whereas Marxist scholars hold that sports were invented by capitalists to dominate and exploit workers (Guttman, 2004), and yet others argue that sports mainly serve to amplify sex differences and bolster male dominance (Birrell & Cole, 1994; Messner & Sabo, 1990).

Because there are so many kinds of sports and each is embedded in its particular culture, it is likely that many perspectives will help explain the existence of sports. Nonetheless, we will focus on evolutionary explanations because they have the greatest potential to be comprehensive. This is because they attempt to integrate information from all scientific fields, including biology (Balish et al., 2013; De Block & Dewitte, 2009; Lombardo, 2012). Thus, unlike the explanations mentioned above, evolutionary explanations account for many other relevant phenomena, including substantial sex differences in morphology and physical

strength (Puts, 2010). Moreover, we will show that an evolutionary perspective provides insights that challenge many nonevolutionary accounts for sex differences in sports interest and motivation.

In considering our exploration of the four leading evolutionary hypotheses, several points should be kept in mind. First, these are functional hypotheses that seek to explain why individuals would have evolved dispositions to be interested in participating or monitoring sports, particularly how such behavior could have affected the likelihood of reproducing or passing on genes in other ways (i.e., inclusive fitness). Thus, these hypotheses do not directly address proximate causality, such as how genetic, physiological, and psychological (e.g., learning) mechanisms underlie or contribute to a particular individual’s sports-related interest and motivation. Of course, a comprehensive understanding of any behavior, sports included, does eventually require addressing proximate causality (Balish et al., 2013), and, we will do this below. A related point is that, although these functional hypotheses address goal-directed behavior, they do not assume that the actors explicitly recognize their motives (Miller, 2000).

Another important point about these functional hypotheses is that none requires that sports interest is an adaptation in the sense that the trait evolved to solve a specific problem related to survival or reproduction. In fact, adaptations for sports per se seem unlikely given their diversity in development and form and their rich interface with cultural processes. The functional hypotheses instead assume that sports arise as manifestations or by-products of other adaptations (De Block & Dewitte, 2009; Lombardo, 2012; Winegard & Deaner, 2010). These adaptations likely include motives and capacities to physically compete for mates and status, negotiate and enforce behavioral norms, and monitor the abilities of others. A related point about these hypotheses is that they are mutually compatible. By this we mean that more than one hypothesis may prove to have substantial explanatory power, and some may be complementary. Finally, a hypothesis that substantially explains female sports interest and motivation may not substantially explain male sports interest, and vice versa.

Courtship Display

The first functional hypothesis holds that sports constitute culturally invented courtship displays that reliably advertise participant quality to the opposite sex (De Block & Dewitte, 2009; Miller, 2000). According to this hypothesis, sports are analogous to animal courtship displays, such as when peacocks show off their extravagant tail feathers to choosy peahens (Petrie, Halliday, & Sanders, 1991).

Several lines of evidence support this hypothesis. First, sports are highly effective at differentiating the abilities of individuals, and many athletic abilities have been demonstrated to be partly heritable (Tucker & Collins, 2012). Second, athletic ability has been shown to correlate with several putative “good genes” traits that could indicate the conferring of benefits to a choosy individual’s offspring. These include fluctuating asymmetry (Longman, Stock, & Wells, 2011; Manning & Pickup, 1998), second-to-fourth digit ratio (2D:4D; reviewed in Hönekopp & Schuster, 2010), and facial attractiveness (Ahn & Lee, 2014; Park, Buunk, & Wieling, 2007; Postma, 2014; Williams, Park, & Wieling, 2010). Third, excelling at sports is associated with greater access to mates, at least for men. Evidence comes from historical societies (Golden, 2008; Guttman, 2004), a small-scale agricultural society (Llaurens, Raymond, & Faurie, 2009), and large contemporary societies (Faurie, Pontier, & Raymond, 2004; Lombardo, 2012). Moreover, experiments show that describing a man as an athlete increases his desirability as both a long-term and short-term romantic partner (Brewer & Howarth, 2012; Schulte-Hostedde, Eys, & Johnson, 2008; see also Michael, Gilroy, & Sherman, 1984).

Despite this evidence, the courtship display hypothesis has a major problem because it predicts that females should be the primary spectators when males participate in sports, and males should be the primary spectators when females participate. As reviewed above, however, much evidence shows that males are substantially more likely than females to be both the participants and the spectators (Apostolou, 2014b; Apostolou et al., 2014; Lombardo, 2012).

Although the courtship display hypothesis cannot provide a comprehensive account of sports, it may still be important. One way it

might be important is explaining females’ considerable interest in watching male sports. Two points somewhat weaken this idea, however. One is that females’ interest frequently reflects motivation to watch or attend a sporting event with family or friends, rather than closely evaluating males’ athletic abilities (Dietz-Uhler et al., 2001). The second point is that this version of the courtship display assumes that women would have frequently exercised mate choice during human evolutionary history. However, much evidence from historical, agropastoral, and hunting and gathering societies indicates that women’s marriages and mating would have been substantially governed by kin, especially parents, during human evolutionary history (Apostolou, 2010, 2014a). Other evidence also supports the idea that female mate choice, although important at times, would have often been less crucial to men’s mating success than direct contests for status with other men (Hill et al., 2013; Llaurens et al., 2009; Puts, 2010).

