16

The Biological Basis for Gender-Specific Behavior

Gregg Johnson

I recall one Saturday afternoon telling my wife that I would occupy the children in the front yard so she could get some things done in the house. We live on a relatively busy street. Our four children were all under six years old at the time. I became immersed in the task of teaching Nicholas to ride his two-wheeler and was unaware that two-year-old Neil was toddling out into the street. Lois, glancing out the window, saw his intentions and arrived in time to intercept him and to offer me some helpful parenting advice.

On another occasion, we took Nate for his one-year-old picture. My wife and I were behind the camera. Nate was positioned on a stool on a countertop. The photographer began thrusting a fuzzy puppet on a stick toward Nate to get him to smile. On one final thrust of the toy, Nate suddenly lunged forward to grab it and fell headlong over the countertop into my wife's hands. We both had been standing about ten feet from the counter. It occurred to me that Lois initiated her dash to the counter well before there was any indication to me that Nate would respond in this way.

Such observations by numerous amazed fathers have perhaps led to the idea of maternal instinct and women's intuition. One cannot draw conclusions from these examples, but they provide a framework from which to ask the historically debated nature-nurture questions. Are there differences in male and female behavior patterns? If there are measurable differences, to what degree are they culturally or biologically based? The current scene suggests that such differences are largely culturally imposed, that such gender norms restrict our full potential, and that we should actively eliminate all cultural elements that continue to foster traditional attitudes that the sexes might be differentially gifted. Let us explore the evidence.

In our search for a Biblically informed and rational perspective on sex roles and gender identity, I would argue for including a search of our current biological understandings of sexual dimorphism. I am convinced that God has both anticipated and ordained our search for wisdom through the study of nature (Romans 1:20; Psalm 104:24). David identifies two sources of truth in Psalm 19 as: (1) evidence from the created world, and (2) declarations from God's Word. God bids Adam to "have dominion over the earth," which embodies the concepts not only of having control over but also of knowing, protecting, and exercising stewardship over. Scripture warns of the dangers in the pursuit of human wisdom and tendencies to rely on our own understandings to the exclusion of the simple truths of His Word (Proverbs 3:5–6; 1 Corinthians 1:19–31; 8:1). Yet we will be held accountable for the knowledge we have received from both Scripture and nature. It is important, then, to seek a balanced and concerted wisdom from each of these sources of truth. I am also convinced that if we seek wisdom in prayerful submission to God's leading we will not find truths in nature that directly contradict the Word of God. Yet we must expect that revelations through our study of nature may give us new perspective and insight into our understanding of Scripture and its Author. As God is the author of neither temptation nor confusion (James 1:13; 1 Corinthians 14:33), I continue to press the search for truth and wisdom through science.

Although our primary evidence in this chapter will come from biological studies, it is valuable to note a landmark review of psychological literature on the subject of gender differences. Maccoby and Jacklin made a rather complete survey of the literature to determine whether there was consistent experimental support for any of the traditional gender stereotypes. They found that the majority of studies revealed that males scored higher in levels of aggressiveness, dominance, self-confidence, and activity level. Females scored higher on verbal ability, compliance, nurturance, and empathy scales.[1] Women tend to socialize more intimately with a few friends. Men are more apt to form larger groups.

My purpose in this chapter is to demonstrate that these differences are not only real but likely have their roots in our unique biology as males and females. Furthermore, these differences are present at birth (and even before) and are amplified according to individual hormonal and genetic dictates. We are differently gifted as male and female not only in anatomy and physiology but also in behavior. It is a marvelous God-given pattern that enhances pair bonding, dual parenting, and extensive division of labor, characteristic not only of humans but of many of the higher social animals.

A couple of cautions are warranted here. First, some of the evidence presented here comes from animal studies of the brain and behavioral correlates. We must be cautious when extrapolating such data to human beings. However, when data on many different animals reveals universal characteristics or recognizable trends, such data can be very instructive in understanding our own biology. Indeed, drug testing, surgical procedures, and many other medical advances are first perfected on animals and then the technology is transferred to humans. This is possible since higher animal systems function similarly to those of humans. We have taken a strange position in the past that while the other nine systems function very similarly in higher animals and humans, we can expect no such parallels in the nervous system. A second caution is that we are speaking of averages and patterns that cannot be completely universalized. It is always possible to discover individual uniquenesses and variations that deviate markedly from the norm. There are certainly females who are more aggressive than the average male or males who are more nurturant than the average female. The data simply reflect trends and average differences seen between the sexes taken as groups.

Although some studies have come to different conclusions than those represented in this chapter,[2] most of the support for those conclusions appears to be based on psychological survey and test data that are more suspect than those underlying this survey because they depend on more uncontrollable variables. The following data and evidence seem compelling and tip the balance in this controversial issue in favor of a divinely ordained and biologically rooted division of gifts between the sexes.

---

[1] E. E. Maccoby and C. N. Jacklin, *The Psychology of Sex Differences* (Stanford, CA: Stanford University Press, 1974), pp. 349–355.

[2] James A. Doyle, *Sex and Gender: The Human Experience* (Dubuque, IA: William C. Brown, 1985); Laurel Richardson, *Dynamics of Sex and Gender: A Sociological Perspective* (New York: Harper and Row, 1988); Anne Fausto-Sterling, *Myths of Gender: Biological Theories About Men and Women* (New York: Basic Books, 1985); Ruth Bleier, *Science and Gender: A Critique of Biology and Its Theories on Women* (Elmsford, NY: Pergamon Press, 1984).

