

Background

HOW THE BRAIN LEARNS

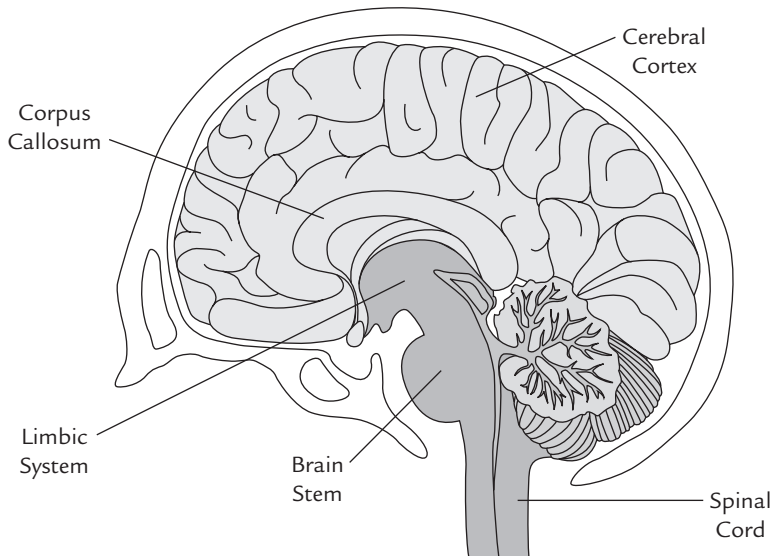
THE HUMAN BRAIN HAS ONE HUNDRED BILLION NEURONS AND ONE HUNDRED TRILLION connecting cells. An adult brain is approximately four to eight pounds of dense matter in three major layers: the *cerebral cortex* at the top; the *limbic system* in the middle; and the *brain stem* at the bottom, connecting with the spinal cord. The brain grows from the bottom up, the upper limbic system and the four lobes of the cerebral cortex (neocortex) developing later than the lower limbic system and brain stem.

In general, the three layers of the brain are known for distinct functions, although all functioning areas of the brain constantly interact.

The *brain stem* is where fight-or-flight responses are harbored. This most primitive part of the brain is essential for survival.

The *limbic system* generally is where emotion is processed. A sensory stimulant comes into the brain through the eyes, ears, skin, or other organs, and the person experiences an emotive response to it. Although some aggressive responses are brain-stem responses, others come from the limbic system as well—specifically from the amygdala, which lies at the bottom of the limbic system, just above the brain stem.

The four lobes at the top of the brain are where thinking generally occurs. In each lobe, different sensory stimulants are processed. Certain cortices in the top of the brain (for example, the prefrontal cortex) handle the majority of moral and



other decision making. The top of the brain is divided into the left and the right hemispheres. The left is primarily associated with verbal skills—speaking, reading, and writing—and the right is primarily associated with spatial skills, such as measuring, perceiving direction, and working with blocks or other objects.

When a child is learning the implications of a novel or how to do math, the top of the brain generally is involved, although emotional responses often occur, especially if the student has an emotional reaction to the content of the lesson. In this way, the neocortex and the limbic system work together. Examples of emotional reactions are “I feel sympathy for Hester Prynne” and “I can’t do this; it’s too hard.” The emotive response in the limbic system can slow down or shut off most thinking in the top of the brain. In neurological terms, a child who thinks she can’t do something might fulfill her own thinking; during the crisis of esteem, her blood flow remains heavily in the middle of the brain, not moving up to the thinking centers.

Inherent Differences Between Boys’ and Girls’ Brains

Researchers, such as Laurie Allen at UCLA, Ruben Gur at the University of Pennsylvania, and Camilla Benbow at the University of Iowa, have discovered structural and functional differences in male and female brains and gender-different

approaches to learning and living that result primarily from brain differences, not environmental forces. Their research has been corroborated worldwide.

Boys and Girls Learn Differently! helps teachers become aware of how the brain learns in general and how boys' and girls' brains learn differently. With this understanding, teachers can help children accept their differences and celebrate their natural strengths. They can also aid them in compensating for their natural weaknesses.

Differences between girls and boys are not evidence of gender superiority or inferiority. There are some things boys tend to be better at than girls, and vice versa. Of course, there are exceptions. Brain differences are best understood as a spectrum, rather than as female and male poles. There are also "bridge brained" children, who have nearly equal qualities of male and female characteristics. Their brains are the most "bi-gender."

Developmental and Structural Differences

Most females' brains mature earlier and more quickly than those of males. Brain development in infants is often most pronounced in the right hemisphere and gradually moves to the left. The movement starts earlier in females than in males. Girls may acquire complex verbal skills as much as a year earlier than boys do. Often, a preschool girl reads faster and with a larger vocabulary, and speaks with better grammar, than does a preschool boy.