The other way the courtship display hypothesis may be important is in explaining female interest in participating in sports and male interest in watching the females participate. This possibility seems particularly likely for girls’ and women’s participation in stylistic (or display) sports, such as gymnastics, figure skating, diving, and synchronized swimming. Such sports seem likely to serve, in part, as courtship displays because they frequently emphasize feminine movements, which apparently contribute to women’s typical (i.e., nonsport) courtship displays (Hugill, Fink, & Neave, 2010). In addition, these sports usually involve wearing feminine attire and using facial cosmetics, which can increase attractiveness (Etcoff, Stock, Haley, Vickery, & House, 2011). Perhaps most importantly, an exceptional athlete may enjoy a large audience which can allow them to more efficiently advertise their mate-relevant qualities. The fact that many others are attentively watching a woman perform a feminine display might even enhance a man’s estimation of her qualities (i.e., nonindependent mate choice: Vakirtzis, 2011). Supporting this are data from the multicountry sports study, which found that women were more likely than men to report that they participate in sports to improve their appearance (“to look good”), and the sex difference was significant in 24 of 37 countries (Apostolou, 2014b).

Girls' and women's relatively strong interest in watching females participate in stylistic sports (Apostolou et al., 2014; Guttman, 1986; Sargent et al., 1998) can also be reconciled with the courtship display hypothesis. This is because monitoring other females might allow them to evaluate potential competitors in the mating market or to improve their own courtship displays.

It is also notable that, although stylistic sports are apparently restricted to large contemporary societies (Craig, 2002; Deaner & Smith, 2013), dancing by both men and women occurs in a wide variety of societies, and there are many reports of women's dancing attracting the attention of male suitors (Hanna, 2010). This can be viewed as supporting the courtship display hypothesis for sports because it seems likely that dancing and feminine display sports are, to a considerable extent, manifestations of the same psychological adaptations.

A key question is whether the courtship display hypothesis can provide a plausible account for females' interest in participating in gender-neutral and masculine sports (i.e., all sports that are not stereotypically considered feminine; Koivula, 1999; Lauriola et al., 2004). This is a crucial issue because gender-neutral and masculine sports are far more numerous than feminine sports (Deaner & Smith, 2013; Koivula, 1999; Lauriola et al., 2004), and these sports are played much more frequently, even by females (Deaner et al., 2012).

One might be initially skeptical of the courtship display hypothesis with regard to females' interest in masculine sports because, as the stereotype suggests, males often express disdain at women's participation in these sports, and female athletes also express concerns that participation might diminish perceptions of their attractiveness (e.g., Kane & Snyder, 1989; Shakib, 2003). Furthermore, studies correlating second-to-fourth digit ratio with athleticism typically yield a reliable association in females (e.g., Giffin, Kennedy, Jones, & Barber, 2012; Manning, Morris, & Caswell, 2007).

Nevertheless, the assumption that male suitors will generally avoid athletic, possibly masculine, women may not hold. Our suggestion may seem surprising because there are many studies showing male mate preferences for women with feminine traits, including voice (Feinberg, 2008), face shape (Rhodes, 2006),

and body shape (Singh, 1993; see also Cashdan, 2008). However, these preference studies generally feature an unconstrained design (i.e., no trade-offs; N. P. Li, Bailey, Kenrick, & Linsenmeier, 2002) that might limit their generalizability. Specifically, these studies show that, all else being equal, men prefer women with feminine traits but they do not investigate under what conditions this preference might be counteracted by preferences for other traits, such as dependability, social skillfulness, and ambitiousness (see Atkinson et al., 2012; Cashdan, 2008). We mention these traits because men's perceptions of them were increased in an experiment describing a woman as a participant in a team sport (Schulte-Hostedde, Eys, Emond, & Buzdon, 2012).

In addition, we expect that men will show a mating preference for women who are in good phenotypic condition, including possessing much physical strength. Physical strength, and the assertiveness likely associated with it, would be advantageous in many contexts, including in protecting and provisioning offspring and kin (Campbell, 2002; Cashdan, 2008). Supporting this idea is a study reporting that hand grip strength—a sexually dimorphic trait associated with prenatal testosterone exposure and phenotypic condition—was positively correlated with female reproductive success in the Himba, a traditional nomadic society (Atkinson et al., 2012). Intriguingly, feminine voice was also positively correlated with reproductive success, suggesting that male mate preferences in this society would be expected to encompass both strength and femininity (Atkinson et al., 2012). Because sports participation generally reveals and contributes to strength and other aspects of phenotypic condition (e.g., cardiovascular function), we suspect that excelling in sports will generally boost perceptions of female attractiveness.