The data and evidence for this view are arranged under the following subheadings: (1) ethological observations on sex, (2) sex differences in non-nervoussystem physiology, (3) sex differences in the peripheral nervous system, (4) sex differences in the hind brain and limbic system, (5) sex differences in the cerebrum, (6) sex differences evident at birth, and (7) sex differences in stress management.

I. Ethological Observations on Sex

Ethologists are students of animal and human behavior who draw generalizations regarding social behavior across animal and human groups. They point out that among most higher social mammals studied, males are more aggressive than females and take dominant leadership roles in social groups. Males are more territorial, competing and sparring with other males for control of resources, societies, and, in particular, control of access to reproductive females.[3]

Among most mammals, males tend to build hierarchical social order. They are more reactive and less cautious. They are involved in breaking up squabbles of lesser ranking males, females, and juveniles. They set directions and courses of action for the group as a whole.[4] Females are more involved in parenting as a result of the close dependence of infants on maternal milk supply. Females of most groups studied are not as driven by competitive, territorial or hierarchical urges. They tend to socialize more horizontally and equally with other females. They are cautious in mating, solicitous particularly of males that are the most dominant and control the most resources. Females are more concerned with parenting, nurturing, and maintaining pair bonds with mates through grooming or care-giving behaviors. They tend in their broader social contacts to be less confrontive and combative and more interested in building and maintaining social bonds. They are peacemakers and conformists to group expectations.[5]

Anthropologists find similar kinds of universal sex-specific behaviors among human cultures. Of two hundred fifty cultures studied, males dominate in almost all. Males are almost always the rule makers, hunters, builders, fashioners of weapons, workers in metal, wood, or stone. Women are primary care givers and most involved in child rearing. Their activities center on maintenance and care of home and family. They are more often involved in making pottery, baskets, clothes, blankets, etc. They gather food, preserve and prepare food, obtain and carry firewood and water. They collect and grind grain.[6] The fact that these universals transcend divergent animal groups and cultures suggest that there must be more than a cultural basis for these sex differences. The data point to biological predeterminants of gender-related behavior. Indeed, as we survey the biology of mammals and humans in particular, we find sex-related differences in all of the organ systems, including the brain and nervous system.

II. Sex Differences in Non-nervous System Physiology

---

[3] G. Siann, *Accounting for Aggression: Perspectives on Aggression and Violence* (Allen and Unwin, 1985), pp. 82–92.
[4] I. S. Bernstein, "Analysis of a Key Role in a Capuchin (Cebus albifrons) Group," *Tulane Studies in Zoology* 13 (1966): 49–54.
[5] M. Daly and M. Wilson, *Sex, Evolution, and Behavior* (Boston: Duxbury Press, 1978), pp. 55–79.
[6] G. Murdock, "The Common Denominator of Cultures," in *The Science of Man in the World Crisis*, ed. R. Linton (New York: Columbia University Press, 1945), pp. 123–142.

The conventional view on sex role development presented in psychosocial literature through the 1960s to 1980s has been that, apart from obvious morphological and physiological differences essential for reproduction, men and women are essentially the same in their potentials and capacities. Any behavioral differences that can be measured have been viewed as reflections of culturally imposed norms.

The biological profiles of males and females, however, reveal myriad basic physiological differences, many of which shape behavior. The basal metabolic rate is about 6 percent higher in adolescent boys than girls and increases to about 10 percent higher after puberty. During metabolism, girls convert more energy into stored fat, while boys convert more energy to muscle and expendable circulating reserves. At age eighteen, girls have almost twice the body fat (about 33 percent) of boys. Boys at age eighteen have about 50 percent more muscle mass than girls, particularly in the upper body. Males, on the average, have denser, stronger bones, tendons, and ligaments, which allow for heavier work.[7] Differences in metabolism and muscular ability likely give males a push in this more energetic direction.

Males have more sweat glands and can dissipate heat faster than females. Women have a thicker layer of subcutaneous fat that acts as insulation and energy reserve. Consequently, they can withstand cold better and have better energy supply for activities requiring extraordinary endurance. Women have raised their performance in long-distance swimming, running, and other endurance sports until it is similar to that of males, which their physiology favors. But males retain a significant advantage in sports that require short bursts of strength, such as sprints.

Men, on the average, have larger windpipes and branching bronchi and 30 percent greater lung capacity taken as a percent of their respective body weights. Men also have relatively larger hearts and can pump a larger volume of blood. Males have 10 percent higher red blood cell counts, higher hemoglobin readings, and consequently higher oxygen-carrying capacity. They have higher circulating clotting factors including vitamin K, prothrombin, and platelets.[8] Their rapid clotting and higher basal metabolic rate leads to more rapid healing of wounds and bruises. Males have fewer sensory nerve endings in the skin and higher peripheral pain tolerance. This combination of traits may aid in encouraging males to be more active and to be risk takers.

Women, on the average, have more stored and circulating white blood cells. They have more granulocytes and B and T lymphocytes for fighting infection. They produce more antibodies faster and thus have a more rapid and effective response to infectious invaders. They will develop fewer infectious diseases and succumb to them for shorter periods of time.[9] Ethologists argue that for females caring for multiple offspring and interacting with other females and their offspring in social groups, where communicable diseases can spread rapidly, this is a particularly advantageous trait. Males who have been historically less involved in these activities but more involved in hunting, protection, building, war, etc., are more in need of a good wound-healing system.[10]

---

[7] A. Glucksman, *Sexual Dimorphism in Human and Mammalian Biology and Pathology* (Academic Press, 1981), pp. 66–75.
[8] *Ibid*., pp. 77–110.
[9] *Ibid*., pp. 77–85.
[10] J. Durden-Smith and D. Desimone, *Sex and the Brain* (New York: Arbor House, 1983), pp. 71–73.

