Laying the Groundwork

Key Neurological Concepts

The Gift Of Reflection

The Significance Of Enrichment

THE BRAIN AND GIFTED LEARNERS
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ages 5-14
The Brain and Gifted Learners

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Editor’s Note* It is my pleasure to present Barbara Clark as the guest editor for this special issue on The Brain and Gifted Learners. Brain research has long been a special focus in Dr. Clark’s writing and speaking and we are fortunate to have her expertise in preparing this issue.

Barbara Clark is a Professor Emeritus of California State University, Los Angeles and the author of the widely used text, Growing up Gifted, now in its seventh edition. She has published in professional journals and has chapters in a number of books. She has served as the Editor of World Gifted, the newsletter of the World Council for Gifted and Talented Children, and as review editor for the Gifted Child Quarterly and The Journal of Gifted Education. Dr. Clark is a Past President of the World Council for Gifted and Talented Children, a Past President of the National Association for Gifted Children, and is on the Board of Directors and a Past President of the California Association for the Gifted. She is a recognized international scholar and has presented major addresses and workshops throughout the United States and in countries around the world. As Advising Editor of the Gifted Education Communicator she contributes to the planning and development of the journal.

*GECommSpring0801-26.qxd  3/27/08  5:17 PM  Page 2

It is with professional pride and personal joy that, as guest editor, I present to you the first journal in the field of gifted education to devote an entire issue to informing educators about the current contributions of brain research and its application to teaching and learning. Your understanding of how far this research has come and the impact it can have on the development of giftedness, as the highest expression of each person, is critically important to the field, but even more important to the children whose lives you guide. The advancements in this field of neuroscience have the ability to change what we as teachers in the home and in the school can provide for children. As you discover the impact you can have on their growth and the development of their abilities, the importance of the environments you create, and the extent to which you can affect their future through your understanding and resulting actions, you will be in awe and, I hope, deeply energized. The opportunities are boundless. In these pages you will find a review of what we know about the brain, some ideas on how the information can transform education, and reflections on a further reach into the development of wisdom and thoughts about the future.

We begin with an introduction to the form and function of the brain itself. We look closely at a neuron as the basic cell of the brain and the process it uses to communicate among the hundreds of billions of cells within the brain. Immediately we are overwhelmed by the vast multitude of constant activity that comprises our acts of thinking, learning, and remembering. We discover the uniqueness and changeability of our own processes and the unlimited impact we can have on these processes by the experiences and environment that we provide. The interactive functioning of the brain provides a model that can be replicated to create powerful learning and teaching. Understanding a bit about form and function allows us to better understand the importance of our role in the development of the brain and mind and how dynamic the process is with heredity providing the possibilities and the environment actualizing the potential. This introduction leads us to a quick review of how we have conceptualized intelligence in the past and now in light of the new information.

Neuro-psychologist Nadia Webb adds to our understanding of the workings of the brain with her view of functional zones and core organizing principles. Her discussion of the brain’s connectivity, plasticity, and redundancy brings a new dimension to how the brain functions and shows us other important ways that we affect brain development. In a discussion of what we know about the gifted brain, we encounter the issues of neural speed, expansiveness, efficiency, and flexibility. In her conclusions regarding how we can affect development, Webb makes a plea for helping our students tolerate challenge. Mastery and higher levels of development can only be realized and sustained when the student finds the balance between the “rage to learn” and the lack of skill and knowledge of the novice learner.
From the work of pioneer researcher Marian Cleeves Diamond comes a review of the early findings from The University of California, Berkeley, one of the first research laboratories to study the interaction between the environment and the developing brain. Diamond discusses the significance of enrichment from the results of work contributed by her and the team of scientists who first asked the question, “Does the environment physiologically change the form and function of the brain?” The answer was a history-making, “Yes, significantly!” After being replicated in laboratories worldwide these unexpected data began what was to become an earnest exploration of brain function that has lead to our current ability to use the principles of enriching heredity in the home and in the classroom. In her discussion she draws our attention again to the plasticity of the brain and the importance of the environment to optimal development.

In “The Gift of Reflection and the Development of Wisdom,” Daniel Siegel and Beth Seraydarian imagine a world in which we value wisdom and compassion as much as we do intelligence and logic. In so doing they allow us to round out our inquiry into the functions of the brain by showing us how to include—and the importance of including—the development of wisdom. They make the case that traditional education has been pressured into focusing on linguistic and logical skills rather than on the basic elements of wisdom with the result that our children lack the essential emotional intelligence they need to live fully. With their guidance we now look at the brain through a new lens. Siegel and Seraydarian reiterate the premise that the mind can be considered to have infinite potential. They suggest that four major factors enhance the actual synaptic change within the brain: novelty, focus of attention, aerobic exercise, and emotional arousal. Again we are reminded of the need to integrate these four major functions. Their discussion of mindful awareness and reflection introduces the promise of cultivating wisdom in our children, an important gift to the next generation.

With the article, “Teaching Our Students About the Brain,” Susan Ryan takes us into her world of children and learning. She shares some of her experiences and the strategies she has used successfully with her students as they explored the form and functions of their brains. Using the very principles that research has found to support learning, she allows us to participate in a session and experience the lesson with her students. She provides both a guide and some seasoned principles for using these ideas at home or the classroom with gifted learners.

Another source for guidance in bringing well-thought-out learning experiences into the classroom is the “Hands-on Curriculum” department. Intuition is a most sophisticated, complex, and fascinating area of human ability. Ann MacDonald and Jim Riley present you with a plethora of ideas for how you can expose your students to the concept of intuition, a function of the prefrontal cortex, and give them the opportunity to develop their own intuitive abilities.

Throughout this issue you will find notes from elementary, middle, and high school classroom environments that relate to providing support for the developing brain. A reference list in addition to those at the end of each article will direct you to further reading that can extend your understanding of the brain and developing powerful learning experiences. Two book reviews are offered giving you an overview of quite disparate, but highly informative books from these references.

Change is always a bit intimidating. It is the hope of all who have contributed to this edition of the Gifted Education Communicator that you will find within these pages the information, the understanding, and the motivation to bring the necessary changes into your home or classroom that will allow more children to develop their gifts and talents and to create for yourself the curiosity and interest to continue to follow the area of neuroscience as it informs education and the learning process. The exploration of the brain and mind can only aid our children in the growth of their special abilities if we take the information into our homes and classrooms, translating these ideas and findings into strategies and environments that allow each child to become the very most he or she can be. From this beginning, let us now continue this exciting and most important journey.

