Journal of Organizational Behavior
J. Organiz. Behav. **27**, 143–162 (2006)
Published online in Wiley InterScience (www.interscience.wiley.com). **DOI**: 10.1002/job.349

Evolved sex differences and occupational segregation

KINGSLEY R. BROWNE*
Wayne State University Law School, 471 West Palmer Avenue, Detroit, MI 48202, U.S.A.

Summary Average sex differences in workplace outcomes are often assumed to be products of a malfunctioning labor market that discourages women from nontraditional occupations and a biased educational system that leaves women inadequately prepared for scientific and technical work. Rather than being a product purely of discriminatory demand, however, many sex differences in occupational distribution are at least partially a result of an imbalance in supply. Sex differences in both temperament and cognitive ability, which are products of our evolutionary history, predispose men and women toward different occupational behavior. The tendency of men to predominate in fields imposing high quantitative demands, high physical risk, and low social demands, and the tendency of women to be drawn to less quantitatively demanding fields, safer jobs, and jobs with a higher social content are, at least in part, artifacts of an evolutionary history that has left the human species with a sexually dimorphic mind. These differences are proximately mediated by sex hormones. Copyright © 2006 John Wiley & Sons, Ltd.

Introduction

For much of the last century, social science was in the grip of 'nurturists,' exemplified by the extreme behaviorism of John Watson, famous for declaring that 'there is no such thing as inheritance of capacity, talent, temperament, mental constitution and characteristics' but rather that these traits 'depend on training that goes on mainly in the cradle' (Watson, 1925, pp. 74–75). What defined humans as a species was simply their capacity for culture. The content of that culture was thought to be largely arbitrary with respect to biology and actually defined by the culture itself. Although other animals were perceived as having an intrinsic nature, the concept of a distinct 'human nature' had little place. Beyond their capacity to acquire and transmit culture, humans were viewed as the animal equivalent of tofu—characterless by themselves but capable of absorbing almost any flavor from the cultural stew in which they find themselves.

Paradoxically, at the same time that social scientists were busy fashioning a categorical wall between humans and other animals, natural scientists were transforming the idea that humans evolved

* Correspondence to: Kingsley R. Browne, Wayne State University Law School, 471 West Palmer Avenue, Detroit, MI 48202, U.S.A. E-mail: kingsley.browne@wayne.edu

 Accepted 25 February 2005

from prehuman mammalian ancestors from eccentric, if not blasphemous, speculation into accepted scientific fact. Structural and functional comparisons of humans and nonhuman primates—whether of the skeleton, the brain, or eventually the DNA—became an important task of anthropologists, biologists, and others.

Only more recently has the scientific community embraced the almost ineluctable insight that if humans evolved through principles of natural selection, then the human mind is as much a product of evolution as the human body and, of course, as much the product of evolution as the bodies and brains of other animals. In recent years, organizational-behavior researchers have begun applying the insights of evolution to their own field (Colarelli, 2003; Nicholson, 1998).

One of the most robust findings of evolutionary psychology is that the human mind is sexually dimorphic, with the sexes differing, on average, in a variety of temperamental and cognitive traits. Sex differences in such traits might plausibly be expected to have a substantial effect on social behavior and social patterns. One social domain in which these differences may play out with substantial force is the workplace (Browne, 2002, 1998a, 1998b, 1997, 1995).

Students of occupational behavior have long understood that people tend to gravitate toward, and succeed at, jobs for which they have the skills and ability and that provide them with the satisfactions that they desire. This common-sense idea has been formalized in the 'Theory of Work Adjustment,' under which an optimal match requires two dimensions of correspondence between the individual and the job–correspondence between the individual's abilities and the occupation's demands, and correspondence between the individual's values and interests and the occupational's rewards (e.g., compensation, type of work) (Dawis & Lofquist, 1984).

Because two groups exhibiting average differences in talents and tastes would be expected to make different workplace choices, it would be surprising to find, despite the different selective pressures that have been operating on the two sexes for millions of years and the differently designed psychologies that have emerged as a result, that men and women would act interchangeably in the labor market. Yet much public–policy literature assumes that when men and women are distributed differently in the workplace, it has little to do with individual preferences and mostly to do with unequal opportunities. In other words, the perceived problem is typically seen as a problem of demand rather than supply. This article will review evidence that evolutionarily derived sex differences can account for a large part of the occupational segregation seen today in workforces around the world.

The Sexually Dimorphic Mind

The psychological literature on sex differences in temperament and cognitive abilities is vast (Geary, 1998; Halpern, 2000; Kimura, 1999; Mealey, 2000) and, because of space limitations, can only be sketched out rather than fully described. Many of these differences involve traits that the vocational literature suggests would likely have workplace consequences.

Competitiveness, dominance, and status-striving

On most measures of direct competitiveness, males score higher than females, and competition tends to be a more positive experience for males (Ahlgren, 1983; Lynn, 1993). Men behave more competitively in face-to-face bargaining simulations (Walters, Stuhlmacher, & Meyer, 1998), and adding a competitive element to a task increases the intrinsic motivation of males but does not do so for females (Conti, Collins, & Picariello, 2001). The perception that an academic program is competitive tends to result in improved performance by men but decreased performance by women (Hoyenga & Hoyenga, 1993). Women also report higher levels of stress associated with competition (Mirowsky & Ross, 1995). Females do compete, of course, but they often employ different means and pursue different ends (Cashdan, 1998; Hrdy, 1981).

Males also engage in more dominance behaviors, that is, behaviors intended to achieve or maintain a position of high relative status—to obtain power, influence, or resources (Mazur & Booth, 1998). Men and women often differ in the form their dominant acts take, with women tending to display 'prosocial' dominance—acts tending to maintain social relationships—and men tending to display 'egoistic' dominance—acts designed to increase one's status in the social group (Hoyenga, 1993). Men are also more likely to endorse ideologies approving of hierarchical relationships between social groups (Sidanius, Pratto, & Bobo, 1994).

Risk-taking

Men exhibit a greater preference for risk—both physical and nonphysical risk—than women. Men are disproportionately involved in risky recreational activities such as car racing, sky diving, and hang-gliding. Indeed, sex is the variable most predictive of the extent of participation in high-risk recreation (Schrader & Wann, 1999). Men are also disproportionately represented in physically risky employment. Over 90 per cent of all workplace deaths in the U.S. are males (Bureau of Labor Statistics, 2003). Risk-taking is correlated with a number of other stereotypically male traits. Individuals who rate high on achievement and dominance, for example, tend to be high risk-takers, while risk-taking is negatively correlated with a number of stereotypically feminine traits, such as affiliation, nurturance, and deference (McClelland & Watson, 1973).

Females are more averse not only to physical risk but also to social risk, and this sex difference may be partially responsible for sex differences in achievement-orientation (Arch, 1993). Greater risk aversion may also contribute to women's relative scarcity in positions involving 'career risk'—as reflected in the concentration of women in 'staff' jobs, such as human resources or corporate communications, rather than in 'line' jobs, such as running a plant or division—which may adversely affect their prospects for advancement (Browne, 2002).

Nurturance and interest in children

Females exhibit more nurturing behavior than males in all societies, both inside and outside the family. Throughout the world, it is women who are the primary caretakers of the young, the sick, and the old (Geary, 1998). The more social orientation of females is reflected in a consistently found sex difference in 'object versus person' orientation. Females tend to be more 'person-oriented,' while males tend to be more 'object-oriented' (Geary, 1998).

Differences in orientation affect individuals' values. Women's self-identity and self-esteem tend to be centered on sensitivity to and relations with others, while men's self-concepts tend to be centered on task performance, skills, independence, and superiority over others (Josephs, Markus, & Tafarodi, 1992). In one study, 50 per cent of women but only 15 per cent of men agreed with the statement, 'I'm happiest when I can succeed at something that will also make other people happy' (Moir & Jessel, 1989, p. 157).

Spatial ability

Males outperform females on some spatial tasks, with targeting and three-dimensional rotation showing the largest and most reliable sex difference (Kimura, 1999). A meta-analysis of mental-rotation studies found an average effect size of 0.66 for adults, and the effect size in many studies approaches or exceeds 1.0 (Voyer, Voyer, & Bryden, 1995). Robust sex differences in targeting have been found, again with effect sizes of around 1.0 (Watson & Kimura, 1991). Females, on the other hand, outperform males on the spatial task of 'object location'—that is, remembering where an object is located and identifying which objects in an array have been moved from their prior location (Silverman & Eals, 1992).