One of the last steps in the brain's growth occurs as the nerves that spiral around the shaft of other nerves of the brain are coated with myelin, which allows electrical impulses to travel down each nerve quickly and efficiently. An older child is generally more developed than a younger one, in large part because of myelination. Myelination continues in all brains into the early twenties, but is complete in young women earlier than in young men.

The corpus callosum is the bundle of nerves that connects the right and left brain hemispheres. It is up to 20 percent larger in females than in males, giving girls better cross-talk between the hemispheres. There is more (and quicker) development in females than in males in the prefrontal lobes, where regulation of emotion finds its executive decision making, and the occipital lobes, where sensory processing often occurs.

Girls take in more sensory data than boys do. On average, they hear better, smell better, and take in more information through the fingertips and

skin. Females tend to be better than males at controlling impulsive behavior. They tend to self-monitor high-risk and immoral conduct better than males—especially if the boys and girls are equally untrained in ethics or impulse control, so girls are less likely to take moral risks than boys. Boys are more likely to show physical aggression.

Girls tend to have better verbal abilities and rely heavily on verbal communication; boys tend to rely heavily on nonverbal communication, being innately less able to verbalize feelings and responses as quickly as girls.

Males tend to have more development in certain areas of the right hemisphere, which provides them with better spatial abilities, such as measuring, mechanical design, geography, and map reading.

Chemical and Hormonal Differences

Males and females have different amounts of most brain chemicals. The male brain secretes less serotonin than the female brain, making males more impulsive and fidgety. The crying of a child stimulates secretion of oxytocin in the female brain to a far greater degree than in the male brain. Oxytocin is one of the brain chemicals that, being more constantly stimulated in females, make the female capable of quick and immediate empathic responses to others' pain and needs.

Males and females possess all human hormones, but females are dominated by estrogen and progesterone, and males are dominated by testosterone. These hormones have contrasting effects. Progesterone is a female growth hormone and the bonding hormone. Female hormonal levels vary with the menstrual cycle and other circumstances (for example, hearing a child cry, seeing another person suffer, being pregnant, competing), making females' moods swing. Testosterone is the male growth hormone and the sex-drive and aggression hormone. Males receive five to seven surges of testosterone every day, beginning in prepuberty (around age ten). During these, hormonal flow can make their moods vacillate between aggressive and withdrawn.

A girl may be likely to bond first and ask questions later. A boy might be aggressive first and ask questions later. A girl is likely to try to manage social bonds in a group situation through egalitarian alliances, but a boy tends to manage social energy by striving for dominance or pecking order.

Scientists long believed that the human reaction to stress was “fight or flight,” but most stress research had been done on males. A UCLA study—reported by Taylor, Klein, Lewis, Gruenewald, Gurung, and Updegraff in 2000—suggests that part of a woman’s response to stress is oxytocin, which buffers the fight-or-flight response and causes her to tend to children and gather in friendship and collaboration with other women. During these acts, more oxytocin is released, which further counters stress and produces a calming effect. This calming response does not occur in men, because testosterone, which stressed men produce in high levels, seems to reduce the effects of oxytocin. Estrogen seems to enhance it.

Hormones also influence learning ability. For instance, when her estrogen is high, a girl scores higher on both standardized and in-class tests than when it is low. When a boy’s testosterone is high, he performs better on spatial exams, such as math tests, but worse on verbal tests.

Hormonal levels vary in both boys and girls. Some boys are high-testosterone (very aggressive, socially ambitious, striving for dominance, heavy in muscle mass). Some boys are low-testosterone (more sensitive, softer in appearance and manner). By adulthood, males can have six to twenty times more testosterone than females. When both males and females compete, their testosterone levels go up, but because males have much higher testosterone, they tend to be more aggressively competitive than females. Females can increase their testosterone by competing more. Women who received testosterone in clinical tests become more independent, socially ambitious, and aggressive.

Functional Differences

Boys use the right hemisphere of the brain more, girls the left. Boys move more emotive material down from the limbic system to the brain stem, where fight-or-flight responses are stored; girls move more of it upward to the upper brain, where complex thought occurs. Ruben Gur has used brain-imaging techniques to show that the resting female brain is as active as the activated male brain. The female brain uses its resources quickly and often and in more places. Therefore, the female brain has a learning advantage.

Quite often a girl’s response to a situation is more complex than a boy’s. Males tend to manage stimulants with more of what is called “task focus.”

Because the male brain is not as activated in as many places, it becomes overwhelmed by stimulation more quickly, causing it to decide on the importance of stimulants for their necessity to a task. A lot goes untouched by the male brain because it does not attend to those things, preferring to manage stimulation by “sticking to a plan.” The advantage in this is a quick, direct route to a goal. A disadvantage is that if the task goes badly or failure emerges, the male has fewer resources to redirect himself.

Two areas of greater functioning in the female are memory and sensory intake. Two areas of greater functioning in the male are in spatial tasks and abstract reasoning. Boys have the edge in dealing with spatial relationships (such as objects and theorems); a girl’s brain responds more quickly to a greater quantity of sensory information, connecting it with the primacy of personal relationships and communication.