—Barbara Clark, Guest Editor
LETTERS TO THE EDITOR

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CALENDAR OF CONFERENCES

2008

APRIL 10–12, 2008
Montana Association for Gifted and Talented Education
Holiday Inn Grand, Billings, MT
cgfted.org

APRIL 14–15, 2008
Ohio Association for Gifted Children
Columbus, OH
oga.com

APRIL 17–19, 2008
Pennsylvania Association for Gifted Education
Harrisburg Hilton Towers, Harrisburg, PA
penngifted.org

APRIL 21–22, 2008
Eastern Iowa Gifted Education
Marriott Hotel & Conference Center, Coralville, IA
aea10.k12.ia.us/springworkshop.html

APRIL 29–30, 2008
Michigan Alliance for Gifted Education
West: Kent ISD, Grand Rapids
East: Livingston ESA, Howell, MI
migiftedchild.org

MAY 9–10, 2008
Association for Bright Children of Ontario
Royal Ontario Museum, Toronto, Ontario, Canada
abconratio.ca

JUNE 9–11, 2008
Intermountain Conference on the Education of the Gifted & Talented
Utah State University, Logan, UT
sail2.ext.usu.edu/gifted/Home.cfm

JUNE 17–22, 2008
Autonomous Learner Model
Estes Park Center, Estes Park, CO
ALPsPublishing.com

JUNE 23–25, 2008
Professional Summer Institute
The College of William and Mary, Williamsburg, VA
cfge.wm.edu/professional_psi.htm

JULY 7–18, 2008
Confratute
University of Connecticut, Storrs, CT
gifted.uconn.edu/confratute/

JULY 14–18, 2008
10th Asia-Pacific Conference on Giftedness
Nanyang Technological University, Singapore
10apcgifted.org/index.html

JULY 18–20, 2008
SENG (Supporting Emotional Needs of the Gifted)
Salt Lake City, UT
sengifted.org

JULY 27–AUGUST 1, 2008
Gifted and Talented Edufest
Boise State University, Boise, ID
edufest.org

SEPTEMBER 25, 2008
2008 Gifted Education Conference
University of St. Thomas, Saint Paul, MN
stthomas.edu/education/events

OCTOBER 2–3, 2008
Wisconsin Association for Talented & Gifted
Blue Harbor Conference Center, Sheboygan, WI
wag.org

OCTOBER 5–6, 2008
Virginia Seminar on Gifted Education
Hotel Roanoke, Roanoke, VA
vagifted.org

OCTOBER 12–14, 2008
Missouri Conference on Gifted and Talented
Tan-Tar-A Lake of the Ozarks, MO
mogam.org/www/conference.

OCTOBER 13–14, 2008
Colorado Association for Gifted and Talented
Englewood, Colorado
coloradogifted.org

OCTOBER 17–18, 2008
New England Conference on Gifted and Talented Education
Mansfield Holiday Inn, Mansfield, MA
necgt.org/

OCTOBER 23–25, 2008
Washington Association of Educators of the Talented and Gifted
Lynnwood Convention Center, Lynnwood, WA
waetag.net/Conferences.htm

OCTOBER 24–25, 2008
West Virginia Association for the Gifted and Talented
Summersville, WV
wvgifted.org

OCTOBER 29–NOVEMBER 2, 2008
National Association for Gifted Children
Tampa, FL
nagc.org

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Cynthia, Jack,
and Peter Austin

...permitting us to more widely distribute this important information to key decision makers in the field of education.

We appreciate their support and their recognition of the importance of information on brain function and gifted education.

UPCOMING ISSUES OF THE GIFTED EDUCATION COMMUNICATOR

Summer - Parenting Gifted Children
Fall - Visual & Performing Arts
Winter - Equity & Excellence

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CALIFORNIA ASSOCIATION FOR THE GIFTED 5
Children aren’t born knowing what others consider to be “right conduct.” The process of parenting consists largely of teaching children social rules and how to understand their interactions with other living creatures and the environment, everything from the superficial to the profound. Most parents are pretty good at teaching what is expected and acceptable behavior, what is “polite” and what isn’t. I’ve found that where families differ more is in the degree to which they help their children consider what underlies all those rules and expectations—the ethics of relationships and responsibilities. I’m continually surprised, when I ask well-behaved youngsters why we do this or don’t do that, to discover that they don’t have a clue.

Why isn’t it enough to label behaviors as “nice,” “good,” or “polite,” as though that were sufficient explanation? (Neither is, “Because I said so!”) It is, of course, easier just to let it go at that, but what are we leaving to our children if we do so? For one thing, we’re teaching them that a powerful, perhaps arbitrary (perhaps parental) rule maker has decreed what is right or wrong, not that there are dependable principles by which one can guide one’s life or make one’s way in new situations. For another, we frequently wait to catch them doing something wrong before we step in, teaching mainly what not to do if you don’t want to get in trouble (or worse, how to avoid detection).

Additionally, except for the speed and intensity of our response when they misbehave, we give them little sense that one sort of transgression (eating with your mouth open, for example) is more or less serious than another (battering baby sister with a hurtful word or a baseball bat). Finally, we have imparted no distinction between custom (in some societies, a big belch after eating is a compliment to one’s host) and the ethics of justice, fairness, kindness, caring, generosity, and respect—the bedrock of character, the essence of the kind of people we want them to grow up to be.

Families do differ, of course, in the specifics of what they value most and what constitutes the future they hope for their children. They differ to some extent in philosophy as well—some emphasizing individual responsibility for one’s own fate and welfare, and others emphasizing the caring and support one gives to others. Because of diversity among the families in our schools, school boards and educators tend to back away from teaching more than bare-bone essentials of everyday conduct. It is, then, even more than in the past, up to families to do the job, some relying on their ethnic heritage or their churches, some involving elders and extended families, some breaking with their past and forging their own way.

PARENTS ENCOURAGING ETHICAL BEHAVIOR

Your own behavior is a powerful model they will emulate. You also want them to understand, though, that you are guided by principle:

( Teaching please and thank you): “Ask me so I want to.”

• “Sorry I was late picking you up. I hate to make you worry.”
• “Picking up your room is almost like your saying thank you to us for working hard to get you clothes and toys and books you like.”
• “I’m going to turn in this change that has been collecting on my bureau, because it costs the government—that means all of us—a lot to make the coins. If I keep them out of circulation, the mint has to make more.”
• “I’m filling this bag for the food drive because it doesn’t seem fair that some families don’t have enough to eat, when we have just about whatever we want.”
• “I’m making out our income tax return, and I thought you might be interested in looking at the charitable contributions our family has made this year. Would you have picked these priorities?”