If the courtship display hypothesis holds for females' interest in participating in sports, it predicts that, all else being equal (e.g., physical appearance), adolescent girls and women who participate in or excel at sports will be viewed as more desirable as mates than nonparticipants. Although recent experiments addressed this prediction for male athletes (Brewer & Howarth, 2012; Schulte-Hostedde et al., 2008), apparently only one older experiment has addressed it for female athletes (Michael et al.,

1984). In this study, men read vignettes about a hypothetical woman who was described as athletic or nonathletic; men perceived the athletic woman as more attractive, although this was only true for the men who were themselves athletes. It would be worthwhile to address the reliability of this effect in contemporary times. It would be also interesting to extend the research, perhaps by assessing attractiveness as a short-term compared to a long-term mate and by asking male participants to make trade-offs among various attributes.

Spectator Lek

The second functional hypothesis holds that sports constitute physical competitions for status, differing from unrestrained combat or warfare because they reduce the risk of physical harm to competitors and more publicly and efficiently reveal crucial qualities, such as strength, endurance, bravery, and fighting ability (Deaner et al., 2012; Faurie et al., 2004; Lombardo, 2012). This hypothesis has been developed most fully as the “male spectator lek hypothesis” (Lombardo, 2012), although below we will consider whether it applies to girls and women. This hypothesis proposes that—in a manner partially analogous to mate choice leks in some bird species—boys and men congregate in dedicated areas to compete in sports to display their qualities and gain status, and, simultaneously, other, nonparticipating males monitor the performances so that they can evaluate potential competitors and allies. For instance, a man should be wary of offending a champion archer and instead might try cultivating a close alliance with him to increase his odds of success when hunting game, raiding a neighboring group, or attaining influence in his group. This hypothesis even encompasses the possibility that men evaluate other men as spouses for their female kin based on their athletic ability (Apostolou, 2014b; Llaurens et al., 2009).

The male spectator lek hypothesis clearly accommodates the fact that many sports involve combat-relevant skills, such as running, tackling, and throwing and dodging projectiles (Craig, 2002; Deaner & Smith, 2013; Guttman, 2004). The courtship display hypothesis does not easily explain this pattern, and most non-evolutionary hypotheses do not either. More-

over, because coalition-based aggression has been important during much of human evolutionary history (Gat, 2006; Smith, 2007), this hypothesis can explain the common occurrence of team sports (Craig, 2002; Deaner & Smith, 2013; Guttman, 2004). Team sports are also difficult to reconcile with the courtship display hypothesis because few animals perform cooperative courtship displays in groups (e.g., long-tailed manakins: D. B. McDonald & Potts, 1994).

Another strength of the male spectator lek hypothesis is its ability to accommodate the finding that men are generally more interested in playing and monitoring sports than are women. This finding follows from the hypothesis because many lines of evidence indicate that throughout human evolutionary history and during contemporary periods, men have been substantially more likely than women to engage in contests involving physical aggression (Archer, 2009; Puts, 2010; M. Wilson & Daly, 1985), between-groups raiding and warfare (Gat, 2006; Smith, 2007), and cooperative big-game hunting (Marlowe, 2007). This history is revealed by pronounced sexual dimorphism in musculature, skeletal systems, and cardiovascular systems and the fact that men (but not women) possess secondary sexual characteristics (e.g., beards, pronounced jaws, deep voices) that function to threaten rivals (Puts, 2010).

A key prediction of this hypothesis is that sports success should be linked to the attainment of status. Studies in contemporary societies support this prediction in male children (Chase & Dummer, 1992; Chase & Machida, 2011; Eder & Kinney, 1995), adolescents (Goldberg & Chandler, 1989; Holland & Andre, 1994; Thirer & Wright, 1985), and adults (Földesi, 2004; Loy, 1972; Sohi & Yusuff, 1987). In historical societies as well, athletic success was a common path to attaining high status for men (Golden, 2008; Potter, 2012). In addition, the finding that sports achievement is associated with increased access to mates (see above, “Courtship Display”) supports this hypothesis because male status is reliably associated with access to mates (Nettle & Pollet, 2008).

The association between male sports achievement and mating success does raise the question, however, of whether the courtship display and spectator lek hypotheses are truly distinct.

In fact, they are. The courtship display hypothesis predicts that women will closely watch a man engaging in the sport and judge his suitability as a mate based on his performance. The male spectator lek hypothesis, by contrast, predicts that women will be mostly uninterested in the details of a male's performance; they will instead judge him based on the status he gains relative to other men by engaging in the sport.

A second prediction of the male spectator lek hypothesis is that the sex difference in sports interest should be especially pronounced for team sports and for combat and hunting sports. This prediction follows from the hypothesis because the skills emphasized in these kinds of sports (e.g., throwing, grappling, working cooperatively) seem more closely related to the attainment of male status than the skills featured in more general sports (e.g., footraces). Supportive evidence regarding team sports participation comes from observations in public parks in the U.S. (Deaner et al., 2012) and retrospective self-reports in Ireland (Lunn, 2010), the U.K. (Stamatakis & Chaudhury, 2008), Australia (Ferrar et al., 2012), and the U.S. (Deaner et al., 2012; Vaughter, Sadh, & Vozzola, 1994). In addition, the recent multicountry study discussed above found that, in 36 of 37 countries, men were significantly more likely than women to list a team sport rather than an individual sport as their most frequent physical activity (Apostolou, 2014b). Finally, although it did not reach statistical significance, an analysis of 50 societies in the HRAF found that sports played exclusively by males were more likely than sports played exclusively by females to involve teams (Deaner & Smith, 2013). This study also found statistically significant support for the prediction regarding combat and hunting sports: males were the exclusive participants in 98% of hunting and combat sports but were the exclusive participants in only 69% of other sports.