The male digestive system functions at a higher pace. They have larger teeth, more salivary glands, more active gastric glands of the stomach. They are therefore more subject to ulcers. Their metabolic machinery converts more food to circulating energy and building blocks and less to fat. Their circulating blood sugar, cholesterol, and amino acids are higher. They eat more meat and protein and assimilate food faster. This perhaps accommodates the larger muscle mass that must be maintained. This is particularly true of young men still developing muscle. Males, however, often continue the protein and fat-rich diets well after the body-building years and years of high activity. The high levels of cholesterol and triglycerides then collect in blood vessel plaque, causing hardening of arteries and constriction of vessels. As a result, males are more at risk of heart attacks, strokes, hypertension, and related ailments such as headaches, ringing ears, and dizziness.

Women, whose metabolism favors fat storage, have more trouble eating enough to maintain their needed vitamin and amino acid requirements without putting on fat as well. There seems to be some relationship between a certain minimum level of body fat and fertility in women. Women athletes, body builders, or those who are particularly thin have higher levels of infertility.[11] It may be that a certain level of fat sufficient to carry the developing fetus and provide milk after birth is necessary before pregnancy will occur. This would be a logical, God-given feminine provision to prevent pregnancies during periods of unstable food supply or even famine. Today's emphasis on being thin may contribute to the concurrent high level of female infertility.

While both sexes have androgens and estrogens, these sex hormones are found in quite different concentrations in the two sexes. Males begin producing gonadal testosterone at about the sixth or seventh week of gestation. This has an immediate effect on all of the organ systems, such that heart rate, respiratory rate, red blood cell counts, and brain structure are already sexually divergent at birth. The male testosterone level is two to three times that of the female until puberty, at which time it becomes, on the average, fifteen times higher than that of a female. Females produce about twice the estrogen of males prior to puberty and eight to ten times the estrogen after puberty. Female estrogen varies considerably depending on the time of the menstrual cycle.[12]

All of the sexually dimorphic physiological traits mentioned above seem to be rather directly correlated with the level and ratio of these two sex hormones. In castrated males or estrogen-treated males, the red blood cell count, cholesterol level, clotting factors, basal metabolic rate, and many other factors decrease sharply to levels more like females. Likewise, in males with Klinefelter's syndrome (who have an extra X chromosome) and those with gonadal dysgenesis, where testosterone levels are more intermediate between males and females, physiological traits are intermediate. Such males with lower testosterone share females' longer life expectancies and better verbal than math scores on aptitude tests.[13] These data argue strongly for a biological rather than any cultural explanation for these sex differences.

---

[11] E. S. Gersh and I. Gersh, *Biology of Women* (Baltimore: University Park Press, 1981), pp 288–291.
[12] J. Stein, ed., *Internal Medicine*, 2nd ed. (Boston: Little, Brown, 1987), pp. 2331–2338.
[13] Glucksman, *Sexual Dimorphism*, pp. 66–86.

Sex differences present in all the organ systems across various mammalian species go far beyond the superficial anatomical characteristics necessary for reproduction. These differences are direct responses to the levels of circulating hormones, which differ significantly between the sexes. It is difficult to avoid the conclusion that these physiological differences predispose males and females to certain behavioral and aptitude leanings. The debate heats up considerably when we suggest that there are fundamental differences in the structure and function of the brain and nervous system that predispose the sexes to certain behaviors and capacities. Nevertheless, it would be very strange to find hormones affecting all other systems and not the nervous system.

III. Sex Differences in the Peripheral Nervous System

The ability to discriminate two simultaneous pin pricks placed at close proximity on the skin is called the two-point discrimination test. Using this type of test, researchers find that women, on the average, have a more acute sense of touch. Females have finer body hair, on the average, which is more easily moved and results in finer sense perception. Females, likewise, have more acute senses of hearing, smell, and taste.[14] It has been argued that females are generally more perceptive and aware of context. Perhaps their more responsive sensory system allows them to monitor their environment more completely and with more discrimination. Such a system would give women an advantage in child care and social interaction. They would be able to pick up subtle environmental cues, such as a baby's cry or cough, or telltale odors or sounds that might escape the less discriminating male system.

There have been reports that females have finer discrimination of color, particularly in the red end of the spectrum, can tolerate brighter lights, and see better in dim light, while men can read finer print and are better at night vision.[15] Again, advantages in color discrimination might aid females in detecting rashes or slight flushes in infants and children that might indicate fever or diseases. They might be better able to detect slight facial flushing of peers or spouse, which may indicate anger or other emotional upset. Studies suggest that females are better able to read the emotional content of faces such as anger, sadness, or fear.[16] These more acute senses may give females a general advantage in social interactions. If males have better ability to read fine print or in general discriminate detail on which they are focusing, it may have been an advantage while hunting, tracking, or in other historically male pursuits requiring good hand-eye coordination.