DILEMMAS

Life is full of dilemmas in which competing principles pull you in two directions at once, and there may be no single right answer. Engaging your children in struggles with hard decisions are wonderful occasions for teaching the basic truth that ethics is what makes us truly human. Sometimes you’ll run into situations worthy of discussion; if not, sometimes you can pose “what if?” problems.

• What should I do if I realize that the grocery clerk gave me a $5 bill instead of a $1 bill in change? What if it’s a big chain store that has lots of sales every day? What if it’s a little neighborhood store? What if I know that the clerk is going to have to make it up herself if the cash in her register doesn’t match the records?
• What if two of your friends get into a shouting fight during recess? What if it’s a fist fight? What if your best friend is involved and is winning? What if your best friend is losing?
• What if your friend tells you a secret, one that makes you really worried about them? Should you tell a grown-up? If so, who would it be?
• What if your teacher says something that you know is incorrect?
• What if you see a friend cheating on a test by looking on someone else’s paper? What if he is looking on your paper?
• What if you know your friend copied most of a term paper off the Internet? What if she copied a sentence from one place, another sentence from another, and so on—and didn’t identify them?
• What if your friend is running for class president but you think someone else would do a better job? Who gets your vote?
• What if there’s a cheaper price for kids 12 and under to get into the movies and you just turned 13? Do you ask for a kid’s ticket? What if you don’t have enough money for a regular ticket? What if you do?
• What if you see someone take money out of the collection box in church? What if you know they really don’t have enough money themselves? What if you don’t know that?
• What if a family has enough money to send only one of its children to camp (or to college)? How should they decide which child to send?
• Is it worse to steal $100 than $10?
• Should kids get paid for doing family chores when parents don’t? Why?

You get the picture. Don’t try to suggest solutions to your children, and don’t hurry them—let them stew a while and maybe change their minds several times. The best dilemmas are the ones where there are good arguments for both sides, and people of good will can disagree.

SPECIAL ISSUES FOR GIFTED STUDENTS

Because highly capable students and adults have “special gifts,” should they “give” more than others might be expected to? Or is everyone—no matter what their level of ability—responsible to do their very best, for themselves, their families, and others? Or is none of this true—no one has such responsibilities? This is a deep philosophical question for your bright children to come to terms with, whatever their answers.

And if more were to be expected of a gifted student or adult, what would this imply?
• Serving as “assistant teacher,” generously helping fellow students in class?
• Enduring interminable boredom with cheerfulness and patience?
• Getting all A’s?
• Pushing beyond assignments to produce work that is deep, extensive, and insightful?

• Getting the best education you can and working hard at it?
• Providing leadership to others in your job or in community affairs?
• Volunteering time in community service?
• Doing the best job of parenting you can, including maximizing your own children’s talent development?
• Applying your talents to finding solutions to social and world problems?
• Developing your special talents even if they are not particularly satisfying?
• Choosing a profession that has value for others rather than “just” your own personal fulfillment?
• Choosing a career that gives direct benefits to others in need (e.g., medicine or social work) versus a career with more indirect social contributions (if any), such as basic research in geophysics or archeology?
• Working full-time even if you don’t need to?

What, indeed, do you think of these questions? Have you ever explicitly considered them? Can you help your children to look honestly at both sides of the issues? Many gifted students do, indeed, resent what they see as an undue burden that is none of their own doing. What choices have you made? Think of adults you know, and quite possibly admire, who have taken one path or another to fulfill—or not fulfill—the promise of their childhood abilities. What do their lives teach people in your family?

Here is yet another example of demands of parenting you may not have anticipated. As you explore difficult questions with your children, you may find that, deep within your own philosophy, lurks more complexity than you had guessed. May you celebrate complexity, and help your own children, while they strive to be “good,” to tolerate ambiguity, uncertainty, and imperfection in themselves and others!

NANCY M. ROBINSON, Ph.D., is Professor Emerita of Psychiatry and Behavioral Sciences at the University of Washington and former Director of what is now known as the Halbert and Nancy Robinson Center for Young Scholars. Her research interests have focused on effects of marked academic acceleration to college, adjustment issues of gifted children, intellectual assessment, and verbal and mathematical precocity in very young children.

“Engaging your children in struggles with hard decisions are wonderful occasions for teaching the basic truth that ethics is what makes us truly human.”
Olympic diver Laura Wilkinson is the only woman in history to earn three medals from the diving platform. When she broke three bones in her foot just months before the summer games in 2000 and couldn’t practice, mental rehearsal was the only tool she could use to train until just a few weeks before the competition. Even so, Laura was able to upset the heavily favored Chinese divers to win the gold medal at the 10-meter Platform Dive event at the Sydney Olympics.

The ability to see a desired performance in one’s head improves achievement, but how do we go about teaching this skill to young people? There are a number of simple games to build the foundational skills needed to use mental rehearsal. Once you’ve taught students how to breathe and relax their bodies, try one of the games described here to get them started.

**SHARPER IMAGE**

Before they can use mental rehearsal effectively, students must improve their ability to recall what they want to imagine. This game has them practice attending to and recalling visual images. Ask them to quietly sit on the floor or in a chair directly in front of a good friend. Tell them to close their eyes and try to capture the sharpest possible image they can of the other person. Encourage them to imagine all the details of their face and movements. Allow a full minute—or thirty seconds if they’re under the age of nine. Then invite them to imagine the other person talking and to try to capture the sound of their voice. Imagine their expressions too. Allow another 30-60 seconds. Finally, tell them to notice all the feelings they have about their friend. Then tell them to open their eyes and look closely at one another, taking note of what was missed in their imagination. Let them comment on what they now notice that they will add next time they take a snapshot in their mind. Let them play this game a couple of times a week to strengthen their attention and visual recall ability.

**SCENE SWITCH**

The ability to form sharp images and to control those images affects how well individuals can visualize. Most people can form an image in their mind, but they usually don’t control it very well initially. They don’t see themselves successfully performing the task. Instead, they see themselves making mistakes. They imagine screwing up. The higher the achievement and the higher the stakes involved, the more practice it takes to control the images. Students who can form the images and control them well will achieve a lot. There’s nothing mystical about this switching procedure. It’s just a skill for improving one’s ability to mentally rehearse desired achievements. It works on developing your students’ ability to bring images to mind when they need them.

1. Pick a quiet, undisturbed place for your students to sit and use the exercises you taught them earlier to get fully relaxed and focused.

2. Ask them to imagine a favorite scene that is familiar and calm, maybe a favorite vacation spot, or favorite walk, or a favorite time of day. Tell them to imagine vivid details of that scene, capturing the colors, the sounds, and the smells. They are to fill the scene with as much sensory detail as they can.

   Have them stay with the scene for a couple of minutes, to allow their senses to experience as much of the scene as they can while remaining relaxed physically.