Could female sports interest also be explained with the spectator lek hypothesis? On theoretical grounds, it seems unlikely. This is because, although higher status in women is linked to greater reproductive success, women rarely gain status through direct (i.e., contest) competition or by cooperating with a large interconnected group of unrelated individuals (Benenson, 2013; Campbell, 2002). Instead, women typically gain status by marrying high status men, forming exclusive, high-investment,

egalitarian friendships with other women, using indirect competitive tactics, and opportunistically excluding other women (Benenson, 2013).

The spectator lek hypothesis for females is also contradicted by sports data. In particular, unlike the case for males, few students, male or female, believe that excelling in sports, at least stereotypically masculine ones, is a likely avenue for females to achieve status or popularity (e.g., Chase & Machida, 2011; Holland & Andre, 1994; Sabo & Veliz, 2008). In fact, a study of middle school students found that participation in athletics consistently predicted large gains in status and popularity for boys but not for girls (Eder & Kinney, 1995). Studies of sports motivation also challenge the applicability of this hypothesis for females. This is because female athletes are less likely than their male counterparts to endorse competition and winning as motives for participating (see above, "Competitiveness").

Another key piece of evidence contradicting the spectator lek hypothesis for females is that females' interest in monitoring or consuming sports is not merely less than that of males; females' interest seems exceptionally low for monitoring women's sports (see above, "Spectatorship"). It is not that contemporary women are uninterested in the lives of unrelated strangers: there are numerous profitable magazines, websites, and TV programs that cater to women's interest in monitoring (nonsports) celebrities' romantic trysts, indiscretions, appearance, fashions, and cultural pursuits (Consoli, 2012). For most women, however, this interest apparently does not extend to watching unrelated women play (nonstylistic) sports.

Allying With Coalitions

The third functional hypothesis holds that sports interest, specifically interest in monitoring sports teams, arises as a result of the activation of adaptations that would allow individuals to form and maintain coalitions with others in the context of small-scale warfare (Winegard & Deaner, 2010). This hypothesis was originally developed to explain sport fandom, which can be defined as individuals emotionally identifying with a team and desiring its success. The hypothesis builds on scholarship showing that warfare has been a recurring challenge during human evolutionary history (Gat, 2006; Smith,

2007), and that this challenge has produced a legacy of psychological adaptations (M. M. McDonald, Navarrete, & Van Vugt, 2012).

According to the allying with coalitions hypothesis, individuals ally with sports teams (or other groups) when competition between groups exhibits characteristics that would have been relevant during warfare (Winegard & Deaner, 2010). These characteristics include men as group members, competitions based on warfare-relevant skills (e.g., fighting) groups associated with geographical areas, visual symbols of group identification, and spoils (e.g., access to mates) following success. When individuals perceive most or all of these characteristics, they become likely to ally with a particular group (or team). Allying with a group would involve many behaviors, including providing material support to the group, expressing commitment to the group's goals, displaying the group's symbols, emotionally identifying as a member of the group, and monitoring the group's competitions. When directed toward a sports team, these allying behaviors can be summarized by the phrase "being a sport fan."

For the most part, being a sports fan appears economically irrational in large societies because popular teams (e.g., Montreal Canadiens), even when successful, do not provide fans with material benefits such as mates, food, territory, or protection from raiding rival groups. Nevertheless, being a sports fans may yield psychological benefits including heightened feelings of social connectedness, especially after the fan's team ("their team") wins (Wann, 2006).

The allying with coalitions hypothesis is consistent with studies of sport fandom, including many demonstrations that sports fans behave as if they were actual members of "their team" (e.g., Wann, 2006; Wann, Haynes, McLean, & Pullen, 2003). For example, highly identified sports fans, male and female, report greater willingness to engage in aggression against rival players and coaches (Wann et al., 2003). The allying with coalitions hypothesis was also supported in the only study designed to directly address it: Winegard and Deaner (2010) showed that, among U.S. undergraduates, the level of sport fandom was positively associated with the endorsement of group-relevant moral concerns, especially loyalty to one's group, but not with the individualizing moral concerns of harm or fairness.

In the context of this review, the allying with coalitions hypothesis is important because it is the only hypothesis that readily accounts for the occurrence of sport fandom, which has been repeatedly documented in large societies, both historical and contemporary (Craig, 2002; Guttman, 1986; Potter, 2012). The spectator lek hypothesis, for example, can explain why men would be interested in watching groups of men play sports but it cannot explain why they emotionally identify with teams. The allying with coalitions hypothesis also can account for the fact that women's interest in watching men's team sports is considerable and apparently greater than their interest in watching women's team sports (see above, "Spectatorship").