The preceding arguments are an attempt to identify the original purpose for such differing allocated capacities given our heritage as hunters or agrarian people. At the core of our survival is the ability to find food and reproduce, roles that were associated with men and women respectively in Genesis 3:16–19. Females have been concerned more heavily with infant care due to breast feeding, and males with provision of food. In support of this basic division of labor, God has given each sex special gifts to carry out its task. This is not to argue that these gifts should only find expression in child rearing in the case of women or providing and protecting in the case of men. Yet it is out of this God-given design that these gifts arose and flourished. While

[14] Durden-Smith and Desimone, *Sex and the Brain*, pp. 71–73.
[15] Glucksman, p. 100.
[16] M. McLaughlin and T. Shryer, "Men vs Women: The New Debate Over Sex Differences," *U.S. News and World Report*, August 8, 1988, pp. 50–58.

today's technology may have reduced the need for such rigid division of labor, the gender gifts and aptitudes remain.

IV. Differences in the Limbic System

The limbic system includes the hypothalamus and amygdala and several other nuclei of the midbrain and lower forebrain. It is the seat of drives and emotions. It controls and regulates many involuntary visceral responses such as digestive, respiratory, and circulatory activities. It controls our thermoregulation, including sweating and shivering. Drives like hunger, thirst, sex, fighting, and fleeing are modulated in the hypothalamus. When drives are satisfied, the hypothalamus stimulates the pleasure center. Drives are continually shifting and being prioritized by the limbic system. Behavioral response to these drives results when impulses build and present an appropriate target object.

The thresholds to set off responses in the limbic system differ between males and females. In males, testosterone stimulates the production of neurotransmitters in the hypothalamic area. This excess of neurotransmitters waiting in readiness in the synaptic areas tends to lower the threshold of response in males, such that less stimulation is required to set off behavioral responses to such things as food, sexual, or threat stimuli. Elevated estrogen in females has the opposite effect, inhibiting synaptic firings in the brain region and requiring more sensory and cognitive stimulation in order to elicit the same response.[17] This may explain male tendencies to be more reactive and quicker to act and to make decisions. It may also explain feminine patience and tolerance of more stimuli without reaction. These differences may explain the gender-specific reactions of males and females in sexual interactions. It may also explain why females are more patient with children.

Males of most species studied, including humans, appear to be more aggressive, dominant, assertive, and seekers of control. Some social science studies suggest that the degree of difference in aggressive tendency is slight and that the variation with the sexes is far greater than the difference in the means. They suggest also that much of the difference may reflect cultural expectations. Studies on animals, however, reveal a more complex picture of aggression. Moyer has done much research on the types of aggression manifest in various animals. He contends that there are actually seven different types of aggression that can be identified. Three of these are found primarily in males, one primarily in females, and three seem to be found equally distributed between males and females. Researchers have been able to identify and map specific regions of the brain that control these types of aggression, using electrical implants in cats.[18] The stimulation of predator aggression results in an individual's adopting a stalking stance with ears back, fur sleek, and head low. On the other hand stimulation of competitive aggressive response is characterized by ears up, fur standing on end, back arched, teeth bared, often accompanied by hissing and snarling. Competitive male aggression and territorial aggression are evoked in animals that are electrically stimulated in the preoptic area of the hypothalamus.

---

[17] B. McEwen, "Neural Gonadal Steroid Action," *Science* 211 (1981): 1303–1311.
[18] K. E. Moyer, *The Psychobiology of Aggression* (NY: Harper and Row, 1976), pp. 3–25.

In some animals, this area turns out to be eight times larger in males than females.[19] There are also more neurons and dendritic connections in the male preoptic area than in the female.[20] This enlarged male center has been reported in rats, cats, dogs, monkeys, and humans.

Predatory aggression is stimulated by centers in the amygdala. Males tend to have a larger amygdala and have more neural connections between the amygdala and other centers of aggression in the hypothalamus.[21] Intermale aggression appears to be a uniquely male trait, while predatory and territorial aggression appear to be stronger responses in males as well. One cannot be sure that because these centers are present in other animals they are also in humans; however, it is known that men have significantly larger preoptic areas and amygdalae than women, and it may be reasonable to assume that the cause of differences in human aggression do have a biological basis.[22] It may be, then that males gravitate to competitive sports, thrive better in a competitive business world, enjoy argumentation, etc., more than females. Males enjoy hunting and fishing more often, tend to collect and amass various resources from vintage cars to baseball cards to money, and may have more inclination to hoard. Among most higher mammals and human societies, it is the male that leaves the group during postpubertal maturing, while females stay in the group remaining bonded to their mother. The wanderlust and adventure-seeking disposition associated with young males may also have a biological basis. Males may simply have a predisposition to such behaviors due to larger centers for them with more neural connections as well as their lower threshold of stimulation in general. Castration of male animals reduces this behavior substantially and reduces the size of these centers and the amount of free neurotransmitters found in the area. Replacement of testosterone by injection restores normal size of centers and intensity of behavior.[23]

There is, then, a strong correlation between the amount of testosterone and the intensity of these behaviors. Among men there is a strong correlation between testosterone level and sexual activity and aggressive behavior. Juvenile delinquents and criminals incarcerated for violent crimes have, on the average, twice the level of testosterone found in the normal male population. (Of course, this does not excuse such criminal behavior or imply that it is unavoidable.) XYY syndrome men (having an extra male Y chromosome) have elevated levels of testosterone.[24] They are taller than average and have more problems with acne, but they are relatively normal in intelligence and other temperament characteristics. They are, however, more aggressive and twenty times more likely to have problems with the law. Men are more likely to be aggressive, assertive, confrontive, and reactive, not so much because of cultural expectation as because of their biological predispositions. The human male drive for power, wealth, fame, and resources may thus be rooted in hormones and brain differences.