3. When they have this wonderful picture in their mind, sharply detailed and vivid, tell them to “freeze-frame” it. Direct them to lock it in place and turn it off. Then they are to go back to their deep breathing and focus on their relaxation. Have them keep the scene turned off for two minutes.

4. Direct them to bring the scene to mind again. They are to imagine the same scene with all the details and pleasant emotions they experienced before. Have them spend two to three minutes enjoying this scene before turning it off again and focusing once more on their relaxed breathing.

Remember to remind students that mental rehearsal is not a good substitute for actual practice. No amount of mental rehearsal will be effective if they haven’t bothered to physically practice the skill they’re trying to master. Mental rehearsal is intended as a supplementary tool to boost performance and it’s been demonstrated to be especially effective at building confidence and enhancing self-control.

**RESOURCES**


Maureen Neihart, Psy.D., is a child psychologist and former teacher and school counselor from Montana. She is Associate Professor of Psychological Studies at the National Institute of Education in Singapore.
Science + Art + Ethics = Effective Leadership

A leader is an elaborator of a vision. —Theodore Hesburgh

Of all the criteria on which we administrators are evaluated regularly, how we demonstrate our leadership ability is probably the most important both to us personally and to those we serve. Why? Doesn’t leadership look different as situations change?

Regardless of the setting, effective leadership comprises both a cognitive and an affective component. The cognitive aspect of leadership is the science of it—knowing what must be done to move an individual or group from one point to another. How the leader accomplishes this is the personal, or affective component—using one’s own Mind Style™ (see Gregorc references end of article) to achieve the intended goal. Overarching the two is ethics, which relates to the integrity of how the mission itself is carried out. The following scenario, familiar to administrators, illustrates how these three elements function together to help develop effective leaders.

THE BOARD-SUPERINTENDENT DIRECTIVE

At a recent board of education meeting, parents, students, and advocates from the gifted education community presented robust data indicating the district’s gifted and talented students K-12 are not receiving sufficient research-based service to accommodate their advanced learning needs appropriately. The superintendent now has appointed two principals to each lead a group of K-12 teachers in the development of an action plan to present to the Board. Each plan is due to the superintendent in 30 days.

Selected for their record as effective leaders, Ms. Johnson and Mr. Walker exercise their leadership in completely different ways. Ms. Johnson is a “take charge” type of professional. Her mind style is highly “Concrete Sequential,” in Gregorc’s Mind Style parlance, and she keeps her group sharply focused on its goal: the action plan the superintendent has requested.

Ms. Johnson is results-oriented, gets to the point quickly, and articulates in detail her high performance expectations of the superintendent’s requirements as stipulated. The leader’s role, as Ms. Johnson sees it, is to communicate the goal to be accomplished, monitor the group’s progress toward achieving it, and evaluate the effectiveness of how the goal was met.

In a nearby room is Mr. Walker, whose “Abstract Random” mind style is diametrically opposite his colleague’s. He views his group and himself as partners and the superintendent’s assignment of an action plan an “adventure.” He emphasizes collegiality, asking his group of teachers for their ideas as to how to proceed with the task and invites them to be creative. Bubbling with enthusiasm, he is artistic, energetic, and with an idea a minute, he understands perfectly the importance of the goal, but, unlike his colleague, he employs alternate paths and staff input to develop the final product. Mr. Walker views the leader’s role as facilitator of a collaborative project in which each person’s ideas are valued.

DIFFERENT STROKES FOR DIFFERENT FOLKS

Ms. Johnson’s top-down leadership style is crisp, unequivocally clear, and efficient. A Concrete Sequential (CS) leader, she organizes the action plan assignment in a linear, step-by-step manner; is sharply focused; and helps others focus likewise to achieve the goal. To this leader, time is of the essence: accomplishing a no-frills task need not take “forever,” which is how she perceives more collaborative task completion. Because the CS leader also values control, maintaining close supervisory contact with her group as a unit is key to successful goal attainment.

Such a direct, no-nonsense approach to leadership can be somewhat intimidating to a group of participants whose natural mind styles are different from the leader’s style. CS leaders, in their straightforward manner, often appear blunt and insensitive to the personal needs and idiosyncrasies of the individuals working with them. Additionally, CS leaders strive for the task to be completed precisely as they themselves envision it in its final form; but at times, in their zeal to finish the task, they overlook critical personal aspects of being an effective leader. Problem resolved. Task completed. Goal achieved. These are the products that drive and reward Ms. Johnson and other Concrete Sequential leaders.

On the other hand, Mr. Walker’s Abstract Random (AR) collaborative approach to meeting a goal may be frustrating some teachers in his group whose style, unlike his, is Concrete Sequential. To the AR leader creativity is critically important—creativity, that is, that centers on fresh ideas and novel approaches to solving problems; incorporates invention and extends beyond the traditional boundaries within a given discipline; and requires both risk-taking and using one’s imagination. Creativity to a CS group member, however, means smoothing out the final form of a product through editing, correcting spelling and usage, and inserting needed transitions—applications that bore the daylight out of individuals with a more Random mind style than a Sequential one!
ETHICAL LEADERSHIP: THE GUARD RAIL AGAINST CORRUPTION

Ethics serves as the arch that embraces both Sequential and Random leadership styles. Ethical leadership belongs to no single style, group, or type of goal. Ethics is the guard rail that protects both a leader and those being led against unfair, immoral, and/or illegal behavior that occurs occasionally in the course of a critically-important project. One’s educational degrees, professional accomplishments, employment experience, financial resources, position in the community, or political affiliation—not one of these descriptors or any other—gives a leader license to shortchange those he or she is leading, the person(s) for whom the task is being completed, or anyone else for that matter.

Unfortunately, corruption can be found in every element of today’s society. Almost everyone knows someone who has at some time cheated his or her neighbors, relatives, the government. Within the past decade, the news media have broadcast widely the sordid details of rampant corporate cheating carried out by businesses previously considered to be upstanding and ethical. Even our political leaders in the highest ranks lie to the public on a regular basis. Ethical leadership appears to be a rare goal; the lure of money and power seems to trump integrity. This shameful model is what our nation’s youth are growing up with; all the more reason for our educational leaders to model strong ethical behavior.

Leadership, regardless of situation or mind style, cannot function without a code of ethics supporting the mission. Moving individuals and groups from one point to another requires mutual trust, which must remain solid. Ethics helps develop that trust by uniting the differences in us; it gives every participant in the group a common denominator, a single purpose.