The fact that that males' interest in watching team sports is generally greater than females' is also consistent the allying with coalitions hypothesis. This is because, although warfare often imposed great costs on females, the costs on males generally would have been greater, and the benefits would also have been greater for males (Gat, 2006; Smith, 2007). Thus, males do not merely watch and monitor team sports more than females; they also express greater sport fandom (Dietz-Uhler et al., 2001; Gantz & Wenner, 1991; Winegard & Deaner, 2010).

Finally, we should note that the allying with coalitions hypothesis and the spectator lek hypothesis are complementary (Lombardo, 2012). For example, the success of the team (Cialdini et al., 1976; Wann, 1996) and particular players (Hoegle, Schmidt, & Torgler, 2012; Melnick & Wann, 2011) are both known to influence fandom. This fits the spectator lek hypothesis, which holds that individuals will evaluate individuals based on their sports performance in groups; these observations also fit the allying with coalitions hypothesis because, according to this hypothesis, all else being equal, individuals will prefer allying with successful groups.

Although the allying with coalitions hypothesis provides substantial explanatory power for males' and females' interest in monitoring sports teams, especially male teams, it cannot easily explain other aspects of sports interest, especially interest in participation.

Development of Skills

The fourth functional hypothesis is that sports cultivate the development of skills cru-

cial for other activities. Among evolutionists, the development of skills hypothesis has generally been advanced with regards to warfare or cooperatively hunting large game (Chick et al., 1997; Sipes, 1973). Nevertheless, the hypothesis can be conceived more broadly, that sports develop skills for a range of physically or socially demanding activities (Chick, 1984, 2010). Indeed, in large societies with organized sports, both historical and contemporary, there have been countless claims that sports promote physical and social development, including 'building character' (Eccles, Barber, Stone, & Hunt, 2003; Guttman, 2004; Videon, 2002).

This hypothesis has high plausibility because many sports demand skills or competencies that seem crucial for success outside of sports contexts. These include competing, monitoring the abilities of one's self and others, establishing and maintaining cooperative relationships, developing self-discipline to consistently train, persevering through undesirable outcomes (e.g., losing, injury), developing specific skills (e.g., physically asserting oneself), and negotiating, following, and enforcing behavioral norms. We also note that, although females rarely compete for status with direct physical tactics, they certainly use physical aggression under some circumstances. These include defending against coercive men and fighting with other women over scarce resources, female allies, or mates (Burbank, 1987; Ness, 2004). Thus, like boys and men, girls and women could benefit from sports that develop strength and combat skills.

Several lines of evidence support the development of skills hypothesis. One is that children's play behavior often overlaps with or is a precursor to sports (Lever, 1978; Pellegrini et al., 2004), and there is evidence that play behavior fosters social and motor competence (Graham & Burghardt, 2010). Second, although many adults play competitive sports in modern societies, participation rates are generally far higher for children and adolescents (Deaner et al., 2012; Lunn, 2010). This supports the idea that, in general, 'playing sports' is indeed an elaborated kind of play. Finally, in many societies, observers and participants plainly state that particular sports serve as preparation for corresponding adult activities, often those related to warfare or hunting (Craig, 2002; Gutt-

man, 2004; Oxendine, 1988). Archery and wrestling are the two most popular sports across societies (Deaner & Smith, 2013), and their value as preparation for combat and hunting seems beyond doubt.

A crucial prediction of the development of skills hypothesis is that sports participation leads to the development of skills that prove beneficial outside of the sporting arena. Although the *prima facie* case for this prediction seems strong, especially for combat and hunting sports, there have been few formal tests. The most relevant are studies demonstrating that sports participation correlates with academic performance and other positive life outcomes. Notably, these associations hold for both females and males (Eccles et al., 2003; Sabo & Veliz, 2008; Stevenson, 2010; Videon, 2002). Nevertheless, these studies have two substantial limitations. First, they do not specify what skills are transferable. In fact, they generally do not even show that sports are more strongly associated with positive outcomes than (noncompetitive) exercise. Second, their correlational design means that, despite valiant statistical efforts, the associations could be driven by an unmeasured third variable (e.g., health, family stability) that influences both sports participation and positive outcomes.

The development of skills hypothesis has several strengths, yet it seems unable to provide a comprehensive account of sports. One reason is that it does not readily explain why so many sports, roughly half across societies, emphasize skills specific to hunting or combat (Deaner & Smith, 2013; see also Craig, 2002). If sports merely served as a vehicle for skill development, we might expect that a similarly large proportion of sports would emphasize other ecologically specific skills, such as weaving baskets or processing nuts. Such skills are vital in many societies and often take years to master (Gurven, Kaplan, & Gutierrez, 2006). Nevertheless, across societies, the sports that are not specific to hunting or combat apparently only involve general skills, such as running (Craig, 2002; Deaner & Smith, 2013). The second limitation of the development of skills hypothesis is that it cannot readily explain sports spectatorship and fandom, which occur in a broad range of societies (Apostolou, 2014b; Craig, 2002; Guttman, 1986). If individuals played sports merely to acquire skills, it is unclear why

others would be interested (Apostolou et al., 2014). Skill acquisition in other contexts (e.g., learning to make artifacts or process nuts) rarely attracts large numbers of emotionally invested onlookers.