Maternal aggression, described as females responding to impending danger or harm to their offspring, is common to mammals. This response, which is particularly strong during lactation,

---

[19] R. W. Goy and B. S. McEwen, *Sexual Differentiation of the Brain* (Boston: M. I. T. Press, 1980), pp. 109–111.
[20] A. P. Arnold, "Sexual Differences in the Brain," *American Scientist* 68 (1980): 165–173.
[21] McEwen, "Neural Gonadal Steroid Action."
[22] D. F. Swaab and E. Fliers, "A Sexually Dimorphic Nucleus in the Human Brain," *Science* 228 (1985): 1112–1114.
[23] Arnold, "Sexual Differences in the Brain."
[24] R. T. Rubin, J. M. Reinisch, and R. F. Haskett, "Postnatal Gonadal Steroid Effects on Human Behavior," *Science* 211 (1981): 1318–1324.

may be facilitated by prolactin, the hormone causing milk production.[25] It may also facilitate maternal instinct and bonding. This may explain why mothers are often more protective and aggressive in intervening on a child's behalf than fathers. Female-infant bonding appears to be innate. The baby's cries trigger involuntary responses in the mother such as oxytocin secretion, nipple erection, and pupil dilation. There are no such responses in males, and male bonding is likely a learned response.[26] Maternal instinct may be related to this center, which enhances bonding and protection of young. Such bonding may be important in later social development and learning skills.[27] Mothers show more stress when infants are cared for at day care or by multiple care givers than fathers. A mother may be better equipped to form this important bond due to centers in her brain. When cradling a baby, mothers tend to use the left arm, positioning the baby's ear over the aorta and strongest heartbeat. Babies likely imprint on the mother's heartbeat during gestation and derive comfort from it. We are now engaged in a large-scale experiment with significant numbers of mothers enlisting day care for their infants. We have relatively little information on the importance of bonding and maternal contact to social and intellectual development, but some reports suggest that it is an important factor.

V. Sex Differences in Cerebral Organization

In 1962, Roger Sperry published work on split brain patients for which he later won a Nobel Prize. Central to his work was the study of epileptic patients whose corpus callosum had been severed. The corpus callosum is the bridge of nerve fibers connecting the two cerebral hemispheres. Images on a projection screen presented to the right visual field of the eyes are transmitted to the left hemisphere of the brain. Images presented to the left visual field are transmitted to the right hemisphere. Sperry found that words or images easily described in words are perceived better from the right visual field and left hemisphere. Shapes, patterns, and abstract forms are better recognized if presented to the left visual field and right hemisphere. Through a process of such tests, the functions of the left and right hemispheres were characterized. The left hemisphere controls the right side of the body, written and spoken language, numerical calculation, logic, and reasoning. The right hemisphere controls the left side of the body and processes artistic and musical stimuli, visual spatial patterning, insight, imagination, and emotional responses.[28]

It became popular in the 1960s and 1970s to think of males as more leftbrain dominant and females as more right-brain dominant. This does not now appear to be a correct interpretation of this work. More recently it has been discovered that the lateral isolation of functions into one hemisphere or the other is more characteristic of males. Herbert Lansdell worked with a group of epileptics whose right or left hemisphere had been partially surgically removed. He found that men did poorly on verbal tasks if the right hemisphere was affected. Women suffered far less speech and verbal skill loss as a result of a damaged hemisphere. Women tend to be less lateralized, with verbal centers and visual spatial centers in both hemispheres and with much greater communication between the two hemispheres. Women, then, could identify words

---

[25] Moyer, *Psychobiology of Aggression*, pp. 3–25.
[26] Goy and McEwen, *Sexual Differentiation of the Brain*, pp. 109–111.
[27] K. Zinsmeister, "Brave New World: How Day-Care Harms Children," *Policy Review*, no. 44 (Spring 1988), pp. 40–48.
[28] G. J. Tortora and N. P. Anagnostakos, *Principles of Anatomy and Physiology* (NY: Harper and Row, 1987), p. 323.

flashed to either the right or left visual field more often than men. Likewise, they could identify abstract shapes and images relatively well from either visual field.[29]

Jeannette McGlone found that a shot of anesthetic administered to the right carotid artery (which supplies the right brain) would deaden only the right hemisphere for about thirty seconds before the anesthetic was pumped throughout the body and back to both hemispheres. She found that during this brief time, while the right hemisphere was deadened, males actually performed better on verbal tasks than with both hemispheres intact. When the left hemisphere was deadened, however, males had severe loss of verbal skill. Women had only slight loss of verbal skill when either hemisphere was disengaged.[30]

Sandra Witelson used dichotic stimulation tests to measure brain lateralization. She allowed subjects to touch briefly, simultaneously with both hands, a series of two dissimilar objects out of sight. Men identified the objects felt with the left hand while females more often identified both.

Doreen Kimura also used dichotic listening tests to measure brain lateralization. Through headphones, series of two different number words, like *two* and *nine*, were spoken simultaneously to the two ears. Men were able to report mainly words presented to the right ear (left hemisphere), while women could report numbers from both ears.[31]

Strokes result from blood clots or clogged arteries in the brain. They affect only one hemisphere or the other, depending on the artery involved. Aphasia, the loss of speech due to a stroke involving the left hemisphere, occurs much more commonly in men. Women are much more able to retain verbal skills or retrain their uninvolved hemisphere to take over.