In the scenario above, Ms. Johnson and Mr. Walker, both highly regarded in the district for their respective leadership ability, are ethical although their leadership styles differ from one another dramatically. The test of ethical leadership is adhering to the assignment’s purpose and involving parties with a vested interest in the assignment—teachers, in this case—so they can contribute to the final product requested. No games. No cutting corners. No lies. Ethics lends a project integrity, which many people still respect.

REFERENCES

CAROLYN R. COOPER, Ph.D., is a retired assistant superintendent and served as the specialist in gifted and talented education with the Maryland State Department of Education for several years. A seasoned district-level coordinator of gifted education, she is active in the National Association for Gifted Children and consults with school districts and other organizations on educating gifted and talented youngsters.

BRAIN USES 20 PERCENT OF BLOOD
Approximately 20% of the blood flowing from the heart is pumped to the brain. The brain needs constant blood flow in order to keep up with the heavy metabolic demands of the neurons. Brain imaging techniques such as functional magnetic resonance imaging (fMRI) rely on this relationship between neural activity and blood flow to produce images of deduced brain activity.

BRAIN USES 20% OF OXYGEN BREATHED
Although the brain accounts for only 2% of the whole body’s mass, it uses 20% of all the oxygen we breathe. A continuous supply of oxygen is necessary for survival. A loss of oxygen for 10 minutes can result in significant neural damage.

EARLY BRAIN GROWTH
During the first month of life, the number of connections or synapses, dramatically increases from 50 trillion to 1 quadrillion. If an infant’s body grew at a comparable rate, his weight would increase from 8.5 pounds at birth to 170 pounds at one month old.

NO PAIN IN BRAIN
There is no sense of pain within the brain itself. This fact allows neurosurgeons to probe areas of the brain while the patient is awake. Feedback from the patient during these probes is useful for identifying important regions, such as those for speech, that are spared if possible.

READING ALOUD STIMULATES CHILD DEVELOPMENT
Reading aloud to children helps stimulate brain development, yet only 50% of infants and toddlers are routinely read to by their parents.

Source: brainconnection.com/library/?main=explore-home/brain-facts
An exciting question was asked early in the 1960s in the brain laboratories of the University of California, Berkeley. "Does the environment actually change the brain?" With the answer, "It does, significantly," came multitudes of never-before considered possibilities for those who educate, parent, or in any way guide the lives of children. As others sought answers to even more specific questions concerning the brain and its development, our knowledge of what contributes to its growth, how we can support its development, and the importance of when and in what way the most powerful changes can be made began to unfold. For those of us interested in gifted education it became obvious that our mission had changed from just finding giftedness to creating the experiences and the opportunities for giftedness to develop. Now, with ever-widening inquiry, deepening knowledge of the dynamics of learning is available. Awareness of what is needed to allow high levels of intelligence to develop and its dynamic nature to be maintained challenges us to change our ideas, our beliefs, and the methods and practices that we use with children. What is known and what is becoming knowable will allow us to:

• Create environments that promote high levels of learning.
• Use strategies that add to children's natural need to develop their inquiring minds.
• Provide learning experiences that facilitate the integration of children's thinking, feeling, sensing, and intuiting to support the development of their innate abilities.
• Make effective learning available to all children of all ages and all cultures.
• Consider the possibility of developing each child's uniqueness to higher levels of ability, increasing the population of children we now designate as gifted.

While these possibilities seem intriguing, by taking advantage of the continuing research on the brain not only can we realize these exciting goals, we can become prepared for the amazing possibilities ahead.

Let us begin by reviewing the current knowledge about brain organization and function. These data change our understanding of how we can develop effective learning and teaching. We will look briefly at some of what we have learned about the brain in the past 50 years that is responsible for these changes, suggest how we might share this information with our students, and provide examples of how this knowledge might be used to support effective learning experiences.

**The Neurons or Basic Cells of the Brain**

Over 100 billion neurons (i.e., brain cells) make up the basic structures that provide the functions of the brain. These neurons are tiny information-processing systems that receive and send thousands of signals daily. A neuron is composed of a cell body,
Looking at a Neuron

If you open your hand and spread your fingers to the fullest extent, you will have a good model of the neuron or nerve cell from the brain. The palm of the hand represents the cell body, with the indentation at the center representing the nucleus of the cell. The extended fingers are located in the appropriate place for the dendrites and would more closely resemble dendrites if branches grew from each finger. The arm extending from the hand makes a good model of the axon that, in fact, extends from the cell body in much the same way. It is possible to use both hands as models of neurons to show the exchange of information as it occurs in the learning process. Remember, when transmitting energy from one neuron to another, the axon does not touch the body or the dendrites of the other cell. The conversion of the electrical energy of the information within the cell to biochemical energy during the transmission across the synapse to a new cell and then back to electrical energy as the information enters the new cell is required in this process.

dendrites, and a branching axon as shown in figure 1.

Inside the cell body are the biochemical processes that maintain the life of the cell. The brain accomplishes unbelievable amounts of processing, integrating, evaluating, imagining, deciding, moving, remembering, predicting, and untold other functions to make our lives unique. No two brains are exactly alike, although overall we function with the same processes.

The pathways for receiving information from nearby nerve cells are the dendrites, short fibers that branch out from the cell body. The axon, a long nerve fiber that extends from the cell body and often branches at the end, serves as a transmitter, sending biochemical signals that are picked up by the branches of the neighboring dendrites. The activity between neurons consists of the axon of one cell contacting a dendrite of another. The end of the axon does not actually touch the dendrite of the other cell, but transmits the information across a region where the cells are particularly close. Impulses travel from one nerve cell to another across this junction called the synapse. The transmission of a nerve impulse is an electrical-biochemical-electrical process. At the synapse, the electrical impulses that travel through the cell are converted into biochemical signals and then back to electrical impulses by the receiving cell.

It is this synaptic activity that is thought to be the site for the neural mechanisms of learning and memory. Here, some believe, is the site of intelligence. Of great importance to educators, it is this very neural activity that can be increased or decreased by our experiences. Referred to as neuroplasticity this ability of the brain to increase or decrease function depending on the environmental stimulation continues throughout our lives. The ability to increase function and complexity is at its highest level of operation during infancy and early childhood. Throughout life the principle of progression or regression is in effect; if you are not appropriately stimulated at your level of development you do not maintain, you regress. Just maintaining is not a part of the brain’s plan.

Surrounding the neurons are special cells known as glia. These glial cells outnumber the neural cells 10 to 1, and the number of glial cells can also be increased by the richness of the experiences provided in the environment. The glial cells provide the brain with nourishment, consume waste products, and serve as packing material that glues the brain together. Another very important function is that they insulate the nerve cell creating a myelin sheath around the axon that protects it and amplifies the signal leaving the cell. As the glial cells in the brain increase and provide more myelination, the speed of learning accelerates. This allows for faster and more complex patterns of thinking, two characteristics we find in gifted children.