Mathematical ability

The sexes also differ in mathematical performance. Males tend to excel in tests of mathematical reasoning, especially those involving abstract thinking. In contrast, females excel, although by smaller margins, in arithmetic calculation (Kimura, 1999). The sex difference is relatively small in broad samples, but because males are more variable in performance, effect sizes tend to be larger in more select samples. For example, males outnumber females by almost two-to-one in the top 10 per cent of math ability (Jensen, 1998). Although males outperform females on tests of mathematical concepts, females outperform males on tests of computation (Halpern, 2000). Thus, the greater a test's emphasis on mathematical reasoning, as opposed to computation, the greater the male advantage.

Mechanical ability

Another trait on in which the sexes differ is mechanical ability, with effect sizes often approaching or exceeding 1. Men substantially outperform women ($d = 0.95$) on the mechanical comprehension portion of the Air Force Officer Qualification Test (AFOQT), which is used in selection of candidates to be Air Force officers (Carretta, 1997). Similar results are observed on the Differential Aptitude Test, with male twelfth-graders substantially outperforming females ($d \approx 0.9$) (Lubinski & Benbow, 1992). In the top 10 per cent of mechanical reasoning ability, males outnumber females by approximately eight to one (Hedges & Nowell, 1995).

Verbal ability

Females tend to outstrip males in a number of verbal abilities, including spelling, grammar, and verbal memory. In fact, the female advantage in verbal abilities exceeds the male advantage in mathematical ability in broad samples. Male eleventh graders, for example, score at about the same level as female eighth graders on the National Assessment of Educational Progress (NAEP) (National Center for Education Statistics, 2000). In more select samples, however, the female advantage often declines or disappears, because of greater male variability. Males consistently outscore females on the verbal portion of the SAT, for example, though by a smaller margin than on the mathematics portion (College Board, 2003).

Sex Differences in Evolutionary Perspective

To those having only passing familiarity with evolutionary theory, it might seem odd that males and females would have evolved to be different psychologically. Males and females live side by side, after all, and are thus exposed to the same 'hostile forces of nature' that Darwin identified as driving forces in evolution. How could selective pressures cause divergence between the minds of the two sexes?

The answer to that question is to be found in differential pressures on the sexes relating to mating and reproduction, which have left a lasting—and different—imprint on the minds of human males and females (Buss, 2004). The nature of mammalian reproduction guarantees that males and females will have somewhat different reproductive 'strategies.' The key factor driving sexual selection is the 'relative parental investment of the sexes in their offspring,' with the sex making the greater parental investment becoming a resource for which members of the other sex compete (Trivers, 1972, p. 141). Individuals of the less-investing sex can increase their reproductive success through numerous partners in a way that members of the other sex cannot, a fact that has far-reaching psychological implications. Among mammals, the demands of gestation and lactation mean that females necessarily invest more in their offspring. Moreover, sexually selected traits tend to exhibit greater variability (Cronin, 1991), which makes sense of the fact that many phenotypic traits show more variability in males than in females.

Because mammalian males can increase their reproductive success through mating with multiple females, a male strategy of multiple mating can be adaptive. Successful pursuit of that strategy is complicated, however, by the fact that other males pursue the same strategy. So, males compete among themselves, whether through contests of raw physical power or, as among our closest relative the chimpanzee, through skill at forming male coalitions (a pattern repeated among humans) (De Waal, 1982). Among the small minority of mammalian species (including humans) in which the male provides post-conception investment, female mate choice is driven not only by the genetic endowment of a potential mate but also by his ability and willingness to invest in her and her offspring (Trivers, 1985).

Because of greater variability in reproductive success among males, the stakes of the mating game are higher for males than for females. Thus, evolutionary theory predicts that in order to avoid being shut out of the mating market, males should exhibit greater dominance- and status-seeking and greater risk-taking behavior (particularly with respect to status-seeking, and resource and mate acquisition). This is not to suggest, of course, that males experience a conscious motivation to enhance their reproductive success. Rather, individuals who display these behaviors simply tend to have greater reproductive success, and to the extent that the behaviors are genetically influenced, those behaviors will tend to increase.

If risk-taking and achievement of status have been the route to reproductive success for men, why have they not been for women? One reason is that multiple mates do not produce an increased number of children for women the way they do for men. Achievement of status and political power is, in fact, often associated with reduced reproductive success for women (Hrdy, 1999; Low, 1992). Moreover, as we will see below, risk-taking and dominance-seeking are related to testosterone in both sexes, but higher testosterone levels in women tend to be associated with decreased fertility (Nyborg, 1994), placing a natural limit on the ability of high-testosterone women to pass their genes on to the next generation. Furthermore, risk-taking carries not only lesser reproductive rewards for women but also the prospect of greater cost to reproductive success, as the life prospects of a child in primitive societies were more impaired by loss of its mother than of its father (Campbell, 1999).

Evolutionary psychologists have posited that natural selection is responsible not only for sex differences in temperament but also for differences in cognitive abilities. The male superiority at dynamic spatial perception and targeting is consistent with men's participation in hunting and warfare (Ecuyer-Dab & Robert, 2004). Moreover, because hunters may follow a circuitous route in pursuit of prey, a spatial sense that allowed them to return directly home after the hunt, rather than having to retrace their lengthy route, would have been advantageous. Indeed, men are better than women at finding their way back to a starting point after wandering around in the woods (Silverman et al., 2000). The female advantage at object location also fits comfortably with our hunter-gatherer heritage. Gatherers often return repeatedly to the same location in search of food, a task facilitated by landmark recognition (Silverman & Eals, 1992). Although there would have been no direct selective pressure in our evolutionary past for mathematical ability, that ability may be, at least in part, a by-product of spatial ability (Geary, 1996).

Cross-cultural data support this view of psychological sex differences. Men worldwide exhibit greater dominance- and status-seeking behavior and greater risk-taking (Buss, 2004). Men who achieve positions of power tend to have access to more mates and to leave behind more offspring than other men (Betzig, 1993, 1986). World-wide data also reveal ''amazing cross-cultural consistency'' in cognitive sex differences (Halpern, 2000, p. 122).

Sex Differences in the Workplace

The foregoing general differences in temperament and abilities would be predicted to have workplace implications. Men's orientation toward achieving status in hierarchies, for example, seems to lead them to take the career risks necessary to achieve top positions and to work the greater hours that are necessary to gain both organizational status and greater income. Combined with women's greater desire to participate in the day-to-day activities of their children, this difference in orientation contributes to both the 'glass ceiling' and the 'gender gap in compensation,' two important features of the contemporary workplace that are beyond the scope of this article (Browne, 2002, 1998a, 1998b, 1995). But sex differences in risk-taking, competitiveness, social orientation, and various cognitive abilities also appear to lead to sex differences in occupational interests and, relatedly, in occupational distributions, the subject of this article.

Sex differences in occupational interests

Substantial sex differences are revealed on measures of occupational interest such as the Strong Interest Inventory and the Self-Directed Search. Reliable differences are found on at least five of the six Holland General Occupational Themes (''RIASEC''). Males score higher on Realistic (enjoy building and outdoor work and working with 'things'), Investigative (interested in abstract problems and understanding the physical world), and Enterprising (enjoy persuasion and leadership and are impatient with precise work). Females, in contrast, score higher on Artistic (enjoy creating or experiencing art, music, and writing) and Social (enjoy interacting with people, helping, and instructing). The sixth theme, Conventional (enjoy highly ordered activities, such as organizing and processing data), shows only modest sex differences, which are often statistically significant only in large samples (Aros, Henly, & Curtis, 1998). Lippa (1998) found effect sizes (absolute values) on the General Occupational Themes ranging from a very large 1.06 to a trivial 0.06: Realistic (1.06), Investigative (0.32), Artistic (−0.62), Social (−0.62), Enterprising (0.27), and Conventional (0.06).

The Holland types are 'ideal types,' with individuals exhibiting varying amounts of the six themes, although usually only the dominant three categories are recorded (Holland, 1997). A particular individual might, for example, resemble the Investigative type most strongly and then, in declining order, the Realistic, Conventional, Enterprising, Social, and Artistic. Such a person would be labeled an 'IRC,' so that he would be predicted to have an interest in 'IRC' occupations, such as nuclear-fuels research engineer, computer programmer, material scheduler, toxicologist, and pulmonary-function technician (Gottfredson & Holland, 1996; Holland, 1997).