Another observation that suggests that males are more asymmetrical in their cerebral hemispheres is that among most mammals studied, males have a slightly thicker, larger right hemisphere than left.[32] This is more pronounced early in life, and there is some likelihood that the left hemisphere in males is developmentally retarded by testosterone. Perhaps this helps explain why boys are far more likely to suffer from dyslexia, as well as reading, speaking, and spelling deficiencies in early grades. They are more likely to stutter during early development as a result of a conflict between the right and left hemisphere for control of speech.[33] While the left hemisphere begins to catch up during later development in males, even in adulthood brain asymmetry is more likely among males than among females. In general, females have a larger brain relative to their body weight than males.[34]

It was found that the bridge of nerve fibers or processes between the two hemispheres known as the corpus callosum was significantly larger and contained more nerve fibers in females. This

---

[29] Durden-Smith and Desimone, pp. 62–74.
[30] J. McGlone, "Sex Differences in Human Brain Asymmetry: A Critical Survey," *Behavioral and Brain Sciences* 3 (1980): 21–263.
[31] Sandra Witelson and Doreen Kimura's work is summarized in Durden-Smith and Desimone, pp. 62–75.
[32] McGlone, "Sex Differences in Human Brain Asymmetry."
[33] Durden-Smith and Desimone, p. 162.
[34] Gersh and Gersh, *Biology of Women*, pp. 153–154.

difference was found at all ages of females.[35] Embryonic nerve cells grown in cell culture produce more dendritic processes in the presence of estrogen than in the presence of testosterone.[36] They also make connection with more neighboring cells. This fact may explain why there are more nerve fibers or processes through the corpus callosum connecting the two hemispheres. The female central nervous system may have more interconnections and more networking of nerve fibers.

It appears from all of the above data that women are generally capable of receiving and meaningfully processing more sensory nerve input. Because their nerves interact with more neighboring nerves, they are able to integrate more sensory and stored memory information to derive more complete analysis and assessment of a particular circumstance. It has been suggested, as an example, that if a male and female were both interviewing a potential new employee, the male might become very focused and engrossed in his line of questioning and the accuracy or clarity of responses, while a female would not only process the conversation but also the mannerisms, facial expressions, facial color, dress, hygiene, and many other cues to personality and temperament. The woman would come away from the same one-hour interview with a much more in-depth and complete assessment of the candidate and his suitability for the job. This might in fact be what has for years been called women's intuition. It may be simply women's ability to process, evaluate, and respond to more immediate simultaneous stimuli. A biological argument for the purpose of this ability of females to capture more stimuli would be that in the role of childrearing there is great advantage in being able to receive and process multiple stimuli in order to monitor multiple children and other social contacts. This may also explain my wife's ability to spot Neil's intentions to walk into our busy street while she is busy with other tasks in the house, or to anticipate Nate's lunge off the counter. It may explain how she is able to talk on the phone, write me a note, and continue to mix the appropriate ingredients into her batch of cookies, all at the same time. This kind of simultaneous activity appears to be more difficult for men.

Males, with their more lateralized brains, tend to have thought-processing more regionally isolated and discreet, with fewer interconnecting nerve interactions and perhaps more straightforward, quick reactions to important stimuli. This would be a strategy more conducive to the hunter, tracker, and builder. It may also be conducive to categorical thinking. It could allow more uninterrupted processing of visual/spatial data in the right hemisphere and computational analysis in the left, which could lead to a slight math advantage in males. The more lateralized male brain would be expected to be more single-minded, focused, less distractable, and perhaps less socially aware. This, coupled with the hot-wired limbic system, may increase males' competitive, goal-setting, rule-making, hierarchical approach to social interaction.

Aptitude tests have for years revealed that, on the average, girls perform better than boys in verbal skills and boys perform better than girls in math and visual-spatial skills. Camillo Benbow and Julian Stanley found that of forty thousand junior high students tested, two hundred sixty of

---

[35] Christine de Lacosta-Utamsing, "Sexual Dimorphism in the Human Corpus Callosum," *Science* 216 (1983): 1431–1432.

[36] C. Dominique Toren-Allerand, 1978, "Gonadal Hormones and Brain Development: Cellular Aspects of Sexual Differentiation, *American Zoologist* 18:553–565.

the top two hundred eighty scoring over seven hundred on the SAT-M were male.[37] She suggested that there may be a biological basis for this. The prevailing explanation for such data has been cultural discrimination in education against mathematically inclined girls. This may in part be true, yet there may also be biological reasons for masculine superiority in this area. Girls generally do better in math up through the gradeschool years. Girls probably are developmentally ahead of boys through these years and particularly ahead of them in left-hemisphere tasks, which include computational math. Boys begin to surpass girls in math after the involvement of geometry and algebra and more abstract problem solving, which may invoke thinking with the right hemisphere. Furthermore, this male advantage does not become pronounced until after puberty. In tests of seventh-grade boys, postpubertal boys (who would have a sharp increase in testosterone) outperform prepubertal boys, on the average. Test scores of prepubertal boys improve after puberty. Girls with abnormally high testosterone levels due to hyperactive adrenal glands score more like boys on aptitude tests.[38] XXY boys and other males with low levels of testosterone score more like girls.[39]