Girls can store, for short periods, a greater quantity of seemingly random information; boys can do this more often if the information is organized into some coherent form or has specific importance to them. Boys can store trivia for a long time better than girls can.

Females react acutely and quickly to pain, but their overall resistance to long-term discomfort is stronger than is males.

There is strong evidence that males and females taste things differently. Generally, females are sensitive to bitter flavors and prefer high concentrations of sweet things. Males are attracted to salty flavors. The female’s nose and palate are more sensitive than the male’s. Olfactory sensitivity increases in males when they are around females who are about to ovulate.

➡ *Adapting to Hearing Differences:* Because females are able to hear better than males, sometimes a loud voice is needed for boys. This makes an interesting case for keeping boys near the front of the classroom.

➡ *Adapting to Visual Differences:* Males and females see things differently. Females are generally far better at seeing in a darkened room, whereas males see better than females in bright light. This suggests how teachers should arrange their students in terms of distance or closeness to visual learning aids.

Another intriguing difference applies to teaching music and choir. Six times as many girls can sing in tune as boys.

Differences in Processing Emotion

Brain-based research shows us that processing emotion is an area in which boys are more at risk for missed learning and processing opportunities. The female brain processes more emotive stimulants, through more senses, and more completely than does the male. It also verbalizes emotive information quickly.

When sensory information laden with emotive content comes into the female limbic system, brain activity may move quickly into the four lobes at the top of the brain, where thinking occurs. This makes a female more likely to process hurt and talk about it with others, since more of her activity moves up to the hemispheres that verbalize and reason over the crisis. In this way, females are emotionally tougher; they cry or talk about their distress.

In similar conditions, the male brain seems to move information quickly toward the bottom of the limbic system (the amygdala) and the brain stem, so the male is likely to become physically aggressive or withdrawn (fight or flight). The male's response short-circuits intellectual and academic learning because his emotive processing takes longer and involves less reasoning; in addition, less of his emotional crisis-response neural firing is in the top of the brain, where learning is occurring.

Boys can sometimes take hours to process emotively (and manage the same information as girls). This makes males more emotionally fragile than we tend to think they are. A boy who has had a crisis at home may come to school with a higher stress hormone (cortisol) level than his sister because he has held in, not processed, the emotional stress of the crisis. He may be unable to learn for much of the morning, whereas his sister may quickly process and talk out the stress so that she can learn efficiently. The boy often cannot guide his own emotional processing, especially through words.

Girls are fragile in that they often take things personally. Because girls process more emotive information, they may become overwhelmed by the emotional material.

Of course, there are exceptions to this scenario. Many girls become aggressive and shut down after a crisis, and many boys can shut off their emotions and get to work. However, if we see children who are having trouble learning because they do not have the emotive skills to process feelings quickly or in healthy ways, we must intervene to help them move the emotive information upward. This does not just mean "talk it out," because emotionality is only partially about using words.

Why There Are Differences Between Male and Female Brains

A Brief History of Brain Differences

Until about ten thousand years ago, when the agricultural age arose in many parts of the world, human males were hunters (a very spatial occupation), protectors, and warriors (very aggressive occupations). Females gathered vegetation and cared for children (sensory and verbal occupations). Males built most of the large structures, forming large teams to carry out action. Females did more work inside the structures, arranging and managing home spaces. They worked and verbalized in pairs, triads, and intimate groups.

Females became better at verbal skills; males became better at spatial and more physically aggressive. Females had to care more about small-group consensus; males had to rely more on hierarchies with dominant leadership. Females had to use all their senses and remember variety among things in order to provide child care; males had to focus on single tasks to provide for and protect their communities. Over time, their brains and brain hormones—catalysts for brain activity—came to differ with gender.

The differences exist even in utero (for example, male babies tend to be aggressive, kicking the mother more). Socialization enhances these tendencies in many cultures. In small tribal cultures in which competition for resources within a community is not strong, everyone works together closely, and there are few—if any—wars with other tribes, there are fewer gender differences. In cultures with larger populations where there is great competition for resources, family units are increasingly independent of one another, and conflict with other cultures is a threat, there are more gender differences.

In some ways, boys and girls are becoming more alike (boys are learning to verbalize feelings better, and girls are learning to compete better on athletic and work teams), but they are also becoming more different. More males are born with high testosterone; more females are born with high estrogen and progesterone. Solutions to the problems being experienced in schools involve helping both the more androgynous children and the more gender-different.

Hormones in Utero and at Puberty

All fetuses start out female. In the first trimester of pregnancy, surges of testosterone from the mother's ovaries create the male. One set of surges compels the genitals to drop pelvically and become the penis and testicles. Another wires the brain toward male structure and functioning.