Proximate Hypotheses

We have shown that there are sex differences in sports interest and motivation and, in reviewing the functional hypotheses, argued that, to some extent, these sex differences are manifestations of different adaptations (i.e., courtship display vs. spectator lek). In principle, the proximate mechanisms underlying these patterns might rely solely on cultural, rather than genetic, transmission. For instance, during human evolutionary history men have generally faced greater challenges related to physical competition than have women, and cultural selection might have thus favored parents encouraging their sons but not their daughters to engage in competition-relevant activities.

Nevertheless, in point of fact, adaptations to persistent evolutionary challenges usually depend, at least partly, on genetic transmission (Archer, 2009). For many male-typical morphological and behavioral traits, the SRY gene, which is located on the Y-chromosome, plays a key role because it directs the bipotential gonad to develop into testes rather than ovaries (Ngun, Ghahramani, Sanchez, Bocklandt, & Vilain, 2011). The testes, in turn, secrete high levels of androgens, including testosterone, and many kinds of evidence indicate that prenatal exposure to testosterone contributes to sex differences in cognitive abilities, sexual orientation, and children's toy preferences, activity interests, and play patterns (Berenbaum & Beltz, 2011).

Prenatal Hormones

Several kinds of studies indicate that sports interest is one of the traits influenced by exposure to prenatal testosterone. First, male-typical childhood play and activity patterns, which correlate with prenatal testosterone, predict adult sports interest (Cardoso, 2009; Giuliano, Popp, & Knight, 2000). Second, lower second-to-fourth digit ratio is reliably associated with participation in competitive sports (Hönekopp & Schuster, 2010). Third, females with congenital

adrenal hyperplasia, a disease characterized by heightened prenatal androgen exposure, are more likely than unaffected females to show strong interest in stereotypically masculine sports (Berenbaum, 1999; Berenbaum & Snyder, 1995; Frisén et al., 2009).

Socialization

Prenatal effects are clearly at odds with the common assumption that all sex differences in sports interest are attributable to cultural transmission (e.g., Brake, 2010; Hogshead-Makar & Zimbalist, 2007; Sabo & Veliz, 2008). Nevertheless, as noted above, an evolutionary perspective is fully compatible with the possibility that cultural transmission also contributes to sex differences (Low, 1989). In fact, if cultural transmission, including socialization practices, did not have an influence, it would be difficult to explain why cross-societal patterns of child rearing would conform to functional predictions derived from evolutionary theory (Low, 1989) or, more generally, why natural selection would have favored humans being motivated to shape the behavior of others (Richerson & Boyd, 2005).

So what is the evidence that cultural transmission, specifically socialization, contributes to sex differences in sports interest? One kind of evidence is that boys and men generally have different sport-related experiences than girls and women. For example, a study demonstrated that, even among five- and six-year-old children playing mixed-sex tee-ball (simplified baseball), girls received less coaching, encouragement, and playing opportunities (Landers & Fine, 1996). Studies of this kind are notable, but, by themselves, do not demonstrate that the differential socialization is associated with the differential development of sports interest. Many experiences that plausibly could affect development do not.

The second kind of evidence goes beyond the first because, rather than merely showing that boys and girls have different experiences, it demonstrates that exposure to a potential socializer is associated with differential sports interest. For instance, an adolescent's level of physical activity is correlated with that of his father and older brother (Vilhjalmsson & Thorlindsson, 1998). Another example is that parents' perceptions of their children's sports ability, which are

generally higher for boys, are correlated with their children's beliefs in their own sports ability and participation (Fredricks & Eccles, 2005). Although these kinds of studies are clearly consistent with socializers playing a causal role, they also do not demonstrate causality. This is because the correlations might be driven by the children's behavior affecting the socializers (Fredricks & Eccles, 2005; Vilhjalmsón & Thorlindsson, 1998) or other common-causal variables, such as heritable genetic variation (Hur, McGue, & Iacono, 1996; Lykken, Bouchard, McGue, & Tellegen, 1993).

Experimental demonstrations would constitute the most convincing evidence that socialization contributes to sex (and individual) differences in sports interest. For instance, if girls were exposed to an extensive program of sports training accompanied by encouragement by peers and coaches, this might lead to greater sports interest throughout adolescence and adulthood. We are unaware of any studies that have shown (or even tested for) the efficacy of such an intervention. However, such experiments seem promising because some interventions have been shown to have substantial long-term impacts on several health behaviors, including substance abuse and teen pregnancy (Gavin, Catalano, David-Ferdon, Gloppe, & Markham, 2010). Several interventions have even boosted adolescent (noncompetitive) exercise, although rarely for extended periods (Dobbins, Husson, DeCorby, & LaRocca, 2013).

Another kind of evidence would be 'natural experiments' in the form of 'older brother' effects. In particular, if it were shown that children with older brothers were especially likely to express interest in sports, this would constitute fairly compelling evidence that brothers' (presumed) interest in sports was somehow socially transmitted. There have been many studies along these lines, and they typically show that younger siblings are more likely than older ones to participate in sports, especially dangerous sports (Suloway & Zweigenhaft, 2010). Unfortunately, most of these studies do not report key details, such as whether older brothers have a stronger effect than older sisters or whether the effect applies to girls. However, one study of U.S. high school students reported that girls with at least one older brother were 18% more likely to participate in sports than girls without older brothers (Videon, 2002).

