Article

Biological and evolutionary contributions to developmental sex differences

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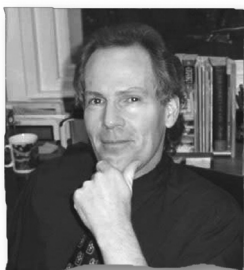
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Abstract

Boys and girls, and men and women show consistent differences, on average, in interests, activity preferences, and social styles. This article summarizes sex differences in human development from infancy through the childhood years and considers how these differences in developmental patterns relate to human evolutionary history. Evidence is reviewed suggesting that the psychological traits that were advantageous differed consistently for men and women during human evolution, consistent with Darwin's (1871) sexual selection as a mechanism through which cognitive and behavioural sex differences evolve and develop during lifetimes. The result is that some sex differences are found very early in development in predispositions to engage in different activities, to attend to different social information, and in methods of social influence. These early differences, in turn, prepare children for somewhat different tasks and roles in adulthood. Although these differences have strong biological origins, developmental experiences serve to flesh out and elaborate on these differences, or to minimize them, depending on the demands of the culture in which the child is situated.

Keywords: evolution, human development, play, sex differences, sex hormones, sexual selection

Introduction

Boys and girls are probably more similar than they are different, and yet they differ in many interesting ways. Boys and girls have different interests, prefer to engage in different activities, and have different social styles. Psychologists have been systematically studying these differences for more than 100 years (Woolley, 1903), but until recently have not seriously considered that they may reflect human evolutionary history. This article describes how knowledge of evolution in general, and human evolution in particular, can inform understanding of developmental sex differences. To this end, in the first major section the basic

mechanisms of Darwin's (1871) sexual selection that result in sex differences in other species are described. In the second major section, evidence for the operation of sexual selection during human evolution and the influence of sex hormones on human sex differences is reviewed. And, in the final major section, sex differences that emerge during human development, beginning with infancy and moving through the pre-school and childhood years are outlined, with a discussion of how these developmental patterns relate to human evolutionary history.

Sexual selection

In addition to the co-discovery of natural selection (Darwin and Wallace, 1858), Darwin (1871) discovered another group of mechanisms that operate within species and are the principle factors in the evolution of sex differences. These mechanisms are called sexual selection, and involve competition with members of the same sex over mates (intrasexual competition) and discriminative choice of mating partners (intersexual choice). The most common dynamics involve male–male competition over access to mates and female choice of mating partners. The most common result is the evolutionary elaboration of the traits, such as size of antlers used in male–male competition, that facilitate competition and choice (Andersson, 1994). It is now understood that these dynamics arise from the degree to which each sex invests in parenting and this in turn emerges from more fundamental differences in the potential rate of reproduction (Trivers, 1972; Clutton-Brock and Vincent, 1991). The basic cross-species pattern is that the sex with the slower potential rate of reproduction (typically female) invests more in parenting, is selective in mate choices, and exhibits less intrasexual competition over mates. The sex with the faster potential rate of reproduction (typically male) invests less in parenting, is less selective in mate choices, and exhibits more intense intrasexual competition.

For female mammals, the potential reproductive rate is limited by gestation time and length of post-partum suckling, whereas the theoretical limit for males is determined by the number of females to which they gain sexual access. The specific dynamics can vary across species and breeding seasons, especially with variation in local numbers of females and males (Emlen and Oring, 1977), but the fundamental prediction of more female investment in parenting and more intense intrasexual competition in males is found in more than 95% of mammalian species (Clutton-Brock, 1989). Critically, the predicted reversal of sex differences is found for species in which males invest more heavily in parenting then females. Females in these polyandrous species have the potential to reproduce in each breeding season with more than one mate (e.g. males incubate eggs) and males mate monogamously. As predicted, females of these species are typically larger, more colourful, and more pugnacious than males and males tend to be choosy (Berglund *et al.*, 1997; Eens and Pinxten, 2000; Jones and Avise, 2001). For species, such as humans, in which males and females both invest in parenting, sexual selection is especially complex and nuanced. In addition to male–male competition and female choice, there is also female–female competition over males with the most to invest in parenting and male choice of mating partners.