During puberty, when surges of testosterone, estrogen, progesterone, prolactin, and other hormones occur, the brain changes toward increased genderization. In both sexes, surges of testosterone swell the amygdala (the part of the limbic system that generates feelings of fear and anger). This is especially pronounced in boys, which explains the rise in aggressiveness seen in both sexes at adolescence, especially in males, who become high-risk. Increased estrogen at puberty causes sudden growth of the hippocampus, the part of the brain that focuses on memory. The hippocampus in girls grows larger than in boys—one reason that females are better than males at remembering things such as names and faces in social relationships. Hormones change a teenager's sex drive, along with many other attitudes and behaviors, such as irritability, aggressiveness, and moodiness.

Researchers have found that a shift in prenatal hormones can affect us in ways that may not become clear until later in life. Testosterone shapes centers in the brain that process spatial information. In studies of girls with congenital adrenal hyperplasia—a condition that causes the adrenal glands to make excess androgen (a testosterone-like hormone) during prenatal development—their brains were found to be permanently changed. They were more aggressive than their sisters and had better spatial skills (such as the ability to rotate objects in their minds or to imagine how pieces of a puzzle fit together). These girls were also more interested than their sisters in becoming “engineers and pilots.”

Hormonal and structural brain differences have profound effects on how males and females learn, act, and live. The following are a few examples.

PRESCHOOL AND KINDERGARTEN Preschool and kindergarten boys and girls often show distinct psychosocial styles, gravitate toward their own gender groups, and often play in their own natural gender roles. For example, little girls use dolls to play at having babies; little boys typically head for the area where the building blocks are. The girls wait more patiently than the boys.

ELEMENTARY SCHOOL Boys and girls become fixed in their gender identities in elementary school, usually by about the fourth grade. Girls typically appear to develop learning abilities with more flexibility and have less trouble than boys do. Ninety percent of elementary school teachers are female, and 99 percent of these have not been trained in how boys and girls learn differently. If structural mistakes in classrooms are being made, girls—learning in a female-oriented environment—can make natural adaptations more easily than boys.

Boys seem to be more impulsive and undisciplined than girls. Reading and writing are hard for a lot of boys. More boys than girls are underachievers, many are unable to focus, and many are diagnosed as having learning disorders.

MIDDLE SCHOOL A middle school-aged child experiences a variety of insights and stresses. There is massive growth of the brain’s cognitive and abstract skills in the neocortex. The body experiences puberty, moving with the brain from childhood to adulthood. Boys begin to act and think more like young men, and girls begin to act and think more like young women.

HIGH SCHOOL High school is a time of refinement for all students, in both brain and gender development. In the brain, myelination of cells continues through the early college years. Development in the prefrontal cortex continues at least until college age, with female prefrontal growth moving a little more quickly than male. For the physical or psychological late-maturer, the first two years of high school are developmental years like middle school, and these students are especially tender. For nearly all high school students, the last two years are when intense mentoring in “gender symbiosis” (how females and males can relate in society harmoniously) is required.

How Brain-Based Differences Affect Boys and Girls

Learning-Style Differences

Worldwide brain-based research shows ten areas of difference. Teachers can apply knowledge of these differences in their classrooms, helping both male and female learning styles to flourish.

1. DEDUCTIVE AND INDUCTIVE REASONING Boys tend to be deductive in their conceptualizations, starting their reasoning process from a general principle and applying it, or ancillary principles, to individual cases. They tend to do deductive reasoning more quickly than girls do; this typically has given them an advantage in fast multiple-choice tests, such as SATs.

Girls tend to favor inductive thinking. They tend to begin with specific, concrete examples and then build general theory, adding more and more to their base of conceptualization. It is often easy to teach them concretion, especially in verbalization and writing. Giving an example is often easier for girls to do than boys, especially early in the conceptualization process.

2. ABSTRACT AND CONCRETE REASONING Boys tend to be better than girls at being able to calculate something without seeing or touching it. Boys often do better than girls when mathematics is taught abstractly on a board. The female brain often finds it easier when it is taught using manipulatives and objects (for example, physical number chains).

Males like abstract arguments, philosophical conundrums, and moral debates about abstract principles; in general, the abstract is explored more by the male brain than by the female brain. Architecture and engineering, which rely so much on abstract design principles, are areas toward which the male brain has gravitated. Bridge-brain females often excel in industrial design and their spatial abilities often surpass those of many boys.

3. USE OF LANGUAGE On average, females produce more words than males. During the learning process, girls use more words; boys use fewer words and often work silently. There is more parity in word use in a female group. In a male group, one or two dominant or attention-seeking males may use a lot of words and the other males use far fewer.

Girls tend to prefer to have things conceptualized in everyday language with concrete details. They are not as interested in verbal obfuscation. Boys often find jargon and coded language (for example, from sports, the law, and the military) more interesting and tend to use coded language to communicate.

4. LOGIC AND EVIDENCE Girls are generally better listeners than boys, hear more of what's said, and are more receptive to details in a lesson or conversation. This gives them security in the complex flow of conversation and

less need to control conversation with dominance behavior or rules. Girls seem to feel safe with less logical sequencing and more instructional meandering.