A final candidate for evidence of socialization involves associations across societies or within the same society across time periods. Several studies are relevant. One is that the sports study using the HRAF probability sample documented more male than female sports in all societies but found that the sex difference was significantly smaller in nonpatriarchal than patriarchal societies (Deaner & Smith, 2013). A second study showed that, across countries, there is a reliable association between women's empowerment and women's Olympic success, in terms of both participation and medals won (Lowen, Deaner, & Schmitt, 2014). There have also been multicountry studies linking women's empowerment to success in women's international soccer (Congdon-Hohman & Matheson, 2013). Such studies clearly support the idea that in societies where women have greater power, females are socialized to be more competitive (Low, 1989). Nonetheless, another possibility is that girls and women in low female empowerment societies are equally interested in sports but are not permitted to express this interest.

The same point applies to the large increases in organized female sports participation that occurred from the early 1970s until the late 1990s in the U.S. (Brake, 2010; Stevenson, 2010). For example, in 1972 females constituted 7% of high school athletes, but in 2000 they constituted 42% (Stevenson, 2010). This pattern fits a socialization view because social roles substantially converged over this time in the U.S., and social roles are thought to be closely related to socialization practices (Wood & Eagly, 2012). However, such data cannot discount the possibility that the girls and women of the 1970s generally had the same general sports interest as contemporary girls and women and merely lacked playing opportunities.

A strong test of socialization across societies or across time periods requires a measure of sports interest that is unconstrained by opportunities. One test in this spirit has been made so far, and it focused on intramural sports participation at colleges and universities in the U.S. (Deaner et al., 2012). Intramural sports participation is an excellent measure of interest because there are no substantial external incentives (e.g., financial aid or scholarships) or constraints on participation (e.g., quotas, roster limits). This study found that, for both co-ed

and single-sex intramural competition, men participated about three times as frequently as women, and this difference had been stable since at least the early 2000s. This result counters a socialization hypothesis because social roles have continued to converge, even since the early 2000s (Deaner et al., 2014; Twenge, Campbell, & Gentile, 2012).

There have also been tests for change across time in the U.S. focusing on competitiveness in distance running (see above, “Competitiveness”). These studies show that the large sex difference in running participation that existed in the 1970s and 1980s has disappeared, yet there is still a large (i.e., about threefold) and stable sex difference in the proportion of runners who show a primarily competitive (i.e., sports) rather than recreational orientation (Deaner, 2006, 2013; Deaner et al., 2014; Deaner & Mitchell, 2011).

Conclusion

Sports are an important mode of human competition, and scholars from many disciplines have considered the apparent sex differences in sports interest and motivation. In first half of this review, we provided what is apparently the most comprehensive review of these differences to date. We showed that, although females’ sports interest is often appreciable, there are many converging lines of evidence that boys and men are substantially more interested than girls and women in sports, both in terms of participation and spectating. Moreover, the evidence suggests that this sex difference in sports interest occurs in all or nearly all societies. We also showed that there is mounting evidence for a reliable sex difference in sports motivation, with males typically showing greater competitiveness and risk taking.

In the second half of the review, we applied an evolutionary perspective to explain—both in terms of functional and proximate causal hypotheses—why females are interested in sport, yet relatively less interested than males. In this concluding section, we highlight our key findings regarding causality and then identify areas for future research.

Key Findings

We argued that the allying with coalitions hypothesis and the development of skills hypothesis apply to both females and males, but that the other two hypotheses apply more specifically. In particular, the sports interest of females, especially their interest in participating, appears substantially explained by the courtship display hypothesis. By contrast, the spectator lek hypothesis primarily applies to males: for boys and men, sports are largely about competing for status, “showing off” one’s qualities to other males, and evaluating the abilities of other males. The differing applicability of the spectator lek hypothesis is indicated by several findings, including that status is consistently associated with male but not female sports achievement and that male athletes are more likely than female athletes to be motivated by competition. Furthermore, this account also explains girls’ and women’s extremely low interest in watching nonstylistic women’s sports.

Explanations for these patterns favored by nonevolutionists, by contrast, beg key questions or seem implausible. For instance, Whiteside and Hardin (2011) suggest that the lack of an appreciable audience of women watching women’s sports is attributable to women’s greater domestic responsibilities and the resulting absence of free time. This does not explain, however, why unmarried girls and women also show minimal interest or why there are no consistent sex differences in total TV consumption (Meier & Leinwather, 2012; Sabo & Veliz, 2008).

The differing male and female motivations predicted by our consideration of the functional hypotheses may have implications for public health. For example, much research has addressed the correlates of physical activity, but the importance of sex as a predictor has been frequently downplayed or ignored despite its potential impact (Trinh, Rhodes, & Ryan, 2008). Moreover, public health studies of physical activity generally do not attempt to distinguish sports from noncompetitive exercise (e.g., Dobbins et al., 2013; Van Tuyckom et al., 2010). If motivation differs substantially by sex, this distinction may be crucial.