Each neural cell is ready to be developed and used for actualizing the highest levels of human potential. With relatively few exceptions, all human infants come equipped with this powerful heritage. To add to the complexity of the brain processes of the neural system, every person has unique genetic patterns and pathways. This structure allows us to process trillions of bits of information in our lifetime. How we develop and use this complex system will depend in part on the extent and effectiveness of our experiences. An individual’s interaction in an enriched environment changes the physical and chemical structure of the neuron, strengthening the cell body. The result is more rapid and complex thought processing. Integration, constant feedback, and challenging experience in an enriched environment are the keys to powerful learning and memory.

Our experiences and what we learn from them are critical to the development of our intelligence and to the very quality of our lives. Giftedness is the label we use to identify high levels of this development. What children learn will determine who they will become.

THE ORGANIZATION OF THE BRAIN

Information is processed within the brain from a vast number of brain areas, through myriad neural pathways and linkages, to be analyzed and integrated in cellular structures at higher and higher levels. The result is retention and storage of unbelievable amounts of data, all contributing to our uniqueness of self and our worldview. While, we do not need
to comprehend the complexity of this total system in order to understand some basic brain structures and functions, it is well to keep it in mind. “The idea that different regions of the brain are specialized for different purposes is central to modern brain science” (Kandel, 2006, p. 123). To more easily communicate how the brain learns, we will discuss four major areas of function within the human brain: the physical, cognitive, affective, and intuitive. Each area has a different structure and chemistry. Use of these general areas will allow us to understand major brain functions and their approximate locations.

The area of physical function. The first area to develop is the brain stem. The autonomic functions of this part of the brain relieve us of consciously processing each breath and each beat of our heart. The reticular formation is located in this area. It is, in essence, the physical basis for consciousness and plays a major role in keeping us awake and alert. In the brain stem, we find the neural pathways for many higher brain centers. The cerebellum, located at the very base of the brain, houses cells concerned with motor control and the communication link to the rest of the brain. This is the area of our physical functions and muscular coordination.

The access to our world is primarily through movement and physical sensing (i.e., sight, hearing, smell, taste, and touch). Our level of intellectual ability, even our view of reality, will depend on how our brain organizes and processes this information. We know that gifted learners have a heightened ability to bring in information from their environment and process it in ways that expand their view of reality making them especially aware and often overly sensitive.

The area of affective function (emotional and social). This second area of the brain, the limbic area or the emotional mind, includes the hippocampus and the amygdala, and is wrapped around the top of the brain stem. Located at midbrain this area contributes significantly to the learning process. Here are the biochemical systems that are activated by the emotions of the learner. Here, too, are processes that enhance or inhibit memory.

The physical area. Begin with the arm-wrist area; this represents the brain stem in which we find the neural pathways for many higher brain centers. The cerebellum, located at the very base of the brain, houses cells concerned with motor control and the communication link to the rest of the brain. This is the area of our physical functions and muscular coordination.

The cognitive area. The exposed surface of the fingers and thumbs of both fisted hands represent the brain stem and the cerebral cortex of the brain. The six layers of neural cells in the cortex comprise the more recent and sophisticated processing within the brain. The cerebrum is divided into two hemispheres. The language area is just below the middle knuckle on your right hand (left cerebral hemisphere). Other functions of the left hemisphere are those that are concerned with verbal, linear, and rational thought. Spatial, mathematical, and gestalt functions are more common to the right cerebral hemisphere (left hand). The hemispheres are connected through the corpus callosum, represented by the fingernails on both hands touching. This bridge between the right and left cerebral hemispheres of the brain has more neural connections than there are in any other part of the body and allows the functions of the two hemispheres to support each other.

The intuitive area. Your thumbs in our hand analogy represent the prefrontal cortex of the cerebrum. Located in this area are the least understood functions of the brain. Insight, introspection, decision-making, adoption of ethic and moral values, creativity, and intuitive knowing are but a few of the functions involved in the processes of this most recently evolved section of the cerebral cortex.
This area affects such diverse functions as anxiety, rage, senti-
mentality, and attention span. In addition, our feelings of personal
identity and uniqueness depend on this area of the brain to com-
bine internal and external experience. It is in this area that affect-
tive feelings provide the connecting bridge between our inner and
outer worlds and add significantly to our construct of reality and
our model of a possible world. By the release of biochemist-
s from the limbic area, the cells of the cortex are either facilitated
or inhibited in their functioning. One activator for growth of
function in this area is novelty; therefore, too much repetition
and sameness can be a problem for learners. Because gifted learn-
ers are often accelerated in both content and process, novelty
must be planned as part of their program.

The affective function does more than support cognitive
processes; in fact, it provides the gateway to enhance or
limit higher cognition. To allow optimal learning, families
must include in the environment and teachers must inte-
grate into their classrooms activities that promote positive
emotional growth.

The area of cognitive function (linear and spatial). This
third system of the brain is located in the convoluted mass
known as the cerebrum with its ridges and deep cerebral fur-
rows. The cerebrum is divided into two hemispheres. Although the
functions of each of the two cerebral hemispheres are different,
the interconnection and integration of the right and left hemi-
sphere specializations is biologically structured. It is our largest
brain system, comprising five-sixths of the total brain mass, and
enveloping the two systems previously mentioned, the brain
stem and the limbic area. It is here that data are processed, action
initiated, and memory stored. The most overriding functions of
the cerebrum involve the reception, processing, storage, and
retrieval of information. Hawkins (2004) acknowledges the cor-
tex of the cerebrum as the seat of intelligence.

The cognitive functions include the verbal, linear, analytic,
sequential, evaluative specialization of the left cerebral hemi-
sphere of the brain and the more spatially oriented, mathemat-
ical, gestalt specialization of the right cerebral hemisphere.
Within the cerebral cortex are over a hundred billion neural
cells that connect through an intricate exchange of energy allow-
ing the establishment of complex networks of thought. Higher
intelligence requires accelerated activity and an increased densi-
ty of the branches of these cells. Stimulating environments pro-
mote this growth and branching, resulting in an advanced
capacity to generalize, conceptualize, and reason abstractly.

The area of intuitive function. The prefrontal cortex is the
site of the intuitive area of brain function. It focuses on behav-
iors associated with planning, organizing, and creating insight,
empathy, and introspection. It is engaged in firming up inten-
tion, deciding on action, and regulating our most complex
behaviors. It energizes and regulates all other parts of the brain.