Boys tend to hear less and more often ask for clear evidence to support another's claim.

5. THE LIKELIHOOD OF BOREDOM Boys are bored more easily than girls; it often requires more and varying stimuli to keep them attentive. Girls are better at self-managing boredom. This has a profound impact on learning. Once a child has become bored, he is likely to give up on learning and to act out in a way that disrupts the class and causes him to be labeled a behavioral problem.

6. USE OF SPACE Boys tend to need to use more space than girls do when they learn, especially at younger ages. When a girl and a boy are put together at a table, the boy generally spreads his work into the girl's space, not vice versa. This tendency can affect psychosocial dynamics. Teachers may consider the boys impolite or aggressive. In fact, they are often just learning in the way their spatial brains require.

7. MOVEMENT Movement seems to stimulate male brains and helps to manage impulsive behavior. Movement is natural to boys in a closed space, thanks to their lower serotonin and higher metabolism, which create fidgeting behavior. Girls do not generally need to move around as much while learning. The following are some examples of how teachers deal with children's need for movement.

➡ *Giving Boys Something to Touch:* Teachers often find that it helps a boy to play with something (silently), such as a Nerf® ball, while he's learning. He's moving, his brain is being stimulated, he feels comfortable, and no one else is being bothered.

➡ *Giving Boys Chores:* Many teachers find that boys who can't stop moving in class can be managed by putting them to work, for example, letting them hand out papers, sharpen pencils, clean the classroom, help other children with their work, or help the teacher to move things.

➡ *Modeling Clay and Doodling:* Rita Rome, an elementary school art teacher, deals with students' needs to fidget by having modeling clay available so that students can keep their hands busy while they look at her. The boys tend to need it more than the girls. When clay isn't appropriate because of the lesson, Rita gives the squirmy kids paper and pencils so that they can do something while listening. She finds that many children can listen better if they can make doodles.

➡ *Using Movement to Introduce Lessons:* In order to explain the concepts of realism and abstraction to third graders, Rita introduced them to the idea of a continuum. She had them place themselves physically on a tall-to-short continuum. The physical movement stimulated them as they placed themselves and made corrections. The following lesson went smoothly because the students understood the concept, and the movement involved gave them a break from listening.

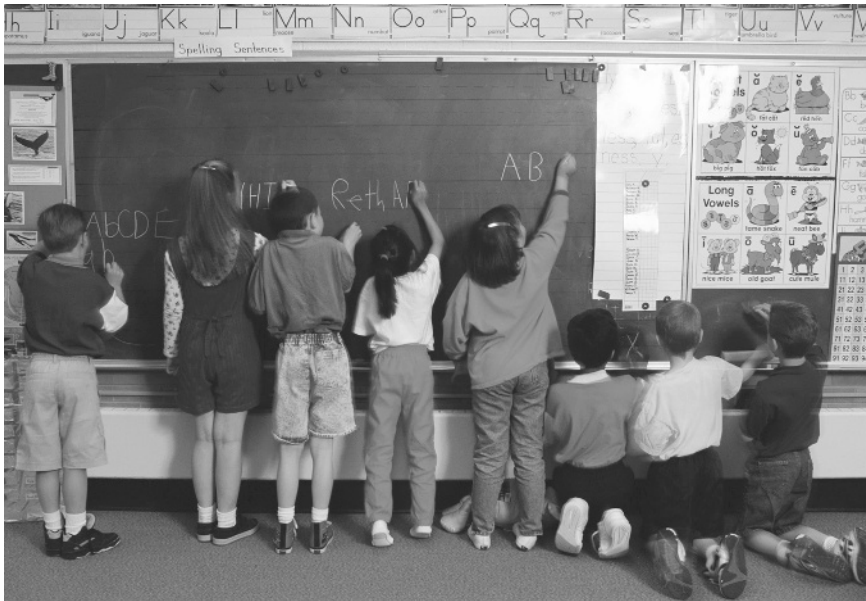
➡ *Breaks:* At all ages, stretch breaks and sixty-second movement breaks are very helpful. Chris Christopher sometimes has students in his high school math classes walk out one door of the classroom and back in the other to break up the day. He also gives periodic thirty-second or one-minute stretch breaks. He finds that the students' minds refocus on the subject better.

8. SENSITIVITY AND GROUP DYNAMICS Cooperative learning, which is good for all children, is often easier for girls to master. Girls learn while attending to a code of social interaction better than boys do. Boys tend to focus on performing the task well, without as much sensitivity to the emotions of those around them.

Pecking orders (social strata) are very important to boys; they are often fragile learners when they are low in the pecking order. Pecking order is established by physical size, verbal skills, personality, abilities, and other factors. Over the years of schooling, children flow in and out of many pecking orders and generally find themselves at the top in one part of childhood and at the bottom in another. Some children gravitate toward the top of large-scale pecking orders, such as "the most popular." Others gravitate toward the top of small-group pecking orders, such as the chess club.