Sex hormones

The differentiation of the reproductive system, brain, and proximate here-and-now expression of the behavioural traits that have evolved by means of sexual selection will be influenced by pre- and post-natal exposure to sex hormones, especially androgens (e.g. testosterone) (Arnold and Gorski, 1984; Morris *et al.*, 2004), although oestrogens may be important for the expression of some traits (Fitch and Dennenberg, 1998). These hormones typically influence sex differences in cognition and behavioural biases through early prenatal organization of associated brain areas, through activation of these areas with post-natal exposure to different hormones (e.g. as during puberty), or some combination. The influences of sex hormones on brain, cognition, and behaviour, however, are complex and sometimes very subtle, often interacting reciprocally with genetic sex, physical health, as well as with social and ecological context and developmental experiences (McEwen *et al.*, 1997; Arnold, 2004).

Developmental sex differences

The developmental period is an evolved trait in itself and functions to allow offspring to learn about the social group and ecology in which they are situated before assuming the survival and reproductive demands of adulthood. Sex differences in developmental activities are predicted to mirror sex differences in patterns of intrasexual competition, intersexual choice, and parenting. For these sexually selected behaviours, adult skills will emerge from an interaction between hormone exposure and practice of these behaviours during development. More precisely, it appears that hormones act to increase behavioural engagement in sexually selected behaviours during development but the achievement of adult-level competencies require extended practice of these behaviours (e.g. play parenting) prior to adulthood.

As an example, for satin bower birds (*Ptilonorhynchus violaceus*), the quality of the bower built by the male provides a good indicator of overall male quality and is the primary determinant of female choice of mating partners (Borgia, 1985); an example of a bower is shown in **Figure 1**. Skill at constructing and maintaining high-quality bowers is related to age, social learning, social dominance, sex hormones, and

Figure 1. Bower building and behavioural male–male competition in the bowerbird (*Chlamydera maculata*). (From Darwin, 1871.)

the frequency of bower destruction by competitors (Collis and Borgia, 1992). During the approximately 10-year maturational period, young males visit the bowers of mature males and imitate their displays and bower building techniques; females mature at about 2 years old and do not build bowers. Borgia and Wingfield (1991) found that testosterone concentrations were strongly related to the quantity of bower decorations, but not to bower quality traits, such as symmetry. Male sex hormones thus appear to influence the energetic features of bower building (i.e. gathering materials) but experience, which comes from practice during the developmental period, influences the overall quality of the construction.

Sexual selection in humans

Sexual selection

Sex differences in physical size, upper-body musculature, rate and pattern of physical development, and hormonal and other physiological responses to stressors and competition provide strong evidence that sexual selection has operated during human evolution (Tanner, 1990), although the extent to which these reflect sexual selection is debated (Geary, 1998; Wood and Eagly, 2002). In any case, these sex differences and many others are predicted to be more nuanced in humans than in most other species, because, as noted, both women and men invest in their children, though often in different ways. The many details of how sexual selection can be used to understand the many attendant features of male–male competition, female choice, female–female competition, male choice, and associated sex differences in level and form of parental investment are beyond the scope of this article (see Geary, 1998, 2002). A few of the basic sex differences in intrasexual competition and parental investment are used to illustrate the utility of sexual selection for understanding human sex differences in adulthood and during development.

In traditional societies, and likely to have occurred during human evolution, men form kin-based coalitions and co-operate in order to compete with other male coalitions for control of ecologically rich territories and for social and political influence (e.g. Chagnon, 1988). This form of male–male competition is often manifested in terms of low-level but frequent raiding, warfare, and political manipulation, and is associated with construction and use of weapons and other tools (Keeley, 1996). Within these kin groups, one-on-one male–male competition involves a mix of physical contests and social/political manoeuvring to form dominance hierarchies and to control in-group politics. Population genetic studies support this anthropological research. These studies suggest that during human evolution males stayed in their birth group, which is a necessary feature of the formation of male kin-based coalitions, and females migrated to the group of their mates (e.g. Seielstad *et al*., 1998). Population genetic and anthropological research also support the prediction that men in successful coalitions have more wives and children than do men in less successful coalitions, and dominant men in successful coalitions tend to be the most reproductively successful (Betzig, 1986; Zerjal *et al.,* 2003).

On the basis of male paternal investment, women are predicted to and, in fact, do compete with one another as well, but not as physically as males. More typically, women compete relationally – called relational aggression – which requires more personal knowledge about and attention to other individuals in the group than is necessary with physical aggression. They use this knowledge to backbite, shun, and ridicule their competitors. One goal is to make these competitors look unattractive ('she's a real slut') to males and perhaps drive these women out of the social group, thus making them unavailable as mating partners to the men in the group (Buss, 1994). Another goal appears to be to disrupt their social support system, which can negatively influence their health and that of their children (Geary, 2002). One possibility is this form of female–female competition evolved, in part, in the context of polygynous marriages; polygyny is very common in traditional societies and almost certainly throughout human evolution (Murdock, 1981).