Many consider the prefrontal cortex the basis of intuitive
thought. The function of intuition, which we all have, but use
in varying degrees, represents a different way of knowing. These
powerful processes lead to the understanding of concepts and
humanity and to an expansion of the reach of the mind. Bruner
(1960) discussed intuition as an important part of the educa-
tion process and encouraged its training. The physicist Capra
(1975) tells us that rational knowing is useless if not accompa-
nied and enhanced by intuitive knowing. Intuition becomes a
part of the planning, future thinking, and insight so necessary
to the intelligent person. The prefrontal cortex is the most
recently evolved section of the cortex and may not become
highly functional until the late teens or early twenties.

We now have four somewhat different brains in one

1. the brain stem and the cerebellum, the smallest and oldest
part of the brain;
2. the structures of the limbic area;
3. the cortex of the cerebrum, largest part of the brain; and
4. the prefrontal cortex, the newest, most sophisticated area
of function.

Research data from the neurosciences suggest that a high level
of intelligence is the result of advanced, highly integrated, and
accelerated processing within the brain. The concept of intelli-
gence—and, therefore, “giftedness” as a label for high levels of
development of intelligence—can no longer be confined to cog-
nitive function; it clearly must include all brain functions and
their efficient and integrated use. The development of higher lev-
els of intelligence results in

1. neural systems that have been found to be more efficient
and effective;
2. neural cells with more dendritic branches resulting in more
synaptic connections among cells; and
3. more glial cell production resulting in more myelination of
the axon and faster synaptic exchanges.

However, to continue to flourish, such a brain needs the
opportunity for exposure to high levels of complexity, depth,
novelty, and acceleration in its learning experiences. Creating
opportunities for the effective operation of this total brain is
our responsibility as parents and educators. ■

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Function

Cognition can no longer be thought of as only the complex linear, rational activities of the left hemisphere. Those are only the functions of one of the hemispheres of the cerebrum. The process of cognition also includes the integration of the spatial, gestalt functions of the right hemisphere. Teaching must provide for the nurture and integration of both of these brain functions.

In the Classroom

In addition to learning the skills of sequencing, comparing/contrasting, association, and understanding known information, students need to be taught to integrate skills of seeing the broad, inclusive view of an idea and the interrelationships of issues. The use and creation of visual images need to be integrated into the learning process.

Example: Metacognition. When a student has been using manipulatives to understand a mathematical process and then finds that such support is no longer necessary, ask the student to verbalize how the process is being thought out internally (e.g., "Tell me how you do this in your head."). This strategy of verbalizing the process will allow students to be aware of the way they are solving problems internally and to clarify and solidify both linear-rational and spatial-gestalt steps to their solutions.
If we are to better educate students we must acknowledge the importance of movement to the learning process and integrate movement and physical sensing (i.e., seeing, hearing, touching, tasting, and smelling) into the learning experience. The purposeful use of a change of the body’s place, position, or posture while learning not only promotes deeper understanding of the information or ideas, it creates a higher rate of retention. Movement makes learning easier by creating higher levels of oxygenation for the brain. Excess stress produces chemicals within the brain that shut down cells. Therefore, relaxation and tension reduction are important for optimal learning. Providing opportunities for students to integrate their minds with their physical bodies support effective teaching and learning.

In the Classroom

If the integration of the mind and body is to succeed, relaxation techniques must be learned, used, and valued. Many systems of relaxation are available. Use of progressive relaxation, mental rehearsal, and guided imagery support tension reduction and can be taught and used in the classroom.

Example: Relaxation. Ask the students to sit in a comfortable position with their eyes closed. Direct them to concentrate on various muscles in their bodies, relaxing them one at a time. Start your guidance with the muscles in their face, head, then their neck, releasing each muscle group slowly progressing down through their body, their arms and legs to their toes. Asking them to image each area as they are relaxing is helpful.

Strategies for physical movement might consist of the use of rhythms, role-playing, physically manipulating materials, and simulations of actual events. A powerful use of movement in the classroom is a strategy known as physical encoding. This is a learning process that uses the physical body to transfer information from the abstract or symbolic level to a more concrete level while taking advantage of the benefits of physical movement.

Example: An introductory activity to understand the concept of fractions. Volunteers are asked to form a small group (four to six students). Another student is then asked to use the group members to show one-half of the group, one-third of it, one-fourth of it, and so forth. All the students can then be asked to form groups of various sizes of their choice. They add, subtract, multiply, and divide fraction problems using their groups. They can then work problems with mixed fractions by using their group and other groups. The entire class should discuss each problem after a group demonstrates a solution. These activities precede pencil and paper work.

The brain makes special use of feelings or emotions in the learning process. Major decisions are made at a feeling level. Emotions have been found to be the gateway-triggering mechanism for higher cognitive function. To take advantage of this gateway, strategies for affective development must be integrated into the students’ daily activities. The success of the affective strategies depends more on the attitude and beliefs of the teacher than of any other area of brain function.

In the Classroom

The strategies involved in developing empowering language and behavior are important in integrating affective processes. There seem to be at least two sources of language that can empower or debilitate the learner: verbal and/or non-verbal messages coming from outside sources, and inner language used to direct and mediate experience. Both affect the belief of the students in their ability to learn. Teachers can help students to be aware of their real feelings and find a way to communicate them clearly. To get the feelings and the words to match is not easy. Students need lots of practice in meaningful situations with the chance to analyze what happened and try again. Realizing how their words and actions affect others is a part of the process. Classrooms where empowering language and behavior is practiced by both students and teachers is a very powerful learning environment.

Example: Using affirming responses instead of judging responses. After an incident of inappropriate classroom behavior the teacher’s response could be: “Larry, I can see you are really upset. Would you like to step outside and talk about it, or would you rather work awhile now and discuss it later?” Rather than: “Larry, you know that kind of behavior is not permitted in this room! What is the matter with you? Can’t you grow up? Now sit down and get to work.”

Another very powerful strategy to support the development of the affective functions of the brain is the use of choice and awareness of perceived control. It has been found that choice
“The intuitive function has been the least recognized by educators, yet it is the most powerful and creative area of human brain function.”

and the resulting perception of control significantly affect student motivation, academic achievement, independence, and self-concept. A classroom may provide possibilities for choice, but unless students clearly see those alternatives and believe they can really make a choice that will be acceptable, the positive effect will be missing. Student decisions must be open, the consequences of each alternative must be known, and there must be alternatives that the student might actually prefer. Choice is of specific concern for middle and high school educators because of its ability to improve student motivation at an age when there is known to be a decrease in student motivation.

**Example: Develop agreements for the classroom with the students instead of just posting the class rules.** All class members, including the teacher, operate from the same rules and standards that were cooperatively devised and clarified to define what is appropriate behavior and what isn’t. Students find it much easier to meet these predictable standards of behavior, are more in control, and perceive the responsibility to suggest solutions to problems they create. When rules are imposed and not agreed on, students naturally resist them.