Two of the four Personal Styles of the Strong also show marked sex differences. Not surprisingly, females tend to be found disproportionately at the 'people' end of Work Style—which measures whether people prefer to work with people or with ideas, data, or things—while men tend to be found disproportionately at the 'ideas, data, and things' end (Harmon & Borgen, 1995; Prediger, 1982; also Lippa, 1998). The sexes also differ on the Risk Taking/Adventure Personal Style, which replicates the Adventure Basic Interest Scale (BIS) from earlier versions of the Strong (Kaufman & McLean, 1998). The sex difference on the Adventure BIS was one of the two largest on the Basic Interest Scales ($d = 1.21$ in the Kaufman & McLean study), the other being mechanical activity ($d = 1.29$). The highest scorers on the Adventure Personal Style are police officers, whereas the lowest are dental assistants.

Relationship between occupational preferences and occupational distributions

Sex differences in occupational interest, which are influenced by underlying sex differences in talents and tastes, influence workplace patterns. One aspect of workplace difference that has received much attention is the relatively low representation of women in many scientific (especially physical science) and blue-collar occupations. These occupations are often referred to as 'nontraditional' or 'traditionally male,' and the low representation of women is frequently ascribed to the 'hostile culture' of these occupations or to outright discrimination. No one would argue that there is no truth at all in such critiques, but the interesting question is why these areas—as opposed to, say, medicine and law—have been so much slower to integrate. The issue is illuminated by considering both the characteristics of the occupations and the sex differences previously described. A related issue, but one which is beyond the scope of this article, is the ascendancy of women in many occupations, especially those such as book editing and public relations (Reskin & Roos, 1990), which put a premium on verbal ability.

Women in Science and Technology

Although women's representation in many scientific fields is lower than that of men, it is not uniformly low. Rather, it varies widely from field to field. It is a reasonably accurate generalization to say that the 'softer' the scientific field, the higher the frequency of women. In the U.S., for example, women in 2002 earned 16 per cent of physics doctorates, 18 per cent in engineering, 29 per cent in mathematics, 34 per cent in chemistry, 45 per cent in biology, and 67 per cent in psychology (National Science Foundation, 2003). In the social sciences, women are relatively scarce in economics but abundant in anthropology and sociology. Even within fields, there is marked differentiation by subfield. Women earn relatively few doctorates in mining/mineral engineering, biophysics, and psychometrics, but considerably more in bioengineering, nutritional sciences, and developmental and child psychology.

These patterns are just what the Theory of Work Adjustment would predict in light of the previously described sex differences. The fields in which women are scarce tend to have the lowest social dimension, while those attracting larger numbers of women tend to have a higher social dimension. Lubinski, Benbow, and Morelock (2000) have characterized this distinction as being between the 'organic' and the 'inorganic.' The fields avoided by women tend also to be the most mathematically and spatially demanding. Given the relative positions of the sexes on the 'people-things' dimension and the abundance of men at the highest levels of mathematical ability, it would be surprising not to find differing sex ratios in these widely differing fields, at least if people sort into occupations based upon their interests and abilities.

Exclusive focus on an individual's cognitive abilities is unlikely to yield accurate predictions of occupational interest, persistence, or success. For example, individuals assigned an SIA Holland code (characteristic of clinical psychologists and nurses) are unlikely to gravitate toward, or flourish in, a field like physics (an IRE occupation) even if they possess the requisite level of mathematical ability. People with high Social codes tend not to thrive in the often-cloistered environment of laboratory science, while those entering math-intensive fields tend to have a ''low need for people contact'' (Lubinski, Benbow, & Sanders, 1993, p. 701).

Women in Blue-Collar Occupations

Despite substantial integration in many white-collar occupations, including the most prestigious ones, sexual integration of blue-collar jobs has been much less complete. For the last two decades, for example, women's representation in blue-collar occupations has remained stable in the U.S. at around 18 per cent (O'Farrell, 1999).

Women's low participation rate in most blue-collar jobs probably results in large part from the sex differences previously described. Some of the largest sex differences revealed by the Strong Interest Inventory are on the 'Realistic' dimension, which measures interest in building, repairing, and working outdoors, and most blue-collar occupations are heavily oriented toward that dimension. In fact, the Holland code for virtually all blue-collar jobs begins with 'R.' Moreover, many blue-collar occupations require a high degree of mechanical ability and interest, for which, it will be recalled, very large sex differences exist.

Although often discounted in this technological age, physical strength remains important in many blue-collar occupations (Deaux & Ullman, 1982), and women have only one-half to two-thirds the upper-body strength of men (Pheasant, 1983). In many studies, effect sizes are greater than 1.5, which means that there is very little overlap between the strength distributions of the two sexes (Bishop, Cureton, & Collins, 1987; Pheasant, 1983).

A further reason that blue-collar occupations are less congenial to women than white-collar occupations is that attributes of many blue-collar jobs are ones that are disfavored by women. Women, more than men, tend to prefer safe and clean working environments, flexible hours, and social contact, but blue-collar jobs often involve outside work in unpleasant weather or inside work in environments characterized by noise, heat, and unpleasant smells (Browne, 2002). Moreover, many blue-collar occupations are quite dangerous, and dangerous blue-collar jobs tend to be ones with the most heavily skewed sex ratio (Browne, 2002; Toscano, 1997). Indeed, the higher the proportion of female employees in an occupation, the less likely it is that it involves hazardous (or other unpleasant) working conditions (Kilbourne & England, 1996).

Competing Explanations for the Origins of Cognitive and Temperamental Sex Differences: Is the Explanation 'Purely Social' or Social and Biological?

Most of the data presented in previous sections are relatively uncontroversial. The facts are what they are. Males and females act in measurably different ways, they exhibit different levels of performance on various cognitive tests, and they are distributed differently in the work force. Where potential consensus breaks down is over the causes of these patterns.

The assumption of much modern social science is that observable sex differences are consequences not of any inherent difference between males and females but rather of societal conditioning that has channeled male and female behavior into preassigned directions. Basic to this view is the notion that the human mind is sexually monomorphic. An alternative perspective, which better accounts for the rich texture of the facts, is that the human mind is sexually dimorphic as a consequence of millions of years of evolutionary history. The dispute, it should be emphasized, is not between those who attribute observed sex differences entirely to culture and those who attribute them entirely to biology. Rather, the difference is between those who attribute the differences wholly to culture (with biology playing either no role or a trivial one) (hereinafter the 'purely social' view) and those who believe that biology and culture both play important roles. Thus, the suggestion offered here is not that social factors, sometimes including outright discrimination, are not part of the story. Instead, it is that the whole story cannot be understood without taking biologically influenced sex differences into account.

The 'purely social' account is, even on its own terms, unpersuasive; there are simply too many patterns that it does not explain. But if the social account is incomplete, what direct evidence is there for the position that biology plays a significant role in occupational behavior? The fact that observed sex differences are consistent with the predictions of evolutionary biology does not by itself prove the existence of biological factors. There is more direct evidence, however, and that comes from the study of sex hormones. The same sex hormones—especially male sex hormones, or 'androgens'—that lead to physical sexual dimorphism in size, strength, body hair, fat distribution, and genital morphology also appear to be important factors in psychological dimorphism. This section will first evaluate the 'purely social' argument and then briefly describe evidence from hormonal studies that illuminates a proximate mechanism for the development of psychological sexual dimorphism.

The sociological account of behavioral sex differences

The core of the 'purely social' argument goes something like this. Males are aggressive, competitive, and inclined to jockey for status in hierarchies because boys are taught that is how 'real men' behave and society rewards such behavior in men. Females are nurturing and risk-averse because girls are taught to behave like 'ladies' and future mothers, and society rewards such behavior in women (Fausto-Sterling, 1992). Similarly, males outperform females in mathematics, because boys and girls learn early that math is 'for boys' and girls are discouraged by parents, teachers, and society from any interest in science. Men end up as auto mechanics because they were given toy cars as children. Despite its widespread acceptance, this explanation does not withstand careful examination. Again, this is not to say that social institutions and social expectations have no effect at all, only that the influence of social factors is often substantially overblown (Lytton & Romney, 1991). Although a full account of the infirmity of the 'purely social' view is precluded by space considerations (see Browne, 2002), it is worthwhile to mention a few of the common arguments and to describe some of the circumstantial evidence of their inadequacy as complete explanations.