New research indicates that girls who are not popular, not called on as much, or not seen or heard in general school life may be less likely to fail in school than boys who are not seen or not socially aggressive. Girls who are low in their pecking order often get better grades than boys who are low in their pecking order. Males on the high end of a pecking order secrete less cortisol; males at the bottom end secrete more. Cortisol can sabotage the learning process; it forces the brain to attend to emotional and survival stress rather than intellectual learning.

9. USE OF SYMBOLISM Both girls and boys like pictures, but boys often rely on them in their learning—mainly because they stimulate the right hemisphere, which is where many boys are more developed. Especially in upper grades, boys tend toward symbolic texts, diagrams, and graphs. They like the coded quality better than girls do. Girls tend to prefer written texts. In literature classes, teachers often find boys inclined to make a great deal out of the author's symbolism and imagery patterns, whereas girls ponder the emotional workings of characters.



10. USE OF LEARNING TEAMS Both girls and boys benefit from learning teams and group work, with boys tending to create structured teams and girls forming looser organizations. Boys spend less time than girls in managing team process; they pick leaders quickly and focus on goal orientation.

An example of using teams follows:

➡ *Lobbying for Art Selection:* Rita's students were asked to select pieces of art based on different theories of "What Is Art?" Seven hand-held symbols helped them, for example, a light bulb for "art can make you think," a teardrop for "art can make you feel." Teams were formed. Each was asked to agree on a piece of art (which represented the team's consensual theory) for its "new museum." The students presented their arguments to their teams, to try to persuade their teams to agree with their selections. The students enjoyed the opportunity to persuade others and learned about contributing and listening in a small group.

Learning Differences and the Intelligences

Howard Gardner has done research in the kinds of intelligence with which children learn.

Five types of intelligence best demonstrate male-female differences. A gender's dominance in an intelligence style often results, in part, from the other gender's brain hiding its ability in that style. The concealment is not conscious; the brain puts forth what it feels best at, leaving undeveloped (unless significantly aided) what it does not feel as good at. A brain formed toward one kind of intelligence probably never will be as good at another kind, but it can get better at all intelligences with proper stimulation. These differences indicate the need for changes in classrooms to accommodate different types of learners.

1. TIME AND SEQUENCE INTELLIGENCES There are three forms of intelligence in this category: remembering the *past*, connecting to the *present*, and anticipating what might come in the *future*. Each requires the ability to rapidly process and communicate sequential information in a timely, orderly manner.

2. **LINGUISTIC INTELLIGENCE** Linguistic ability usually lies mostly in the left hemisphere of the brain. Language ability is not the same as talking competence; although the two are related, silent self-talk is as important to the learning student as language used for communication with others.

3. **MUSICAL INTELLIGENCE** Music generally is processed in the right hemisphere, and rhythm is processed in the left hemisphere. Because it is a whole-brain activity, music can be a powerful influence in many aspects of classroom learning (for example, memorizing, expressing emotion, concentrating, and boosting self-esteem). Both males and females show increased musical development, especially at a young age, when they are musically stimulated. The theory of the “Mozart effect”—that playing complex classical music to babies increases development of both hemispheres—may be exaggerated, but it is accurate in terms of whole-brain development.

4. **LOGICAL-MATHEMATICAL INTELLIGENCE** An enormous range of brain energy and functions (including both hemispheres and the frontal lobes) are involved when brains deal with mathematics and logic, and many students find these subjects to be challenging. Boys are dominant in logical-mathematical intelligence, relying on it more than girls do. After two decades of effort to increase girls’ development in math, females are nearly catching up in most types of mathematics. Even though more girls than boys now take math and science classes, boys are still two to four points ahead of girls in math and science scores (according to the U.S. Department of Education), because the higher levels of calculus, chemistry, and physics involve spatial and abstract cognitives.

5. **SPACE-AND-PLACE INTELLIGENCES** There are two forms of space-and-place intelligences (the nature of space, our place in it, and how we navigate through it). *Spatial* intelligence consists of the tactile and visual abilities to perceive shapes and forms in one’s environment. Engineers and architects use spatial intelligence. Normally, spatial intelligence is found in the right hemisphere of the brain.

Bodily-kinesthetic intelligence is the integration needed to perform a large motor task, such as playing soccer. In this integration of brain functions, the basal ganglia (at the base of each hemisphere of the brain) coordinate the

sensory and motor systems. Simultaneously, the amygdala (in the lower limbic system) produces emotional triggers for movements. The motor cortex (connected above the inner ear in each hemisphere) helps coordinate the movements of each side of the body. The cerebellum (at the lower back of the brain) coordinates and fine-tunes automatic movement that allows the successful occurrence of an entire action.