In these contexts, co-wives compete for the attention and resources of their husband, who is often a dominant male in a successful coalition. Studies of polygynous versus monogamous marriages in traditional societies provide support for this thesis (e.g. Borgerhoff Mulder, 1990; Sellen, 1999). Most generally, children of polygynous marriages show poor growth patterns and increased frequency of illness and death than do children of monogamous marriages. These conditions would promote female–female competition over the husband's resources, because gaining control of these resources would improve the health of and reduce the mortality risks to her children. In any case, relationship aggression would still be expected over potential mates, even in monogamous societies (Geary, 2000). This is because all men are not equal in terms of their value as potential mates and female–female competition is expected and found over the most desirable mates (Buss, 1994).

Sex hormones

As with other species, there is evidence for hormonal influences on a variety of human sex differences, including many of those described in the following sections (see Collaer and Hines, 1995, for review). As an example, a series of recent studies by Baron-Cohen and colleagues demonstrate that prenatal testosterone concentrations, measured in amniotic fluid prior to birth, are associated with a host of cognitive and behavioural sex differences in infancy and childhood. Higher amniotic testosterone concentrations were found to be associated with interest in sex-typed play in 4- and 5-year-old children and restricted play interests in boys (e.g. focus on toy vehicles), and lower testosterone concentrations were related to higher interest in and quality of social relationships in pre-school children and larger vocabulary size in 18- and 24-month-old children (Lutchmaya *et al*., 2002; Knickmeyer *et al*., 2005a,b). These results, however, should be considered preliminary, because the relationship between amniotic testosterone concentrations and extent of testosterone exposure in the developing fetus is not yet fully understood.

Further evidence of the effects of prenatal androgens comes from a small subset of girls born with a condition in which adrenal glands produce excessive amounts of androgen, known as congenital adrenal hyperplasia (CAH). These girls often have male-like genitalia at birth and show a cognitive pattern of enhanced spatial skills, reduced verbal fluency, and a behavioural pattern of more masculine (e.g. rough-and-tumble play) and less feminine (e.g. play parenting) play patterns (Berenbaum and

Hines, 1992; Hines and Kaufman, 1994; Berenbaum and Snyder, 1995; Collaer and Hines, 1995; Leveroni and Berenbaum, 1998). The converse is true for boys born with androgen insensitivity syndrome (AIS), a relatively rare syndrome occurring in 1 in 100,000 births. This syndrome results not from a lack of testes, but a lack of functioning androgen receptors resulting in tissues unresponsive to testosterone and female-like external genitalia (Cohen-Brendahan *et al*., 2005). Boys with AIS show female-typical preferences in sexual orientation, interests, and poor spatial abilities relative to other boys (Imperato-McGinley *et al*., 1991; Hines *et al*., 2003).

Sex differences in human development

Sex differences in infants

The study of sex differences in infancy is inherently more difficult than the study of sex differences in older children, because the behaviour of infants is more variable than the behaviour of older children (which would obscure many sex differences) and because there are fewer methods that can be used to study infants than older children (Maccoby and Jacklin, 1974). Further, with the study of developmental sex differences, it is often assumed that biologically influenced sex differences will manifest themselves early in development, whereas sex differences that are largely influenced by cultural factors, such as gender roles, will manifest themselves later in development and as a result of the cumulative effects of socializing agents, such as parents (Whiting and Edwards, 1973; Serbin *et al*., 1993). This assumption is incorrect. In species where sexual selection has resulted in the evolution of sex differences, such differences are often not manifested until puberty (Darwin, 1871). In this view, infant boys and infant girls are expected to be more similar than different, and this appears to be the case (Maccoby and Jacklin, 1974; Rothbart, 1989).

According to the tenants of sexual selection, those sex differences that are found in infancy should reflect the seeds of the later described sex differences in play and social development, which, in turn, should provide the experience and practice needed to acquire the behavioural, social, and cognitive competencies associated with sex differences in reproductive activities, such as differences in the nature of intrasexual competition, described above. There are indeed several patterns described in the infancy literature that suggest that the skeletal structure of the later described sex differences in social and play activities are evident in the first year or two of life and in some cases in the first few days of life (e.g. Simner, 1971; Fagan, 1972; Block, 1976; Gunnar and Stone, 1984; Zahn-Waxler *et al*., 1992a,b; Kujawski and Bower, 1993; Davis and Emory, 1995).