The idea that sex-based behavioral differences result from indoctrination into society's expectations of sex-appropriate behaviors is difficult to square with the finding that many behavioral sex differences, including toy choices and playmate preferences, appear before children can identify their own sex or the sex of others (Campbell, Shirley, Heywood, & Crook, 2000; Serbin, Poulin-Dubois, Colburne, Sen, & Eichstedt, 2001; Servin, Bohlin, & Berlin, 1999). Even if infants and toddlers have some implicit sense of sex earlier than is currently appreciated, it is hard to imagine how society could inculcate in these young minds the idea that they should have the preferences associated with their sex. To say that the children pick up subtle but pervasive cues from the world around them is an incomplete answer, because it begs the central question of why these subtle cues affect children so strongly when conscious attempts to direct them in the other direction seem to fail. It would require a mind strongly biologically prepared to classify by sex and assimilate sex roles for these ideas to be soaked up so readily.

The cross-cultural ubiquity of consistent sex differences also counts against—though it does not disprove—the 'purely social' explanation. Sex differences in temperament and cognitive traits are found throughout the world (Geary, 1998; Halpern, 2000; Mealey, 2000). Across the globe, people hold the same stereotypes of men and women (Williams & Best, 1991). If males and females did not differ in fundamental ways, it would be surprising to find that they are either socialized to be different in a consistent fashion throughout the world or that people consistently, but mistakenly, believe them to be different.

There is also much evidence that at least part of the differential treatment accorded boys and girls is a result of differences in the children themselves, rather than in parental expectations (Bell & Harper, 1977; Harris, 1998; Maccoby, 1998; Scarr & McCartney, 1983). Social-constructionists typically assume that the arrow of causation always points from the parent to the child. For example, Williams (1989, p. 11) attributes women's 'greater desire and need for emotional intimacy' to the greater frequency with which parents caress and hold their infant daughters. Perhaps, however, it is the other way around. A study of adults' perceptions of infants found that individuals blind to the sex of newborns rated female infants substantially more 'cuddly' than male infants (Benenson, Philippoussis, & Leeb, 1999). This finding makes it problematic to conclude that later emotional sex differences were caused by differential cuddling of boys and girls. It seems equally plausible, if not more so, that parents are more likely to cuddle particularly 'cuddly' infants and that particularly cuddly infants are more likely to be girls than boys.

One central flaw in the 'purely social' view of sex differences is that because it tends to locate the origins of sex differences in the idiosyncrasies of western culture, it is not well suited to predicting cross-cultural patterns or explaining the origins of the patterns. Fausto-Sterling (1992, p. 199) suggests that the cross-cultural uniformity of sex differences may be attributed to a kind of 'founder effect.' Perhaps, she argues, 'the entire population of the world all evolved from a small progenitor stock and these behaviors have been faithfully passed down from generation to generation a thousand times over.' That argument elides two important questions. The first is why the progenitor group came to adopt its initial rule, although she implies that the choice was mere serendipity. The second is how one can square the faithfulness with which this 'cultural artifact' has been transmitted from generation to generation with its being simply an arbitrary choice. Other cultural traits with seemingly strong roots in the human psyche—such as language, religion, and kinship systems—exhibit tremendous cultural variation. In relatively few centuries, a language can change so much as to be unintelligible to its original speakers. Yet somehow, in Fausto-Sterling's view, the arbitrary pattern of male dominance persisted without reversal in thousands of societies over thousands of generations. Surely, the faithfulness with which this cultural practice was passed down implies something important about the human mind.

Attempting to remedy the flaws of the sociocultural view, Eagly and Wood (1999) have developed a 'biosocial' approach to the origins of sex differences. Under this view, 'sex differences in social behavior arise from the distribution of men and women into social roles within a society' (Wood & Eagly, 2002, p. 701). Unlike the social-constructionists they criticize, Eagly and Wood do not view these roles as having been thrust upon the sexes arbitrarily; instead, they believe that the roles have developed because of two underlying biological facts—greater male size and women's childbearing and nursing. Sex roles grow out of these differences, they argue, because roles are assigned by society to the sex that can do a task most efficiently. For example, hunting is assigned to the stronger and more mobile sex, and child-rearing, at least in the early stages of child development, is necessarily assigned to the sex that lactates. The psychological correlates of these roles, such as the greater risk-taking and physical aggressiveness of male hunters and greater nurturance of female caregivers, are assumed to reflect the socialization of individuals into their socially assigned roles rather than any essential difference between the sexes.

Although having the virtue of explaining cross-cultural uniformities in a more satisfying manner than the strong social-constructionist view, the biosocial theory does not explain some fundamental issues. First, the theory explains why, assuming a sexual division of labor, the tasks would be allocated as they are, but it does not explain why there is a sexual division of labor in the first place. The sexual division of labor is a human universal (Brown, 1991), yet absent some psychological predisposition to creating such a division, it is not clear why many societies have not simply 'assigned' jobs to every individual capable of performing the task. Some specialization is surely efficient, but that specialization need not be by sex. Second, the theory does not explain where the original physical sex differences came from. The female role in gestation and lactation is of ancient origin, of course, dating back to the dawn of mammals. The origin of the male advantage in size and strength is not so obvious, however. The explanation accepted by most evolutionary psychologists is that sexual dimorphism in size and strength—along with the correlated sexual dimorphism in physical aggressiveness and risk-taking—is a result of male–male competition, as it is in many other mammals (Geary, 1998). The biosocial view simply takes greater male size and strength as a given and assumes that they have no psychological correlates. Third, even if the sexual division of labor were initially just a cultural adaptation, one might have expected that natural selection would have 'codified' these rules in the genes over the past thousands of generations. That is, if societies over the millennia assigned hunting and warfare to men and childcare to women, then genetically based variations in strength and physical aggressiveness in men and variations in nurturance in women might have resulted in greater reproductive success for those individuals who did their tasks especially well. Even a division that began as a purely social institution could, and likely would, have had long-term biological consequences. Finally, and perhaps most critically, the biosocial theory entirely discounts the important and now widely recognized effects of sex hormones on psychological functioning described in a subsequent section.

A 'purely social' view of workplace differences

When it comes to workplace differences, advocates of the 'purely social' school also face difficulties. Explanations for modern occupational distributions that are based on broad social causes such as 'patriarchal culture,' societal hostility toward women in the workplace, or society's view of what constitutes appropriate work for women do not go far toward an understanding of existing workplace patterns. It is true that women have not made proportionate inroads in some occupations, with some remaining highly segregated. In the U.S., over 90 per cent of bank tellers, receptionists, registered nurses, and pre-school and kindergarten teachers are women, and over 90 per cent of engineers, fire-fighters, mechanics, and pest exterminators are men (Browne, 2002). Many women can be found in some scientific fields—such as biology and medicine—but far fewer are to be seen in others, such as mathematics, physics, and engineering. On the other hand, one must concede that in many respects women have made substantial, and in some cases breathtaking, advances in the past several decades. In the U.S., for example, over 40 per cent of new doctors and lawyers are women (Browne, 2002). Although some of the greatest changes have taken place in the U.S., similar patterns are observable throughout the western world (Anker, 1998).

A commonly heard sociological explanation for the scarcity of women in science goes something like this. From a young age, girls are channeled away from math and science by parents, teachers, and peers, all of whom inculcate in girls the idea that math and science are for boys. Rather than being encouraged to take math and science in high school, girls are encouraged to take more appropriately feminine classes and to suppress their native abilities in math and science (Dresselhaus, Franz, & Clark, 1994). When girls go off to college, they find a 'well fortified bastion of sexism' that is hostile and unwelcoming to them. This hostility is so great that one commentator has pronounced it 'shocking . . . that there are any women in science at all' (see Holloway, 1993, p. 95).

It must be recognized as an oddly selective hostility toward women that would produce the variegated pattern of women's representation in diverse scientific fields. If the level of female participation is a valid measure of hostility then there is something quite complex about this hostility, given the distribution of women within scientific subfields described earlier. Engineering, in this view, is hostile to women, although bioengineering is less hostile than mining/mineral engineering. Biology is welcoming to women, except for biopyhsics, which is not. Psychometrics is hostile to women but developmental and child psychology are not. It would take an intricate argument to connect this pattern to broad patterns of sexism.