Boys have an advantage in that they are active in their learning, are oriented to body movement, and self-stimulate their spatial abilities, thus increasing right-hemisphere development. A disadvantage is that some boys are in everyone's space when they learn, especially in the early grades, when they haven't learned to control their impulses. So they get in trouble for just being boys. It may be necessary to try to calm down spatial boys, but just as often, helping girls toward physical movement in class stimulates their cortical development in spatial intelligence, in the same way that calming boys down so that everyone can read quietly stimulates their left-hemisphere and linguistic development.

Teachers can help boys to learn by understanding normal male energy, allowing physical movement (from appropriate hugs and touch to getting dirty at recess), and directing normal male energy toward academic focus and good character.

Applying Brain-Based Gender Research

Understanding of innate gender differences leads to understanding of important changes needed in our schools. The following presents only a tiny portion of available research but includes all major categories.

Academic Performance and Classroom Behavior

On average, girls study harder for all courses than boys do, and girls choose to take the harder courses in middle school and high school at a higher rate than boys do. Girls receive approximately 60 percent of the As, and boys receive approximately 70 percent of the Ds and Fs. Among students performing in the top fifth of high school grade ranges, 63 percent are girls.

Boys tend to be louder, more physically aggressive, more competitive, and more prone to attention-getting classroom behaviors than are girls. Boys

goof off more, are louder, and naturally tend toward impulsive behavior, resulting in more teacher attention going to boys. Males tend to be less mature; females more considered. Girls are quieter in class, more passive than boys, and tend toward sedentary behavior. Females and males are even more different during puberty and adolescence, with many males seeking outward dominance and many females seeking inward excellence. Females also have longer attention spans than males and do not need, as often, to move inter-active classroom activity from one subject to the next through verbal dominance and attention strategies.

Although the effort to calm boys down and give girls attention in the classroom is essential, the ultimate standard for a classroom ought not be parity in loudness, raised hands, or dominance. It is better to treat each student with a clear sense of who he or she is and help the student find a personal mode of expression that fits his or her brain system. This is not what we are doing when we over-diagnose ADHD (attention deficit and hyperactivity disorder) and ADD (attention deficit disorder) and drug (mainly male) students with Ritalin.

Reading and Writing Competence

Girls are approximately one and a half years ahead of boys in reading and writing competence, at all school levels, according to the U.S. Department of Education. Boys are dominant in certain aspects of math and science, largely because of their brain structures. Because boys are so far behind in reading and writing, the focus ought to expand from just advocacy of math and science skills for girls to improvement in reading and writing for boys.

Test Scores

Boys score slightly higher than girls on SAT and other college entrance exams. The male brain is better at storing single-sentence information (even trivia) than is the female brain. The male brain holds a visual advantage in working with lists (as in multiple choice) and in making quick, deductive decisions on lists. The female brain thinks more inductively and often needs substantial information to make a decision. This puts the female at a disadvantage in testing that requires very quick decision making in a short time.

Including essay questions (where females hold the advantage), rather than using all multiple-choice questions (where the deductive male brain has the edge) on standardized tests—as the College Board has announced it will do on the SAT I—will help to reduce this gap.

Psychological, Learning, and Behavioral Disorders

Males and females typically experience different disorders, primarily for hormonal and neurological reasons.

More girls than boys experience overt depression and eating disorders in the teen years. The etiology of eating disorders is related to hormonal and brain chemistry, although stimulation of the disorder is often cultural. Females experience a menstrual cycle, with dominance by estrogen or progesterone, which males do not. For every one boy who *attempts* suicide, four girls do.

However, females are less likely to experience a learning, psychiatric, or behavioral disorder. The female brain, emphasizing left-hemisphere development, does not suffer as many attention problems. The female brain uses more cortical areas for more learning functions. If one area of the female brain experiences a slight defect, another makes up for it. Females also secrete more serotonin than males, so are less inclined to hyperactive disorder.

The male brain tends to lateralize its activity—compartmentalizing it in smaller areas of the brain—and, therefore, suffers more learning disorders. Two-thirds of the learning disabled and 90 percent of the behaviorally disabled are boys. They are nearly 100 percent of the most seriously disabled. Girls constitute only 20 percent of ADHD and ADD diagnoses and 30 percent of serious drug and alcohol problems, leaving 80 percent of brain disorders and 70 percent of substance-abuse problems (which indicate covert depression) to boys. For every girl who *actually commits* suicide, four boys do.

Because the male brain lateralizes, a defect in one area of the brain may affect the only area in which a particular learning function is taking place. Special education and alternative education are dominated by boys for this reason. Many boys are misdiagnosed as having ADHD, ADD, and learning disorders because we have not understood their brains or created classrooms that help them deal well with their natural impulsiveness, lateralization of brain activity, left-hemisphere disadvantage, and learning styles.

Both overt depression in girls and covert depression in boys occur, in large part, because we are not creating bonding and attachment communities in our classrooms and schools to the extent that growing children need.