The first of these differences is the general orientation of boys and girls towards other people (Garai and Scheinfeld, 1968; Freedman, 1974; McGuinness and Pribram, 1979; Haviland and Malatesta, 1981; Connellan *et al*., 2001). For infants, the degree of orientation toward other people has been measured in terms of the duration of eye contact, empathetic responses to the distress of others, recognition of faces, and time spent looking at faces. In a review of sex differences in nonverbal behaviour, Haviland and Malatesta noted that 'there is no doubt that girls and women establish and maintain eye contact more than boys and men. The earliest age for which this is reported is one day' (Haviland and Malatesta, 1981, p. 189). In addition, boys and men gaze-avert much more frequently than girls and women, a sex difference that has been found as early as 6 months of age.

A number of other studies suggest that infant girls react with greater empathy to the distress of other people than do infant boys (Hoffman, 1977). Simner (1971), for instance, found that infant girls cried longer than infant boys when exposed to the cry of another infant, but no sex difference in reflexive crying was found when the infants were exposed to artificial noise of the same intensity. Zahn-Waxler and her colleagues found a sex difference in the responses of 12- to 20-month-old children to the distress of other people (Zahn-Waxler *et al*., 1992a,b). In both studies, girls responded to the distress of other people with greater empathetic concern, defined as 'emotional arousal that appears to reflect sympathetic concern for the victim ...manifested in facial or vocal expressions (e.g. sad looks, sympathetic statements...) or gestures' (Zahn-Waxler *et al*., 1992a, p. 129). In one of the studies, girls also responded to the distressed individual with more prosocial behaviour (e.g. comforting) and engaged in more information-seeking behaviours (e.g. 'What's wrong?') than did boys.

However, these differences were only found for distress that was witnessed and not caused by the child. Girls did not show more empathy than boys when they caused the distress in another individual, although boys behaved more aggressively than did girls in these situations. Moreover, the magnitude of the sex differences in empathetic concern and indifference were modest. At 20 months of age, about three out of five girls responded with greater empathetic concern to the distress of another person than did the average boy, whereas two out of three boys showed more affective indifference than did the average girl. Both empathetic concern and affective indifference were found to have moderate genetic influences for both 14- and 20-month-old children, suggesting that these social behaviours are influenced by a mix of biological, social, and contextual factors; between 29 and 35% of the individual differences in these social behaviours appear to be heritable at these ages (Zahn-Waxler *et al*., 1992b).

The results of several studies of the nature and quality of social interactions between parents and infants are also consistent with the view that infant girls are more responsive, and perhaps more sensitive, to social cues than are infant boys (Freedman, 1974; Gunnar and Stone, 1984; Rosen *et al*., 1992). Rosen *et al*. found that 12-month-old children of both sexes will approach an unfamiliar object if their mother signals positive emotions (e.g. smiling) in reference to this object, and they found a sex difference when mothers signal fear in response to the object. In this situation, girls tend to withdraw from the object, whereas boys tend to approach the object. Independent coders rated the intensity of the mother's fear signal and judged that these signals were more intense when directed towards boys than when directed towards girls, suggesting that the difference in the reaction of boys and girls was not likely to be due to the behaviour of their mothers. Rather, the tendency of boys to approach unfamiliar objects more frequently than girls might be one early manifestation of the sex difference in risk-taking and mothers' more intense signals to boys might be a reflection of their prior experiences with unresponsive sons.

15

Although there are more similarities than differences in infant's early orientation to objects and the motion of these objects (Spelke, 2005), boys appear to orient more to some physical information and show greater sensitivity to certain physical cues, such as geometric shape, than do girls (Freedman, 1974; Cohen and Gelber, 1975; McGuinness and Pribram, 1979). In a review of research on infants' visual memory, Cohen and Gelber argued that 'males and females are processing and storing different kinds of information about repeatedly presented (visual) stimuli. Males appear to be more likely to store information about the various components of a repeatedly presented stimulus, for example, its form and color. ... [while] females, unlike males, are more likely to store information about the consequences of orienting' (Cohen and Gelber, 1975, p. 382). In short, it appears that by about 4 months of age, boys selectively attend to the physical properties of objects, such as shape, while girls selectively attend to the consequences of orienting to objects in their environment, rather than to the objects themselves (except when these objects are people).

Infant girls' early orientation to people presages later sex differences in interest in interpersonal relationships and gaining knowledge about the likes, dislikes, and so forth, of other people, as will be necessary for later co-operation and relational aggression (Geary, 2002). Infant boys' interests in objects presage later sex differences in object-oriented and mechanical play that may facilitate learning about, and using tools, a component of male-typical activities in traditional societies, including construction of weapons used in male–male competition.