There is also little evidence for the frequent assertion that girls are channeled away from math and science before college. In the U.S., boys and girls take approximately the same number of math and science courses (National Center for Education Statistics, 2000, p. 24). Girls' math and science performance, as well as their participation, is roughly equivalent to that of boys. In fact, high school girls receive higher grades in math and science, as they tend to do in all subjects. On the mathematics portion of the NAEP, which is taken by students at all ability levels, male and female twelfth-graders perform equally well on average (although boys are somewhat more likely to score at the highest levels). However, on the SAT-M, which is taken by a more elite sample of students, boys outperform girls by approximately 35 points both among all test-takers and among those who have taken calculus and physics (National Science Foundation, 1999, pp. 14–16.)

There is also little evidence to suggest that girls are discouraged by schools and parents from math and science (Raymond & Benbow, 1986). In fact, girls are less likely than boys to believe that they did not receive serious attention from teachers about science (Collier, Spokane, & Bazler, 1998), and female college students are more likely than males to report that they chose science because of encouragement from parents or teachers (Seymour & Hewitt, 1997). Males, in contrast, are more likely to report choosing science because of long-term interest in the subject.

Some find the origins of the sex gap in math and science in social pressures upon smart girls to 'play dumb' in high school, which is said to stunt their intellectual growth and diminish their performance. If girls are 'playing dumb,' however, they are not very good at it, as they get better grades than boys in virtually all classes. On less visible measures of achievement, such as performance on standardized tests, however, girls do less well than boys. This pattern of results—relatively better performance on more public class work and relatively worse performance on more anonymous standardized tests—is precisely the opposite of what would be expected if girls are pretending to be less intelligent than they are.

Some of the social obstacles to female equality identified by those of the 'purely social' school are often not self-evidently social obstacles at all. For example, a study of attrition of women in engineering and science programs found that frequently cited barriers were isolation, lack of self-confidence, and lack of interest in the subject matter (Brainard & Carlin, 1998). It is not obvious that these factors should be considered 'barriers' in the usual sense, as they seem to represent women's reactions to the fields rather than obstacles placed in their way. Negative reactions to science are not surprising in member of a group that tends to be more socially and less quantitatively oriented than the group to which they compare themselves. As noted previously, individuals in math-intensive fields tend to have a low need for contact with other people. A feeling of isolation among social individuals entering such fields is somewhat predictable. Significantly, the rate at which women in the study reported negative perceptions increased over time, so that the percentage of those reporting that their lack of self-confidence was a barrier almost doubled from freshman to senior year (23% vs. 44.5%), and the percentage of women who reported a lack of interest tripled (12.6% vs. 38%). The primary reason given by women who actually switched out of science and engineering was lack of interest.

The conventional explanation for the low representation of women in blue-collar occupations parallels that in scientific fields: society and employers have created expectations about what is 'appropriate' work for women, so that women tend not to seek these jobs. When they do, they face both discrimination and harassment. These are not false explanations, but they are woefully incomplete. Sociologists Irene Padavic and Barbara Reskin have argued that negative attitudes of co-workers have been exaggerated as a reason for women's lack of attraction to blue-collar work (Padavic & Reskin, 1990). The sex composition of blue-collar occupations simply cannot be understood without taking into account the attributes of those occupations and the preferences and abilities of men and women.

One might hypothesize that women do not select blue-collar jobs because of lack of familiarity with them, but women's disinclination to pursue blue-collar occupations is not simply due to lack of exposure. A study examining interest in blue-collar work among female white-collar employees found that women who had performed blue-collar work for their employer during a strike were less inclined to consider blue-collar occupations than women who had not (Padavic, 1992). The fact that most women do not select blue-collar jobs does not mean that those who do select them do not like them. In fact, female blue-collar workers report job satisfaction as high as, or higher than, that of male blue-collar workers (Loscocco, 1990). In general, however, blue-collar jobs impose demands that women are less likely than men to satisfy and have attributes that women are more likely than men to find aversive.

One's initial reaction might be that even if the sexes differ in a particular trait, no single sex difference is sufficient to explain the low representation of women in many fields. Often, however, multiple sex differences may be operating simultaneously. Heavy-equipment mechanics, for example, must have a substantial degree of both mechanical ability and upper-body strength, a willingness to work in messy conditions, and a 'Realistic' Holland orientation. Theoretical physicists must generally have a high level of both mathematical and spatial ability, an 'Investigative' Holland orientation, and a tolerance for socially cloistered environments. All of these traits display substantial sex differences, and to the extent that they are independent, they will have a cumulative effect on the sex ratio in the occupation.

The foregoing should not be taken to suggest that supply-side factors are exclusively responsible for occupational distributions. Apart from such obvious demand-side forces as overt discrimination, it must be recognized that selection decisions are substantially influenced by prior selection decisions that have contributed to the organizational culture and have produced the later decision-makers (Schneider, 1987). The extent to which supply-side and demand-side factors influence occupational distributions no doubt varies widely by time and place.

Hormones: the proximate link between natural selection and psychological sex differences

The lack of fit between the 'purely social' argument and the reality of workplace patterns exposes the weakness of that argument, but it provides only indirect evidence for competing explanations. More direct evidence for the importance of biology comes from the study of sex hormones. The literature on hormonal influences on psychological sex differences is vast and ever-increasing and provides the proximate 'missing link' between the ultimate evolutionary causes of sex differences and their phenotypic expression. Any explanation of social sex differences must take account in some way of this literature.

Androgens have been found to affect the brain in two somewhat different ways. During a critical period of brain development in the fetus, they exert an 'organizing' effect, causing the brain to become masculinized. Later in life, especially at and after puberty, circulating hormones influence behavior more directly, an effect known as the 'activational' effect. This neat dichotomy of organizing and activational effects may be oversimplified (Breedlove, Cooke, & Jordan, 1999), but it is useful for discussion.

Evidence for organizing effects of androgens comes from a variety of sources, including what might be termed 'experiments of nature.' In a condition known as congenital adrenal hyperplasia (CAH), for example, the adrenal gland produces excessive levels of androgens during a critical period of brain development in utero. Girls with CAH have a much more 'masculine' behavioral pattern, tending to be tomboys who are more likely to play with boys and with 'boy toys' and are less interested in infants and marriage than unaffected girls (Berenbaum & Snyder, 1995; Hines & Kaufman, 1994; Leveroni & Berenbaum, 1998). They perform better than unaffected girls on targeting tasks (Hines et al., 2003), and they have been found in some studies to have higher levels of spatial ability than unaffected girls (Hampson, Rovet, & Altmann, 1998), although the consistency of that finding has been challenged (Hines et al., 2003). CAH girls also have more male-like occupational preferences (Berenbaum, 1999). The relationship between androgen exposure and masculinization seems to be dose sensitive, so that the greater the level of hormone exposure, the greater the masculinization of behaviors and interests (Servin, Nordenström, Larsson, & Bohlin, 2003). Although some have criticized reliance on CAH studies on the ground that parents' knowledge of their daughters' condition may affect the girls' behavior (Quadagno, Brisco & Quadagno, 1977), there is little evidence to support that speculation (Berenbaum, 1999; Servin et al., 2003).

Developing female fetuses are also affected by their mothers' levels of circulating hormones during pregnancy. A recent study found a linear relationship between maternal testosterone levels during pregnancy and masculine-typical behavior in daughters at age three and half (Hines et al., 2002). The mother's testosterone level during the second trimester is also inversely correlated with the daughter's sex-typed behavior as an adult. In fact, the mother's testosterone levels during pregnancy are a better predictor of the daughter's behavior as an adult than are the daughter's own adult testosterone levels (Udry, Morris, & Kovenock, 1995). The spatial ability of 7-year-old girls has been found to correlate positively with prenatal testosterone levels in second-trimester amniotic fluid (Grimshaw, Sitarenios, & Finegan, 1995).

Behavior and cognitive performance also seem to be influenced by circulating hormones. A number of researchers have reported an association between testosterone and dominance behaviors (Mazur & Booth, 1998; Tremblay et al., 1998), although the direction of causation is not always clear. A much larger body of data supports a relationship between hormones and cognitive performance. For example, the optimal level of testosterone for high spatial ability appears to be in the low–normal male range, so that among men, those in the low–normal range have the highest ability, while among women, those with the highest testosterone levels tend to have the highest performance because their levels are closest to the low–normal male range (Gouchie & Kimura, 1991). It is not just testosterone that affects spatial ability, however, as estrogen seems to have a depressing effect (Hausmann, Slabbekoorn, van Goozen, Cohen-Kettenis, & Guentuerkuen, 2000), which may at least partially explain the increased sex difference in spatial ability observed after puberty, as well as the tendency of distinctly feminized women to have relatively low spatial ability (Nyborg, 1994).