VI. Sex Differences at Birth

A common response to these apparent biological sex differences is that brain structure and functional differences arise as a result of different learning environments and strategies between girls and boys. There is evidence that nurture and learning affect brain development. Rats raised in stimulus-enriched environments developed larger cerebral cortexes than stimulus-impoverished rats.[40] Rats that are continually paired with submissive rats and learn to win their conflict interactions develop elevated testosterone levels and resultant physiologies.[41] Yet there is also evidence that these differences are present at birth. Female infants have been noted to orient and fix their focus more often on faces, are comforted by voices and touch, and vocalize more often than boys. They respond earlier to smells and sounds. Female infants, on the average, learn to talk sooner and, when learning to draw, tend to draw people subjects. Male infants orient more to objects, lights, and toys, and are comforted more by patterned mobiles and ticking clocks. They develop speech later, draw objects more than faces, and learn three-dimensional drawing faster. Among infant brains studied, males more often show hemispheric asymmetry with a smaller left hemisphere. The female corpus callosum is larger in infants and their preoptic area of the hypothalamus is smaller.

Another line of evidence that suggests that differential male and female mental attributes have some innate biological basis comes from the various sexanomalous syndromes that occur naturally. Males with lower testosterone levels score lower on visual/spatial tests. XYY males have higher-than-average testosterone and score higher in visual/spatial skills and lower in verbal than average males. Females with Turner's syndrome (with only one X chromosome and

---

[37] C. P. Benbow and J. C. Stanley, "Sex Differences in Math Ability: Fact or Artifact?" *Science* 210 (1980): 1262–1265; also, C. P. Benbow and J. C. Stanley, "Sex Differences in Mathematical Reasoning Ability: More Facts," *Science* 222 (1983): 1029–1033.
[38] McLaughlin and Shryer, "Men vs Women," pp. 50–58.
[39] Durden-Smith and Desimone, pp. 86–88.
[40] M. R. Rosenzweig, E. L. Bennett, and M. C. Diamond, "Brain Changes in Response to Experience," *Scientific American* 226(2) (1972): 22–29.
[41] K. J. Flannelly, R. J. Blanchard, and D. C. Blanchard, *Biological Perspectives on Aggression* (New York: Alan R. Liss 1984), pp. 207–260.

extremely low testosterone and estrogen) actually score better on verbal tests than the average female, but much poorer on visual/spatial. These individuals appear in most characteristics like normal girls and are raised that way. Often only at or near puberty is their condition recognized, when they require estrogen administration in order to develop normal secondary sex characteristics. It has been noted that Turner's syndrome females are particularly drawn to traditionally female pursuits, such as care and teaching of children and occupations involving more intensive use of their verbal skills, such as typing, word processing, and taking dictation.[42]

Men whose mothers were treated with diethylstilbestrol (DES), a synthetic estrogen, during pregnancy are less aggressive, less athletically coordinated, and less given to traditionally masculine interests.[43] Women whose mothers were given androgens during pregnancy to avoid miscarriage tend to be more masculine in their behavior. They are tomboyish and energetic and score more like boys on aptitude tests. In general, then, gender behavior and aptitudes follow more closely the hormonal make-up of an individual (and the hormonal influences of his or her mother during gestation) than whether the individual is a male or female. And certainly hormones are a more reliable predictor of gender-related behavior characteristics than cultural persuasions.

VII. Sex Differences in Stress Management

Biologists in the 1960s and 1970s raised concerns that humankind did not have the well-established inherent population control mechanisms exhibited in most higher animals. Since predators, disease epidemics, and famines had been brought under control, it seemed that the only way to control our reproduction was through educated family planning. This was the genesis of the zero population growth (ZPG) movement. More recently, however, we have discovered that human beings react much like other animals in response to stresses in our environment. Animals face long-term stress primarily when food or other resources are in short supply, or when populations are too dense. After long-term stress, higher social animals often react with these types of responses: (1) heightened aggressive behavior, particularly among males, often resulting in fighting and death, (2) elevated abuse and even eating of young, (3) homosexual behavior, (4) miscarriage of and reabsorption of fetuses, and (5) discontinuance of ovulation and infertility.[44] By many measures, human beings in modern societies are living in stressful conditions. Many of the same behavioral anomalies we see in animals have begun to manifest themselves in the human population.

Both animal and human males and females respond differently to stress, and herein lies another important difference in gender behavior. In both males and females, stress initially elevates adrenalin output, which in turn affects the hypothalamus to increase heart rate, blood pressure, basal metabolic rate, and responsiveness of the senses. Under initial pressure both sexes are able to put in long days, stay alert, and remain energetic. After a period of prolonged chronic hyperadrenalin, females begin to produce more cortisol and estrogen. Cortisol reduces the brain neurotransmitter serotonin, which is needed to maintain normal sleeping and waking patterns. It reduces norepinephrine, which is needed for a normal sense of well-being, leading eventually to

[42] Durden-Smith and Desimone, pp. 86–88.
[43] *Ibid*., p. 127.
[44] *Ibid*., pp. 135–151.

a sense of ambivalence and even depression. Estrogen in high amounts acts as a sedative to quiet the system. It reduces heart rate, respiratory rate, and blood pressure. After a prolonged stressful time under the influence of estrogen, women may become depressed. In various studies, women are found to struggle with depression, phobias, hysterias, anorexia and other depression disorders four to ten times more commonly than men.[45]

Men respond initially to stress in the same way as females. A burst of adrenalin incites a male to meet stress head on and overpower whatever the obstacles. When stress becomes chronic, the masculine system begins to enhance the aggressive adrenalin response by gradually increasing the level of testosterone. This androgen compounds the affects of adrenalin by lowering the neurotransmitter thresholds of the hypothalamus such that the whole male system becomes hyper-reactive. Reaction time decreases, while aggressive and sexual behavior are more easily provoked. Heart rate, blood pressure, clotting factors, cholesterol, and platelets increase. Men are able to maintain their elevated energy level perhaps longer than women under stress. They pay the price, however, of having higher levels of heart attack, hypertension, strokes, and other cardio-vascular problems. Their resistance to infectious diseases is diminished also. This, along with their higher basal metabolic rates in general, results in a shorter male life span, on average.