Sex differences in pre-schoolers

It is thought that many forms of play provide means to practice and refine those behaviours that tended to facilitate survival and successful reproduction in adulthood during the species' evolutionary history (Fagen, 1981; Smith, 1982; Pellegrini and Smith, 1998). Play also immediately benefits children in that it allows them to negotiate demands during the developmental period (Bjorklund and Pellegrini, 2002). That said, one would expect to find sex differences in children's self-initiated play activities that recreate and thus provide practice with the social dynamics that were associated with sex differences in intrasexual competition and parental investment during human evolution, and, in fact, they do (Caporael, 1997; Geary and Bjorklund, 2000; Bjorklund and Pellegrini, 2002; Geary, 2002). A few of these differences are illustrated in the following sections.

Rough-and-tumble play

Rough-and-tumble play occurs most frequently in species and in the sex in which social conflict in adulthood is resolved through physical contests, and given this, it has been proposed that these play activities provide the practice needed to develop social–competitive skills (Pellis *et al.*, 1997; Smith, 1982). Studies with non-human species (e.g. rhesus monkeys) suggest the expression of this form of play is influenced by a mix of hormonal, social rearing, and contextual factors (Panksepp *et al.*, 1984; Pellis *et al.*, 1997). For humans, the frequency and vigour of rough-and-tumble play is one of the most consistently found sex differences, favouring boys, in pre-schoolers (DePietro, 1981), and appears to be practice for establishing one-on-one dominance relationships (Omark *et al.*, 1975), as predicted by

the pattern of male–male competition during human evolution and for mammals in general (Geary, 1998).

Boys' rough-and-tumble play involves playful (e.g. as indicated by facial expressions) hitting, pushing, shoving, and so forth (Smith and Hunter, 1992). It emerges at about 3 years of age (Maccoby, 1988) and is found in every culture in which it has been studied. The magnitude and form (e.g. play hitting with sticks) of the sex difference in this type of play can vary across traditional and Western societies, depending on the relative emphasis on physical means as a form of male–male competition in the society (DiPietro, 1981; Charlesworth and Dzur, 1987; Maccoby, 1988; Whiting and Edwards, 1988; Eibl-Eibesfeldt, 1989). In any case, sex differences in rough-and-tumble play are most evident with groups of three or more boys and in the absence of adult supervision (Maccoby, 1988; Pellegrini, 1995), as adults often discourage this type of play (at least in Western, middle-class settings). In situations in which adults are not actively monitoring play activities and when they are not otherwise restricted (e.g. size of the play area), groups of boys engage in various forms of rough-and-tumble play – including playful physical assaults and wrestling – three to six times more frequently than groups of same-aged girls (DiPietro, 1981; Maccoby, 1988).

Play parenting

While pre-school boys are enjoying rough-and-tumble play, pre-school girls are engaged in another form of practice for adulthood – play parenting. This sex difference emerges during the pre-school years, and continues and becomes more robust with development (Sutton-Smith *et al.*, 1963; Lever, 1978; Sandberg and Meyer-Bahlburg, 1994). In support of the prediction that this is an evolved bias, early play parenting substantially improves the survival rate of firstborn offspring in many species of primate, suggesting that this form of play provides experiences that result in improvement of later caretaking competencies (Nicolson, 1987; Pryce, 1993).

For humans, the sex difference in play parenting may be related, in part, to the fact that girls are assigned child-care roles, especially for infants, much more frequently than boys are throughout the world (Whiting and Edwards, 1988). Consistent with sex differences in level of parental investment and predictions based on sexual selection (Geary, 1998), girls also actively seek out and engage in child care, play parenting, and other domestic activities (e.g. playing house) with younger children or child substitutes, such as dolls, much more frequently than same-aged boys (Pitcher and Schultz, 1983). Girls' engagement in these forms of play parenting have been documented in Western and across many traditional societies, such as the Yanamamö Indians of South America, the !Ko Bushman of the central Kalahari, and the Himba of Southwest Africa (Eibl-Eibesfeldt, 1989). Moreover, several studies have shown that these play activities are related to prenatal exposure to androgens (Lutchmaya *et al.*, 2002). Girls affected by CAH engage less frequently in play with dolls and show less interest in infants (Collaer and Hines, 1995). A recent behaviour genetic study suggests that these play preferences are related in part to genes, although experiences are also important (Iervolino *et al.*, 2005). These findings suggest that the sex differences in caregiving and play parenting are not simply due to a sex difference in socially assigned roles.