Hormone treatments produce predictable effects. Spatial performance in female-to-male transsexuals increases after androgen therapy, and male-to-female transsexuals experience enhanced verbal-memory performance after estrogen treatments (Miles, Green, Sanders, & Hines, 1998; Slabbekoorn, van Goozen, Megens, Gooren, & Cohen-Kettenis, 1999; Van Goozen, Cohen-Kettenis, Gooren, Frijda, & Van de Poll, 1995). Even a single administration of testosterone to women in a laboratory setting has been found to result in enhanced mental-rotation performance, (Aleman, Bronk, Kessels, Koppeschaar, & van Honk, 2004), while administration of testosterone to normal men results in a reduction in spatial performance (O'Connor, Archer, Hair, & Wu, 2001).

Biological factors, of course, do not act in isolation from social ones; any more than social factors act without regard to biological ones. Indeed, the extent to which an individual actually responds to socialization pressures may itself be influenced by hormones. For example, Udry (2000) has found that the responsiveness of females to encouragement of femininity is inversely related to their mothers' testosterone levels during the second trimester of pregnancy. Exposure to high levels of testosterone in utero seems to 'immunize' against the effects of feminine socialization, so that encouragement of feminine behavior has little effect and the daughter remains relatively masculine. Females exposed to low levels of prenatal testosterone, however, are more variable in their femininity, depending upon the extent to which they have been socialized in a feminine direction.

In sum, hormones have profound effects on the temperamental and cognitive profiles of the sexes. The 'purely social' view of sex differences, which neglects the very important contribution of these substances, cannot provide a full picture of the mechanism by which the sexes come to diverge and cannot explain the complex and variegated pattern of women's experience in the workplace.

Conclusion

Psychological sex differences have an ancient history in humans. We have, as has been said, a "stone-age mind," and that mind is sexually dimorphic. Evolved preferences and behavioral predispositions—along with social forces—lead men and women to follow somewhat different career paths. An evolutionary perspective makes sense of the nuances of workplace patterns in a way that a purely social account cannot.

Recognition of occupationally relevant sex differences does not foreordain any particular policy choice. Just as there are policy disagreements among those who believe that observed sex differences are entirely the result of differential socialization, there will also be disagreement over policy among those who believe that biology plays an important role. To the extent that policies have been based on an erroneous understanding of the causes of the occupational distributions that they seek to alter, however, policy makers may wish to reconsider the advisability of either their goals or the methods they have adopted to achieve them.

Much of the discourse on the workplace assumes that sex differences in outcomes are necessarily a result of some nefarious social cause. Sometimes they are, of course, but often they simply reflect differences in the talents and tastes of the two sexes. The mere existence of statistical disparities is therefore not particularly strong evidence of discrimination (Browne, 1993). Moreover, when programs intended to recruit women into nontraditional areas produce disappointing results, or meet with initial success but are later plagued by high levels of attrition, it is often concluded that the programs have not gone far enough, when the real problem may be that they have gone too far. The fact that a woman can be persuaded to enter a nontraditional field does not mean that she will remain, and the more persuasive the inducement to participate in the first place, the more likely that the match will end up being less than optimal.

Although it is important that women (and men) be permitted to choose the direction in which their careers take them, it is not sensible to assume a priori that those choices will be, or should be, identical for the two sexes. Similarly, although it is important to be alert to arbitrary social barriers that stand in the way of women's participation in the occupations of their choice, it is not sensible to assume that when women do not enter all occupations in the same number as men, their entry is necessarily impeded by one of these arbitrary social barriers. Freedom to choose, after all, entails the freedom to choose differently.

Acknowledgements

The author is grateful for the comments of Nigel Nicholson and Rod White, co-editors of this special issue of *JOB*, and two anonymous reviewers.

Author biography

Kingsley Browne is a Professor of Law at Wayne State University. His research interests include employment discrimination and the effect of evolved sex differences in the workplace and the military. He is the author of *Biology at Work: Rethinking Sexual Equality* (Rutgers University Press, 2002) and *Divided Labours: An Evolutionary View of Women at Work* (Weidenfeld & Nicolson, 1998).

References

Ahlgren, A. (1983). Sex differences in the correlates of cooperative and competitive school attitudes. *Developmental Psychology, 19*, 881–888.

Aleman, A., Bronk, E., Kessels, R. P. C., Koppeschaar, H. P. F., & van Honk, J. (2004). A single administration of testosterone improves visuospatial ability in young women. *Psychoneuroendocrinology, 29*, 612–617.

Anker, R. (1998). *Gender and jobs: Sex segregation of occupations in the world.* Geneva: International Labour Office.

Arch, E. C. (1993). Risk-taking: a motivational basis for sex differences. *Psychological Reports, 73*, 3–11.

Aros, J. R., Henly, G. A., & Curtis, N. T. (1998). Occupational sextype and sex differences in vocational preference-measured interest relationships. *Journal of Vocational Behavior, 53*, 227–242.

Bell, R. Q., & Harper, L. V. (1977). *Child effects on adults*. Hillsdale, NJ: Erlbaum.

Benenson, J. F., Philippoussis, M., & Leeb, R. (1999). Sex differences in neonates' cuddliness. *Journal of Genetic Psychology, 160*, 332–342.

Berenbaum, S. A. (1999). Effects of early androgens on sex-typed activities and interests in adolescents with congenital adrenal hyperplasia. *Hormones and Behavior, 35*, 102–110.
Berenbaum, S. A., & Snyder, E. (1995). Early hormonal influences on childhood sex-typed activity and playmate preferences: implications for the development of sexual orientation. *Developmental Psychology, 31*, 31–42.
Betzig, L. (1993). Sex, succession, and stratification in the first six civilizations: how powerful men reproduced, passed power on to their sons, and used power to defend their wealth, women, and children. In L. Ellis (Ed.), *Social stratification and socioeconomic inequality* (Vol. 1, pp. 37–74). Westport, CT: Praeger.
Betzig, L. (1986). *Despotism and differential reproduction: A darwinian view of history.* New York: Aldine.
Bishop, P., Cureton, K., & Collins, M. (1987). Sex difference in muscular strength in equally-trained men and women. *Ergonomics, 30*, 675–687.
Brainard, S. G., & Carlin, L. (1998). A six-year longitudinal study of undergraduate women in engineering and science. *Journal of Engineering Education, 87*, 369–375.
Breedlove, S. M., Cooke, B. M., & Jordan, C. L. (1999). The orthodox view of brain sexual differentiation. *Brain, Behavior and Evolution, 54*, 8–14.
Brown, D. E. (1991). *Human Universals*. New York: McGraw-Hill.
Browne, K. R. (2002). *Biology at work: Rethinking sexual equality.* New Brunswick, NJ: Rutgers University Press.
Browne, K. R. (1998a). *Divided labours: An evolutionary view of women at work*. New Haven, CT: Yale University Press.
Browne, K. R. (1998b). An evolutionary account of women's workplace status. *Managerial and Decision Economics, 19*, 427–440.
Browne, K. R. (1997). An evolutionary perspective on sexual harassment: seeking roots in biology rather than ideology. *Journal of Contemporary Legal Issues, 8*, 5–77.
Browne, K. R. (1995). Sex and temperament in modern society: a Darwinian view of the glass ceiling and the gender gap. *Arizona Law Review, 37*, 971–1106.
Browne, K. R. (1993). Statistical proof of discrimination: Beyond 'damned lies.' *Washington Law Review, 68*, 477–558.
Bureau of Labor Statistics. (2003). *Fatal occupational injuries by worker characteristics and event of exposure, all United States, 2002*. Retrieved July 24, 2004, from: http://www.bls.gov/iif/oshwc/cfoi/cftb0161.pdf
Buss, D. M. (2004). *Evolutionary psychology: The new science of the mind* (2nd ed.). New York: Allyn & Bacon.
Campbell, A. (1999). Staying alive: evolution, culture, and women's intrasexual aggression. *Behavioral and Brain Sciences, 22*, 203–252.
Campbell, A., Shirley, L., Heywood, C., & Crook, C. (2000). Infants' visual preference for sex-congruent babies, children, toys and activities: a longitudinal study. *British Journal of Developmental Psychology, 28*, 479–498.
Carretta, T. R. (1997). Group differences on US Air Force pilot selection tests. *International Journal of Selection and Assessment, 5*, 115–127.
Cashdan, E. (1998). Are men more competitive than women? *British Journal of Social Psychology, 37*, 213–229.
Colarelli, S. M. (2003). *No best way: An evolutionary perspective on human resource management*. Westport, CT: Praeger.
College Board. (2003). *SAT®* Verbal and math scores up significantly as a record-breaking number of students take the test. Retrieved July 24, 2004, from: http://www.collegeboard.com/prod_downloads/about/news_info/cbsenior/yr2003/pdf/CBS2003Report.pdf
Collier, C. M., Spokane, A. R., & Bazler, J. A. (1998). Appraising science career interests in adolescent girls and boys. *Journal of Career Assessment, 6*, 37–48.
Conti, R., Collins, M. A., & Picariello, M. L. (2001). The impact of competition on intrinsic motivation and creativity: considering gender, gender segregation and gender role orientation. *Personality and Individual Differences, 30*, 1273–1289.
Cronin, H. (1991). *The ant and the peacock: Altruism and sexual selection from Darwin to today.* Cambridge: Cambridge University Press.
Dawis, R. V., & Lofquist, L. H. (1984). *A psychological theory of work adjustment*. Minneapolis: University of Minnesota Press.
Deaux, K., & Ullman, J. C. (1982). Hard-hatted women: Reflections on blue-collar employment. In H. J. Bernardin (Ed.), *Women in the work force* (pp. 29–47). New York: Praeger.
De Waal, F. B. M. (1982). *Chimpanzee politics: Power and sex among apes*. London: Jonathon Cape.
Dresselhaus, M. S., Franz, J. R., & Clark, B. C. (1994). United States: interventions to increase the participation of women in physics. *Science, 263*, 1392–1393.
Eagly, A. H., & Wood, W. (1999). The origins of sex differences in human behavior: evolved dispositions versus social roles. *American Psychologist, 54*, 408–423.