Some biologists argue that in social settings of early civilizations, where women were likely to band together to care for children and common household chores, depression served a purpose. It was an important nonverbal communication signal to other women in the social group of a need or problem. It often resulted in a corporate response from the small social group. Today, with the fragmentation of the family and with more working women, there is little remnant of these small kinship-based social groups to respond to needs. Depression smolders unnoticed or without meaningful response until it becomes clinically debilitating.

The male system of stress response (i.e., to go into overdrive) functioned well for males of hunting/gathering societies, whose stresses often meant higher energy output, which burned up the excess cholesterol and blood sugars. Today's male stress, however, is often more mental than physical, and these physiological changes are actually a health risk. It is then particularly advantageous for males to get regular exercise in order to offset this phenomenon.

Men and women respond differently to stress, and they are stressed by different environmental factors. By virtue of their gifts in language, their more networked nervous system, their acuity of perception, and their patience, women are more comfortable with and gravitate to social interaction and communication. They have physiologies and temperament traits that prepare them uniquely for child care. Their maternal instincts and bonding facility are stronger. Breeches of relationships, especially within the family, are particularly stressful for females. Inability to have children or to provide basic needs for a child are also common sources of feminine stress. Women need a sense that their social sphere of significant others is intact. They find fulfillment in caring for others and meeting needs. According to Willard Harley, women are stressed and vulnerable to an extramarital affair when one of these five needs is not met in their

[45] E. O. Wilson, *Sociobiology* (Cambridge, MA: Harvard University Press, 1980), pp. 42–43.

marriages: (1) need for affection, (2) need for conversation, (3) need for honesty, (4) need for minimal financial well-being, and (5) need for family commitment.[46]

Men appear to be more stressed when frustrated in goal achievement or when they feel a lack of control of their surroundings. They are stressed when frustrated in sexual fulfillment or when they sense a lack of support or respect from their wife and family. Harley proposes five reasons why a man would violate his marriage and seek fulfillment in an affair: (1) lack of sexual fulfillment, (2) lack of recreational companionship, (3) lack of an attractive spouse, (4) lack of domestic support, and (5) lack of admiration.

Men and women have different gifts and perhaps different needs. Men need a sense of accomplishment and achievement in goals. Women need a sense that their important social ties are healthy. I believe the admonition in Ephesians 5:28–32 for husbands to love their wives and wives to respect their husbands reflects a deep, important need of each sex. Men, who by nature are more assertive, who arrange their social organization hierarchically, and who seek to elevate their level of control and respect, can find fulfillment and daily stress relief through the admiration of a wife who respects her husband. A wife needs to have a sense of complete and healthy relationships with all of her significant social members. She needs an outlet for her nurturant urges and a sense of fulfilled communion. At the center of her social relationships is her husband and her family. She is then most fulfilled by the love, reception, and recognition of her husband and family.

These gifts and needs are by no means expressed and fulfilled only within marriage. Aggressiveness, nurturance, empathy, and verbal and visual/spatial gifts are all essential to a healthy society. My intent is not to suggest that individual fulfillment is dependent on marriage. I think, however, that males and females have been differently gifted in God's plan because of their historic roles in feminine child rearing and masculine provision and protection for the family.

Conclusion

Are we as men and women different? The evidence presented here suggests that we have some fundamental physiological and neural differences that are present at birth and predispose us toward certain behaviors dependent on gender. We should not conclude automatically that because men and women may have different gifts, traditional roles are the only way they may be expressed. Yet it seems very significant that these different gifts correspond very well to the different roles given to men and women in Scripture (see other chapters in this book). These unique abilities, coupled with the traditional roles, have served mankind well and enabled us to fulfill the commission to multiply and fill the earth very efficiently. It may well be that along with the fundamental division of labor in marriage referred to in Genesis 2–3, God gave the necessary gifts to uniquely accomplish those tasks.

Our culture has changed, and the demands for traditional roles may have varied, yet our basic, God-given physiological differences have not. We excel at different gifts, and all the gifts are needed. Let us hope that, by recognizing the existence of gender differences, we can better

[46] Willard Harley, *His Needs, Her Needs* (Old Tappan, NJ: Fleming H. Revell, 1988).

understand each other and help to maximize each other's potentials. Likewise, by accepting our God-given gifts, we can resist cultural pressures to become what we are not, to seek to master gifts we don't possess.[1]

[1] Gregg Johnson, "The Biological Basis for Gender-Specific Behavior," in *Recovering Biblical Manhood & Womanhood: A Response to Evangelical Feminism*, ed. John Piper and Wayne Grudem (Wheaton, IL: Crossway, 2006), 280–293.