16

Social styles and segregation

One of the most consistent sex differences in social behaviour is the tendency of children to form same-sex play and social groups (Maccoby, 1988; Whiting and Edwards, 1988; Moller and Serbin, 1996; Strayer and Santos, 1996). This social segregation begins as early as 3 years of age and becomes increasingly frequent through childhood. Maccoby and Jacklin (1987) found that 4- to 5-year-old children spent 3 hours playing with same-sex peers for every single hour they spent playing in mixed-sex groups. By the time these children reached elementary school, the ratio of time spent in same-sex versus mixed-sex groups was 11:1. Similar patterns have been found for French Canadian children (Strayer and Santos, 1996), children in England and Hungary (Turner and Gervai, 1995), and children in Kenya, Mexico, the Philippines, Japan, and India (Whiting and Edwards, 1988), although the degree of segregation varied across these societies.

The tendency of children to segregate themselves into same-sex groups appears to be related, at least in part, to the different play and social styles of girls and boys (Maccoby, 1988; Serbin, Powlishta, and Gulko, 1993). As described above, boys and girls, on average, prefer different play activities, but they also use different social strategies to attempt to gain control of desired resources (e.g. toys) or to influence group activities. For example, Charlesworth and Dzur (1987) examined sex differences in task performance and strategy usage in pre-schoolers by restricting access to a desired object – a cartoon movie viewer in which only one child could watch at a time. They found that boys and girls tend to use different strategies for gaining access to this object and for eliciting co-operation from other group members. Both sexes were equally effective at achieving viewing time. Typically, boys gained access to the cartoon viewer by playfully shoving and pushing other boys out of the way, whereas girls typically gained access by means of verbal persuasion (e.g. polite suggestions to share) and sometimes verbal commands (e.g. 'It's my turn now!').

Segregated social groups may arise as a result of children being unresponsive to the play and social-influence styles of the opposite sex (Maccoby, 1988). For example, boys sometimes try to initiate rough-and-tumble play with girls, but most girls withdraw from these initiations, whereas most other boys readily join the fray. Similarly, girls often attempt to influence boys through verbal requests and suggestions, but boys, unlike other girls, are generally unresponsive to these requests (Charlesworth and LaFrenier, 1983). Girls as young as kindergarten have been shown to be more uncomfortable with direct competition (Benenson *et al.*, 2002; Roy and Benenson, 2002), a common feature of boys' groups, which leads to more avoidance of these groups. Thus, children seem to form groups on the basis of mutual interests and the ability to influence group activities, and sex-segregation results, at least in part, from the sex differences in play interests and styles of social influence. Possibly the most important effect of this segregation is that beginning during the pre-school years and continuing through childhood and adolescence, boys and girls grow up in, and are influenced by, different peer-related social contexts. Even if parents treat boys and girls in similar ways, which they do in Western culture (Lytton and Romney, 1991), boys and girls create different social worlds for themselves and are in part socialized differently in these worlds by their peers (Harris,

1995). This socialization will reinforce and exaggerate any hormonally-based sex differences.

Sex differences in children

Boys' play

Many of the sex differences in play activities that emerge during pre-school continue throughout childhood, and in fact, are often exaggerated. For boys, rough-and-tumble play increases in frequency and peaks between 8 and 10 years of age (Pellegrini and Smith, 1998). During this time (i.e. childhood), boys also become increasingly interested in and skilled at competitive group-level activities. As boys enter middle childhood and early adolescence, more and more of their free time is spent with other boys engaging in activities such as team sports. These activities seem to allow boys to practice and refine skills necessary for effective coalitional competition (Geary *et al.*, 2003). Group-level competitive themes in boys' play activities have been noted across cultures (Whiting and Edwards, 1988; Eibl-Eibesfeldt, 1989), however the degree of overt aggression appears to be culturally dependent and hinges on the degree of male–male physical aggression in adulthood. Parents encourage or suppress the level of aggression in these activities, or redirect it to culture-specific forms of competition (e.g. education) (Ember, 1978; Keeley, 1996; Geary, 1998).