Ecuyer-Dab, I., & Robert, M. (2004). Differences in spatial ability evolved from competition for mating and female concern for survival? *Cognition, 91*, 221–257.

Fausto-Sterling, A. (1992). *Myths of gender: Biological theories about women and men* (2nd ed.). New York: Basic Books.

Geary, D. C. (1998). *Male, female: The evolution of human sex differences*. Washington, DC: American Psychological Association.

Geary, D. C. (1996). Sexual selection and sex differences in mathematical abilities. *Behavioral and Brain Sciences, 19*, 229–284.

Gottfredson, G. D., & Holland, J. L. (1996). *Dictionary of Holland occupational codes*. Odessa, FL: Psychological Assessment Resources.

Gouchie, C., & Kimura, D. (1991). The relationship between testosterone levels and cognitive ability patterns. *Psychoneuroendocrinology, 16*, 323–334.

Grimshaw, G. M., Sitarenios, G., & Finegan, J. K. (1995). Mental rotation at 7 years: relation with prenatal testosterone levels and spatial play experiences. *Brain and Cognition, 29*, 85–100.

Halpern, D. F. (2000). *Sex differences in cognitive abilities* (3rd ed.). Mahwah, NJ: Erlbaum.

Hampson, E., Rovet, J. F., & Altmann, D. (1998). Spatial reasoning in children with congenital adrenal hyperplasia due to 21-hydroxylase deficiency. *Developmental Neuropsychology, 14*, 299–320.

Harmon, L. W., & Borgen, F. H. (1995). Advances in career assessment and the 1994 Strong Interest Inventory. *Journal of Career Assessment, 3*, 347–372.

Harris, J. R. (1998). *The nurture assumption: Why children turn out the way they do*. New York: Free Press.

Hausmann, M., Slabbekoorn, D., van Goozen, S. H. M., Cohen-Kettenis, P. T., & Guentuerkuen, O. (2000). Sex hormones affect spatial abilities during the menstrual cycle. *Behavioral Neuroscience, 114*, 1245–1250.

Hedges, L. V., & Nowell, A. (1995). Sex differences in mental test scores, variability, and numbers of high-scoring individuals. *Science, 269*, 41–45.

Hines, M., Fane, B. A., Pasterski, V. L., Mathews, G. A., Conway, G. S., & Brook, C. (2003). Spatial abilities following prenatal androgen abnormality: targeting and mental rotations performance in individuals with congenital adrenal hyperplasia. *Psychoneuroendocrinology, 28*, 1010–1026.

Hines, M., Golombok, S., Rust, J., Johnston, K. J., Golding, J., & the Avon Longitudinal Study of Parents and Children Study Team. (2002). Testosterone during pregnancy and gender role behavior of preschool children: a longitudinal, population study. *Child Development, 73*, 1678–1687.

Hines, M., & Kaufman, F. R. (1994). Androgen and the development of human sex-typical behavior: rough-and-tumble play and sex of preferred playmates in children with congenital adrenal hyperplasia (CAH). *Child Development, 65*, 1042–1053.

Holland, J. L. (1997). *Making vocational choices: A theory of vocational personalities and work environments* (3rd ed.). Odessa, FL: Psychological Assessment Resources.

Holloway, M. (1993). A lab of her own. *Scientific American, 269*, 94–103.

Hoyenga, K. B. (1993). Sex differences in human stratification: a biosocial approach. In L. Ellis (Ed.), *Social stratification and socioeconomic inequality* (Vol. 1, pp. 139–157). Westport, CT: Praeger.

Hoyenga, K. B., & Hoyenga, K. T. (1993). *Gender-related differences: Origins and outcomes*. Boston: Allyn & Bacon.

Hrdy, S. B. (1999). *Mother nature: A history of mothers, infants, and natural selection*. New York: Pantheon Books.

Hrdy, S. B. (1981). *The woman that never evolved*. Cambridge, MA: Harvard University Press.

Jensen, A. R. (1998). *The g factor: The science of mental ability.* Westport, CT: Praeger.

Josephs, R. A., Markus, H. R., & Tafarodi, R. W. (1992). Gender and self-esteem. *Journal of Personality and Social Psychology, 63*, 391–402.

Kaufman, A. S., & McLean, J. E. (1998). An investigation into the relationship between interests and intelligence. *Journal of Clinical Psychology, 54*, 279–295.

Kilbourne, B. S., & England, P. (1996). Occupational skill, gender, and earnings. In P. J. Dubeck, & K. Borman (Eds.), *Women and work: A handbook* (pp. 68–70). New York: Garland Publishing.

Kimura, D. (1999). *Sex and cognition*. Cambridge, MA: MIT Press.

Leveroni, C., & Berenbaum, S. A. (1998). Early androgen effects on interest in infants: evidence from children with congenital adrenal hyperplasia. *Developmental Neuropsychology, 14*, 321–340.

Lippa, R. (1998). Gender-related individual differences and the structure of vocational interests: the importance of the people-things dimension. *Journal of Personality and Social Psychology, 74*, 996–1009.

Loscocco, K. A. (1990). Reactions to blue-collar work: a comparison of women and men. *Work and Occupations, 17*, 152–177.