Maturity, Discipline, and Behavior

The maturity gap between boys and girls, especially in the teens, is one of the most pronounced brain-based gaps and may be the most profoundly disabling feature of classroom life. It is the root of many behaviors labeled “defective.”

Female hormones mature earlier and guide the girl toward long-term emotional attachments at a time when immature male hormones may guide the boy toward short-term experimental attachments. When teenage intercourse results in pregnancy, it is usually the girl who drops out of school. Many teen mothers seek to care for children as part of their unmentored biological imperative. Ninety percent of fathers in their teens and early twenties abandon the girl and child. Lacking guidance and familial attachment, they seek new attachments.

The maturity gap between boys and girls affects girls in other ways, including harassment of pubescent girls by boys. Cultural and peer pressures to have sex too early affect both males and females.

More impulsive and less mature than the female brain, the male brain gets a boy into far more trouble in class and in school. Boys cause 90 percent of the discipline problems in school, constitute 80 percent of the dropouts, garner the majority of school punishment for immature behavior, and leave school at a higher rate than girls do.

The kind of classroom discipline that works for girls—often inconsistent, at times very friendly, and lacking profound authority—does not work so well for many boys in middle school and early high school. Male hormones are flooding, and many boys mature through elder dominance systems in which intense bonding and authority best manage them until they learn to manage themselves.

Educational Aspirations

Both male and female teenagers in the United States have profound fear of failure—to meet their parents’ demands and to compete in school and in the workplace. Boys fear failure more than girls do. The Department of Education

has found that, on average, eighth-grade and twelfth-grade girls have higher educational aspirations than boys. A nongovernmental study corroborated this: three-fourths of girls and only two-thirds of boys “believe they will have many opportunities available to them after they graduate” from high school. In fact, 60 percent of college students are female, and college graduation is the most consistent indicator of stable future income.

Athletics and Extracurricular Activities

The majority of sports funding and community support still goes to male athletics. Boys participate more in sports activities; only 37 percent of high school athletes are girls. Conversely, girls are the majority of student-government officials, after-school club leaders, and school-community liaisons. Our studies show that this is mainly a result of the nature of male and female brains. Boys tend to choose interactive social activities that de-emphasize verbalization and emphasize spatial and physical aggression. Girls tend to choose interactive social activities that emphasize verbalization.

Whereas advocacy for girls in sports and boys in other social interactions is essential, 100 percent female participation in athletics isn’t neurologically or hormonally realistic. Many girls (and boys) don’t like team sports and do not need to be pressured into them. Boys need a great deal of help in directing themselves toward social interactions other than sports, but boys will probably never gravitate as fully as girls do to clubs that promote coeducational verbal interaction.

Cultural Gender Bias

Boys are at the most gender-based disadvantage in our schools. In kindergarten through sixth grade, almost 90 percent of teachers are women, and female learning and teaching styles dominate. Teachers have not received training in male brain development and performance. Most systems rely on less kinesthetic and less disciplined educational strategies than many boys need.

Earlier writers believed that girls were the primary targets of bias in our schools. The lack of a biological foundation to their studies may have been coupled with a desire to deal with anti-female bias in the workplace by “proving” similar bias in the schools. Although boys are called on more than girls

in class, much of the attention boys get in class is punitive, not rewarding, and girls who are not called on often outperform the boys.

When asked how they feel about their school experiences, girls are more likely to express negative feelings and to detail negative experiences; boys are more reluctant to share feelings about any experience and to share details about an experience in which they have suffered pain or privation. They like to appear tough. In studies, girls were only slightly more likely than boys to express feelings of privation and bias.

Of course, there are some gender disadvantages to girls. In some classrooms, boys dominate discussions, and the voices of girls are lost. Role modeling in literature is more often male than female, and male heroes dominate. In some schools, good-old-boy networks teach males that they are inherently privileged and bestow advantages on them, especially in access to employment networks.

Sexual Abuse and Violence

Because males primarily victimize other males, boys are about three times more likely than girls to be victims of violence on school property. The area of greater violence against females is sexual harassment. Girls are more often victims of sexual abuse suffered at the hands of teachers, parents, coaches, school staff, and other students.

Although female violence is increasing, males dominate the violence statistics. Boys are brain- and testosterone-driven toward spatial expression of stress; they tend to lash out physically and with more sexual aggression and physical rage than girls. This trend continues through adulthood.

The U.S. Department of Justice found that, as early as first grade, it can be predicted who the offender males will be. Most of these boys are doing poorly in school, which contributes to their self-concepts of shame and inadequacy and their compensatory aggression against others.

The hormonal and neurological factors in male violence and sexual abuse may never change, but our culture must. Teachers must do what they can to better protect both girls and boys. Males need a different school culture—one with closer bonding, smaller classes, more verbalization, less male isolation, better discipline systems, more authority, and more attention to male learning styles. Anti-bullying curricula help students to understand their own internal systems for expressing angry energy, sad energy, and hurt energy.