More precisely, detailed observations of spontaneous play activities of boys and girls yields several consistent differences. Boys' social play involves, on average, larger groups, more role differentiation within these groups, more explicit goals, and more risk-taking (Sutton-Smith *et al.*, 1963; Walrop and Halverson, 1975; Eder and Hallinan, 1978; Lever, 1978; Savin-Williams, 1987; Maccoby, 1988; Sandberg and Myer-Bahlburg, 1994; Benenson *et al.*, 1997). In fact, Lever found that 11-year-old boys' games were more complex and they engaged in group-level competition three times as often as did same-aged girls. In a similar study, nine out of 10 boys reported engaging in athletic competition more than the average girl (Berenbaum and Snyder, 1995). Differences in the predisposition to engage in group-level competitive activities is related, in part, to prenatal androgen exposure (Collaer and Hines, 1995). Girls affected with CAH are more likely to participate in athletic competition than their unaffected female peers, and engage in more playful physical assaults (Hines and Kaufman, 1994). Boys' focus on larger groups and the role differentiation and formation of dominance hierarchies within their groups, along with the role of prenatal androgen exposure, is consistent with the view that these activities serve to develop and refine competencies associated with intrasexual male–male coalitional competition in adulthood (Geary *et al.*, 2003).

Boys' social styles

The social styles of most boys follow from the types of activities they prefer. Compared with girls, boys interrupt more during conversations, are less likely to acknowledge another's viewpoint, are more focused on dominance and status, are more likely to be directly competitive, are more tolerant of inequalities in relationships and interpersonal conflict, and are less attentive to the emotional states of conversation partners, among other differences (Buck *et al.*, 1972; Winstead, 1986;

Maccoby, 1990; Parker and Asher, 1993; Crick *et al.*, 1996; Leaper *et al.*, 1999; Strough and Berg, 2000; Benenson *et al.*, 2002; Roy and Benenson, 2002).

It is not that boys do not value interpersonal relationships, they do, and in fact must, to develop and maintain coalitions. In contrast with girls, intimacy in boys is often achieved simply through shared activities, especially when coordinated behaviour is needed to achieve mutual goals (Sherif *et al.*, 1961; Savin-Williams, 1987). The context of team sports and associated close camaraderie is a unique source of intimacy for boys (Zarbatany *et al.*, 2000), which is consistent with the idea that boys are predisposed to flesh out and develop competencies related to effective coalitional competition. Rapidly developing alliances, especially in the context of group-level competition with mutually shared goals, serve to increase cohesion within the group and thus the group's efficacy at achieving their goals. In keeping with this idea, boys are more willing than girls to incorporate additional boys (and presumably athletic girls) into their group during competitive games (Rogers *et al.*, 1984), and even in contexts that are not immediately competitive (Feshbach, 1969; Eder and Hallinan, 1978; Killen *et al.*, 2002).

Within their groups, boys form dominance hierarchies and often use playful or outright physical assertion to achieve status in the group, although the latter tends to decline with age (Charlesworth and Dzur, 1987; Savin-Williams, 1987). Dominance hierarchies determine how resources are distributed within the group and provide the structure for role differentiation characteristic of boys' groups, which is necessary for coordinated group activity to achieve a common goal (Geary *et al.*, 2003). Status striving within groups often leads to initial conflict. In the study by Savin-Williams (1987) of adolescents at summer camp, there were initially high levels of conflict in the boys' cabins. Once the dominance hierarchy had been formed, however, conflict substantially decreased. Dominant boys spent more time than subordinants directing group activities and this was often to the competitive advantage of the group. Further, boys become increasingly co-operative and supportive with members of their group. By late adolescence, boys are very skilled in areas of co-operation and social support among members of this group, which in turn makes them a more effective coalition (Geary, 1998).

Girls' play

As with boys, girls' preferred activities become more pronounced and nuanced throughout childhood. Girls continue to seek out childcare opportunities and play parent more than same-aged boys, and are more responsive to infants and younger children (Berman *et al.*, 1977; Berman, 1986; Fogen *et al.*, 1986; Edwards and Whiting, 1993). Interest in infants and younger children increases after menarche, suggesting that hormonal changes associated with puberty are involved in directing this interest (Goldberg *et al.*, 1982); similar effects have been seen in other primates (Nicolson, 1987).

Girls' play is not limited to play parenting, however. In fact, girls engage in a wider variety of activities than do boys, but typically prefer to do these things with a same-sex peer (Martin and Fabes, 2001). In contrast with boys, girls' games are characterized by less role differentiation, smaller play groups, fewer explicit rules and goals, and are more focused on equality

(Lever, 1978; Savin-Williams, 1987). Lever identified several categories typical of girls' play. Girls are likely to engage in single-role play in which all parties are basically doing the same thing (e.g. riding bikes, roller skating), turn-taking games, which allow only one game role at a time and all players have the same task (e.g. hopscotch, jump-rope), and central-person games, requiring two roles in which power is ascribed by 'odd-man-out' rules (or 'odd-woman-out' in this case) such as 'Mother-May-I' or tag. The common theme in these activities is an emphasis on equality and lack of direct competition and explicit domination (Lever, 1978; Savin-Williams, 1987; Benenson *et al.*, 2002; Roy and Benenson, 2002).