Low, B. S. (1992). Sex, coalitions, and politics in preindustrial societies. *Politics and the Life Sciences, 11*, 63–80.
Lubinski, D., & Benbow, C. P. (1992). Gender differences in abilities and preferences among the gifted: implications for the math-science pipeline. *Current Directions in Psychological Science*, *1*, 61–66.
Lubinski, D., Benbow, C. P., & Morelock, M. J. (2000). Gender differences in engineering and the physical sciences among the gifted: an inorganic-organic distinction. In K. A. Heller, F. J. Mönks, R. J. Sternberg, & R. F. Subotnik (Eds.), *International handbook for research on giftedness and talent* (2nd ed., pp. 627–641). Oxford: Pergamon Press.
Lubinski, D., Benbow, C. P., & Sanders, C. E. (1993). Reconceptualizing gender differences in achievement among the gifted. In K. A. Heller, F. J. Mönks, & A. H. Passow (Eds.), *International handbook of research and development of giftedness and talent* (pp. 693–707). Oxford: Pergamon Press.
Lynn, R. (1993). Sex differences in competitiveness and the valuation of money in twenty countries. *Journal of Social Psychology, 133*, 507–511.
Lytton, H., & Romney, D. M. (1991). Parents' differential socialization of boys and girls: a meta-analysis. *Psychological Bulletin, 109*, 267–296.
Maccoby, E. E. (1998). *The two sexes: Growing up apart, coming together*. Cambridge, MA: Belknap Harvard.
Mazur, A., & Booth, A. (1998). Testosterone and dominance in men. *Behavioral and Brain Sciences, 21*, 352–397.
McClelland, D. C., & Watson, R. I. (1973). Power motivation and risk-taking behavior. *Journal of Personality, 41*, 121–139.
Mealey, L. (2000). *Sex differences: Developmental and evolutionary strategies*. San Diego, CA: Academic Press.
Miles, C., Green, R., Sanders, G., & Hines, M. (1998). Estrogen and memory in a transsexual population. *Hormones and Behavior, 34*, 199–208.
Mirowsky, J., & Ross, C. (1995). Sex differences in distress: real or artifact? *American Sociological Review, 60*, 449–468.
Moir, A., & Jessel, D. (1989). *Brain sex: The real difference between men and women*. New York: Dell Publishing.
National Center for Education Statistics. (2000). *Trends in educational equity of girls & women*. U.S. Department of Education, Office of Education Research and Improvement. NCES 2000-030. Retrieved July 24, 2004, from: http://nces.ed.gov/pubs2000/2000030.pdf
National Center For Education Statistics. (1998). *Pursuing Excellence: A Study of U.S. Twelfth-Grade Mathematics and Science Achievement in International Context: Initial Findings from the Third International Mathematics and Science Study*. NCES 98-049. Retrieved July 24, 2004, from: http://nces.ed.gov/pubs98/98049.pdf
National Science Foundation. (2003). *Science and Engineering Doctorate Awards: 2002,* NSF 04-303. (Arlington, VA 2003). Retrieved July 24, 2004, from: http://www.nsf.gov/sbe/srs/nsf04303/pdf/nsf04303.pdf
National Science Foundation. (1999). *Women, minorities, and persons with disabilities in science and engineering: 1998*. (NSF 99-338). Retrieved July 24, 2004, from: http://www.nsf.gov/sbe/srs/nsf99338/pdf/document.pdf
Nicholson, N. (1998). How hardwired is human behavior? *Harvard Business Review, 76*(4), 134–147.
Nyborg, H. (1994). *Hormones, sex, and society: The science of physicology*. Westport, CT: Praeger.
O'Connor, D. B., Archer, J., Hair, W. M., & Wu, F. C. W. (2001). Activational effects of testosterone on cognitive function in men. *Neuropsychologia, 39*, 1385–1394.
O'Farrell, B. (1999). Women in blue collar and related occupations at the end of the millennium. *Quarterly Review of Economics and Finance, 39*, 699–722.
Padavic, I. (1992). White-collar work values and women's interest in blue-collar jobs. *Gender and Society, 6*, 215–230.
Padavic, I., & Reskin, B. F. (1990). Men's behavior and women's interest in blue-collar jobs. *Social Problems, 37*, 613–628.
Pheasant, S. T. (1983). Sex differences in strength: some observations on their variability. *Applied Ergonomics, 14*, 205–211.
Prediger, D. J. (1982). Dimensions underlying Holland's hexagon: missing link between interests and occupations? *Journal of Vocational Behavior, 21*, 259–287.
Quadagno, D. M., Briscoe, R., & Quadagno, J. S. (1977). Effect of perinatal gonadal hormones on selected nonsexual behavior patterns: a critical assessment of the nonhuman and human literature. *Psychological Bulletin, 84*, 62–80.
Raymond, C. L., & Benbow, C. P. (1986). Gender differences in math: a function of parental support and student sex typing? *Developmental Psychology, 22*, 808–819.
Reskin, B. F., & Roos, P. A. (1990). *Job queues, gender queues: Explaining women's inroads into male occupations*. Philadelphia, PA: Temple University Press.

Scarr, S., & McCartney, K. (1983). How people make their own environments: a theory of genotype → environment effects. *Child Development*, *54*, 424–435.
Schneider, B. (1987). The people make the place. *Personnel Psychology, 40*, 437–453.
Schrader, M. P., & Wann, D. L. (1999). High-risk recreation: the relationship between participant characteristics and degree of involvement. *Journal of Sport Behavior, 22*, 426–441.
Serbin, L. A., Poulin-Dubois, D., Colburne, K. A., Sen, M. G., & Eichstedt, J. A. (2001). Gender stereotyping in infancy: visual preferences for and knowledge of gender-stereotyped toys in the second year. *International Journal of Behavioral Development, 25*, 7–15.
Servin, A., Bohlin, G., & Berlin, L. (1999). Sex differences in 1-, 3-, and 5-year-olds' toy choice in a structured play-session. *Scandinavian Journal of Psychology, 40*, 43–48.
Servin, A., Nordenström, A., Larsson, A., & Bohlin, G. (2003). Prenatal androgens and gender-typed behavior: a study of girls with mild and severe forms of congenital adrenal hyperplasia. *Developmental Psychology, 39*, 440–450.
Seymour, E., & Hewitt, N. M. (1997). *Talking about leaving*. Boulder, CO: Westview Press.
Sidanius, J., Pratto, F., & Bobo, L. (1994). Social dominance orientation and the political psychology of gender: a case of invariance? *Journal of Personality and Social Psychology, 67*, 998–1011.
Silverman, I., & Eals, M. (1992). Sex differences in spatial abilities: evolutionary theory and data. In J. H. Barkow, L. Cosmides, & J. Tooby (Eds.), *The adapted mind: Evolutionary psychology and the generation of culture*. (pp. 533–553). New York: Oxford University Press.
Silverman, I., Choi, J., Mackewn, A., Fisher, M., Moro, J., & Olshansky, E. (2000). Evolved mechanisms underlying wayfinding: further studies on the hunter-gatherer theory of spatial sex differences. *Evolution and Human Behavior, 21*, 201–213.
Slabbekoorn, D., van Goozen, S. H. M., Megens, J., Gooren, L. J. G., & Cohen-Kettenis, P. (1999). Activating effects of cross-sex hormones on cognitive functioning: a study of short-term and long-term hormone effects in transsexuals. *Psychoneuroendocrinology, 24*, 423–447.
Toscano, G. (1997). *Brief: Dangerous jobs*. In Bureau of Labor Statistics. *Compensation and Working Conditions, Summer*, 57–60.
Tremblay, R. E., Schaal, B., Boulerice, B., Arseneault, L., Soussignan, R. G., Paquette, D., & Laurent, D. (1998). Testosterone, physical aggression, dominance, and physical development in early adolescence. *International Journal of Behavioral Development, 22*, 753–777.
Trivers, R. L. (1972). Parental investment and sexual selection. In B. G. Campbell (Ed.), *Sexual selection and the descent of man* (pp. 136–179). Chicago: Aldine.
Trivers, R. L. (1985). *Social Evolution*. Menlo Park, CA: Benjamin/Cummings.
Udry, J. R. (2000). Biological limits of gender construction. *American Sociological Review, 65*, 443–457.
Udry, J. R., Morris, N. M., & Kovenock, J. (1995). Androgen effects on women's gendered behaviour. *Journal of Biosocial Science, 27*, 359–368.
Van Goozen, S. H., Cohen-Kettenis, P. T., Gooren, L. J., Frijda, N. H., & Van de Poll, N. E. (1995). Gender differences in behaviour: activating effects of cross-gender hormones. *Psychoneuroendocrinology, 20*, 343–363.
Voyer, D., Voyer, S., & Bryden, M. P. (1995). Magnitude of sex differences in spatial abilities: a meta-analysis and consideration of critical variables. *Psychological Bulletin, 117*, 250–270.
Walters, A. E., Stuhlmacher, A. F., & Meyer, L. L. (1998). Gender and negotiator competitiveness: a meta-analysis. *Organizational Behavior and Human Decision Processes, 76*, 1–29.
Watson, J. B. (1925). *Behaviorism*. New York: W. W. Norton.
Watson, N. V., & Kimura, D. (1991). Nontrivial sex differences in throwing and intercepting: relation to psychometrically-defined spatial functions. *Personality & Individual Differences, 12*, 375–385.
Williams, C. L. (1989). *Gender differences at work: Women and men in nontraditional occupations*. Berkeley: University of California Press.
Williams, J. E., & Best, D. L. (1990). *Measuring sex stereotypes: a multination study* (Rev. Ed.). Newbury Park, CA: Sage.
Wood, W., & Eagly, A. H. (2002). A cross-cultural analysis of the behavior of women and men: implications for the origins of sex differences. *Psychological Bulletin, 128*, 699–727.