Our review of the proximate mechanisms underlying the sex difference in sports interest showed that there is much evidence that prena-

tal hormone exposure plays a role. In theory, this evidence could have been recognized by nonevolutionary scholars, but, in fact, this has rarely or never occurred. For example, in this review we have cited dozens of nonevolutionary articles that discuss sex differences in sports interest, and not one of these sources entertains the possibility that biological factors might contribute. This was also true when we perused popular sports and exercise psychology textbooks (Gill & Williams, 2008; Tenenbaum & Eklund, 2007).

Nonevolutionary approaches almost invariably state or assume that socialization, in one form or another, produces all sex differences in sports interest. As we stressed, an evolutionary approach is fully compatible with socialization playing a large role. However, it also recognizes the possibility that it may not. That socialization might not be important may seem implausible to some, but it is worth recalling that individual variation in sexual orientation was long-believed to be entirely attributable to early family experiences; however, there is an emerging consensus that socialization does not substantially contribute (LeVay, 2010). Thus, the importance of socialization in producing sex differences in sports interest is an empirical issue, and, as we showed, the evidence for socialization playing a role is not yet compelling.

The fact that the evidence for socialization is weaker than most recognize and that prenatal hormones almost certainly contribute to sex differences is remarkable because it means that many scholars propagate incorrect views. This is regrettable for several reasons, including that social policies are based on these views. In particular, in the U.S., a federal law, known as Title IX, was enacted in 1972 that prohibits sexual discrimination in educational opportunities, including sports. This law has had numerous positive effects, but, since the mid-1990s, its implementation has been based on the assumption that male and female sports interest is equal or that it soon will be (Brake, 2010; Hogshead-Makar & Zimbalist, 2007). If this is incorrect, it implies that Title IX will lead to suboptimal allocation of resources and possibly discrimination against males (Deaner et al., 2012; Rhoads, 2004).

Future Directions

This review suggests several promising directions for further research. First, the development of skills hypothesis is a good candidate to explain, in part, the sports interest of both females and males. Although there is much evidence consistent with this hypothesis, it is all correlational, so experiments are needed to test whether there truly are long-term benefits that accrue to sports participants. Besides testing the development of skills hypothesis, this research could yield practical insights regarding the value of sports compared to other extracurricular activities.

Second, the evidence that socialization contributes to sex differences in sports interest is also based exclusively on correlational studies.¹ Thus, experiments testing whether socialization-relevant interventions (e.g., sports training programs) have long-term impacts should be undertaken. These experiments might simultaneously test the development of skills hypothesis.

In addition, the socialization hypothesis can be addressed with cross-societal or cross-temporal comparisons. The prediction is that in societies where men's and women's social roles are more similar, the sex difference in sports interest will be smaller. As we reviewed, there are cross-societal studies consistent with this prediction, but they are susceptible to alternative explanations because they did not directly measure sports interest. There have also been attempts to address this prediction by examining changes over time in the U.S. The results did not support the socialization hypothesis, but this could also be attributable to limitations in measuring sports interest. More research in this area is clearly warranted.

A third area ripe for research is the courtship display hypothesis, particularly its prediction that women's desirability as a mate will in-

¹ This criticism might be viewed as unfair because the evidence supporting a role for prenatal hormones is also correlational. However, unlike the case for socialization practices, the experimental manipulation of prenatal hormones in humans is unethical. Moreover, experimental manipulations of prenatal hormones in non-humans have repeatedly shown they contribute to sexually differentiated behaviors, such as rough and tumble play (Berenbaum & Beltz, 2011), that are precursors for sports participation (Pellegrini, Blatchford, Kato, & Baines, 2004).

crease as a function of sports achievement. If, as we suggest, these experiments involved asking male participants to make trade-offs, they could have general implications for understanding mating preferences.

We also hope this review stimulates those interested in sex differences in sociality to consider addressing key questions in sports contexts. For instance, there have been recent studies probing how females and males behave in same-sex groups, and notable findings include that males generally show greater tolerance of same-sex peers and lesser likelihood of excluding them (Benenson, 2013). It would be interesting to test whether such dynamics characterize same-sex sports teams, which arguably have greater ecological validity than the arbitrarily created groups usually studied by psychologists (Browne, 2012).

Finally, we hope this review inspires researchers to apply an evolutionary perspective to sex and individual differences in sports interest and motivation, particularly the psychological mechanisms that contribute to decisions to pursue (or drop-out of) sports and exercise over the long-term. Scholars have long been interested in long-term achievement motivation (Fredricks & Eccles, 2005; Klint & Weiss, 1987) but have generally neglected an evolutionary perspective (but see Deaner, 2013). Scholars who are evolutionarily oriented have made important advances in characterizing emotional and decision making mechanisms (Cosmides & Tooby, 2013), and it therefore seems likely that they will provide critical insights when they turn their attention to long-term achievement motivation. We anticipate particularly rapid progress when evolutionists collaborate with scientists specializing in sports and exercise psychology (Balish et al., 2013).

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