Girls' social styles

Among girls, two types of social relationships emerge, those that involve learning to develop and maintain reciprocal relationships, and those that allow the practice and refinement of relational aggression. The former involves the establishment of interpersonal intimacy, which is achieved primarily through dyadic self-disclosure, emotional support, and an ethos of strict reciprocity (Geary *et al.*, 2003). Within these relationships and compared with boys, girls are more sensitive to social–emotional cues of a dyadic partner (Buck *et al.*, 1972), and work harder to minimize inequalities and conflict (Whitsell and Harter, 1996; Benenson *et al.*, 2002; Roy and Benenson, 2002). Further, girls' relationships are more likely to permanently dissolve as a result of conflict and if strict reciprocity is not maintained (Trivers, 1971; Rose and Asher, 1999; Geary, 2002; Benenson and Christakos, 2003). Just as intimacy in boys is related to adult social success (e.g. increasing the efficacy of coalitions), intimacy among girls functions to develop a core set of relationships that enables girls and women to maintain social, emotional, and interpersonal stability as well as providing support in times of interpersonal conflict (Belle, 1987, 1991; Gore and Colton, 1991; Taylor *et al.*, 2000; Geary, 2002).

Although deep interpersonal intimacy with one or two other individuals can be beneficial, there are costs as well. First, the time and effort needed to maintain reciprocity and social support limits the number of close friendships (Geary *et al.*, 2003). Girls are, in fact, less willing than boys to incorporate newcomers into their social groups (Feshbach, 1969; Eder and Hallinan, 1978; Killen *et al.*, 2002). Further, the disclosure of personal and potentially damaging information is associated with a risk of betrayal and vulnerability to social manipulation and relational aggression (Crick *et al.*, 1996). As noted earlier, aggression among girls is less direct than among boys, is usually aimed at disrupting social networks of other girls, and typically takes the form of gossiping, shunning, and backbiting (Crick *et al.*, 1996). Because these behaviours are more subtle than the physical aggression typical of boys, they often go unnoticed by adults, but they are nonetheless difficult for the recipients. They are more distressed by relational aggression than are boys and it is more likely to affect their self-concept, despite the fact that both sexes report about equal amounts of these forms of aggression (Galen and Underwood, 1997; Paquette and Underwood, 1999). Similarly, girls are more likely to develop psychopathology (e.g. depression and/or anxiety) in response to being a continual target of relational aggression (Zahn-Waxler, 2000; Crick and Zahn-Waxler, 2003). In contrast with boys, who show a reduction in (physical) aggression with age, relational aggression increases with age for girls, and typically peaks during puberty.

These activities mirror the forms of reciprocal relationships needed to maintain a social support network in adulthood among women who are unrelated, as would be expected if females migrated to the social group of their mates and thus away from kin during human evolution (Geary, 2002), and allow for practice of the often subtle and socially complex forms of relational aggression that often emerge among women competing for the same mate or over other valued resources.

Summary and conclusion

Infancy, childhood, and to some extent adolescence, represent the period of the life span in which the competencies associated with survival and reproduction in adulthood are developed and cultivated. To the extent that the skills necessary for competency in adulthood differ between men and women, or at least differed during human evolution, sex differences are expected and found in child-initiated activities that allow practice of these skills. Here evidence was presented to support the notion that children are predisposed to engage in different activities, attend to different types of social information, and attempt to influence social groups in different ways. These sex differences directly map onto recurrent selective pressures throughout our species' evolutionary history, specifically these sex differences mirror sex differences in forms of intersexual competition and parental investment common in traditional societies and almost certainly throughout human evolution.

Differences in infancy (e.g. boys attending more to objects and girls attending more to people) reflect the beginnings of sex-specific developmental trajectories that prepare boys and girls for different tasks. Boys' interest in competitive group-level activities throughout childhood, relative to girls, is consistent with developmental preparation for coalitional warfare, and this rough-and-tumble play is an early form of within-coalition dominance struggles. Girls' greater attention to social/emotional information, fluency with language, and focus on equality in their relationships reflects a developmental pathway that allows for the practice of skills necessary to co-operate and compete with unrelated women in adulthood. In short, boys and girls differ in many ways that reflect our species' evolutionary history, and the developmental period allows for these differences to be exaggerated or minimized, depending on the demands of the culture and social group in which children are situated.

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21

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22