**Function**
The intuitive function has been the least recognized by educators, yet it is the most powerful and creative area of human brain function. According to neurobiologists, the prefrontal cortex that houses this area of function is the most uniquely human area of the brain. It is species specific; we share this function with no other life form. The functions of the prefrontal cortex seem to include future planning, insight, empathy, introspection, and other bases for intuitive thought. It is engaged in firming up intention, deciding on action, and regulating our most complex behaviors. The prefrontal cortex plays a critical role in high-level intellectual and emotional operations, monitoring input, analyzing and synthesizing incoming information, excluding the irrelevant, and then referring the new information to memory. Later, this area reconstructs whole and relevant memories taking the outward leap of hunches and fantasy, guessing and postulating, carrying the mind into the future, making plans, shaping strategies for goals, forecasting, and then making adjustments to fit new perceptions and new goals. Emotionally, the operations of the prefrontal cortex will provide empathy and cues to sociability, the basis for communal spirit, and moral sense. Within this area, there is a high density of contacts between nerve-cell branches. The early maturing of the prefrontal cortex is one of the hallmarks of high levels of human intelligence. The intuitive process seems to be highly synthetic and dynamic, drawing from and integrating all other brain functions. It is this integration that releases creativity.

**In the Classroom**
Strategies that increase awareness of and involvement in intuitive ability are important to optimizing learning. Intuitive activities include: use of imagery, completing a picture from partial information, exploring the open-ended solutions of “what if” problems, acting on a hunch, observing trends, and stretching the mind into the future.

**Example: Guided imagery.** This exercise can elicit original and creative compositions from students, using their own internal images. After discussions of the processes of intuition and use of imagery in creative production by known artists and musicians, ask students to write about “Things I Like at School” and “Things That Bother Me at School.” Begin the lesson by asking students to close their eyes and imagine themselves as photographers taking pictures of things they like and don’t like around the school. After they have had sufficient time to “see” several photos for each topic, ask them to draw and write about their topics, using the pictures they just “took” with their mind camera. Use of this intuitive beginning gives students a tool to succeed in their current and future writing.

It is hoped that this exploration of four areas of the brain and some of the brain-compatible strategies that can be used in the classroom to develop them, will allow educators to create more powerful learning experiences that support learners in developing more integrated and efficient learning.
### Glossary of Words Related to the Brain

<table>
<thead>
<tr>
<th>Word</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amygdala</td>
<td>The region of the brain that is most specifically concerned with emotions and it underlies emotional memory. It is a collection of several nuclei that lie deep in the temporal lobes of the cerebral hemispheres.</td>
</tr>
<tr>
<td>Arborization</td>
<td>The branching of dendrites</td>
</tr>
<tr>
<td>Automaticity</td>
<td>The conversion of behavior after conscious rehearsal to nonconscious behavioral routines. The ability to let your mind wander more freely when something has been mastered.</td>
</tr>
<tr>
<td>Autonomic nervous system</td>
<td>The part of the nervous system consisting of the sympathetic and parasympathetic nerves that controls the internal environment, including the &quot;involuntary&quot; functions, such as heart rate, blood pressure and respiration.</td>
</tr>
<tr>
<td>Axon</td>
<td>A long nerve fiber that extends from the cell body of a neuron and often branches at the end; serves as a transmitter of biochemicals to other neurons.</td>
</tr>
<tr>
<td>Brain stem</td>
<td>One of the three major divisions of the brain, it processes sensation from the skin and joints in the head, neck, and face, as well as specialized senses, such as hearing, taste, and balance. It serves as an intermediary for life-support functions, such as breathing, heart rate, and digestion, allowing them to act in an integrated manner. It monitors muscular movement and sensory input receiving nerve impulses through the cranial nerves. It is made up of the medulla, the pons, and the midbrain and is located above the spinal cord.</td>
</tr>
<tr>
<td>Cell body</td>
<td>The part of the neuron that contains the nucleus with its DNA.</td>
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<tr>
<td>Cerebellum</td>
<td>Located at the base of the brain, it is one of the three major divisions of the brain and is responsible for muscular coordination. It modulates the force and range of motion and is involved in motor coordination and the learning of motor skills. It serves as a communication link to the rest of the brain.</td>
</tr>
<tr>
<td>Cerebral hemispheres of the brain:</td>
<td>The left half of the cerebrum; the hemisphere most responsible for verbal, linear, rational functions. The right half of the cerebrum; the hemisphere most responsible for mathematical, spatial, gestalt functions.</td>
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<tr>
<td>Left hemisphere</td>
<td></td>
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<tr>
<td>Right hemisphere</td>
<td></td>
</tr>
<tr>
<td>Cerebrum</td>
<td>One of the three major divisions of the brain consisting of 5/6 of the brain mass. It is convoluted with wrinkles and deep cerebral furrows that contain centers for sight, sound, smell, and touch; it also is the site for intelligence and memory.</td>
</tr>
<tr>
<td>Corpus Callosum</td>
<td>A large fiber system connecting the right and left cerebral hemispheres allowing them to communicate. There are more connections between the hemispheres than to any other part of the body indicating the need to use both systems to enhance learning and thinking.</td>
</tr>
<tr>
<td>Cortex</td>
<td>The external layer or covering of the cerebrum that carries out many brain functions. Sometimes referred to as the neo-cortex or the cerebral cortex. (Also see Prefrontal Cortex.)</td>
</tr>
<tr>
<td>Dendrites</td>
<td>Short fibers that are branched extensions of the cell body of the neuron; they communicate by receiving the biochemical messages from the axon of other nearby neural cells. The site of the connection between the neurons is called the synapse.</td>
</tr>
<tr>
<td>Frontal Lobe</td>
<td>One of the four lobes of the cerebral cortex (frontal, occipital, parietal, and temporal). The frontal lobe is primarily concerned with working memory, reasoning, planning, decision-making, and judgment, as well as, speech, and movement.</td>
</tr>
<tr>
<td>Glia</td>
<td>The supporting cells surrounding the neurons that are necessary for biochemical, energetic, and structural functions. Gial or glia cells provide the brain with nourishment, consume waste products, protect, and serve as packing material that glues the brain together.</td>
</tr>
<tr>
<td>Heteromodal</td>
<td>Indicates integration of information from the various unimodal regions of the brain, such as expressive language, motion, color, and sound.</td>
</tr>
<tr>
<td>Hippocampus</td>
<td>A sausage shaped neural structure located in the temporal lobes of the cortex that is necessary for the storage of memory.</td>
</tr>
<tr>
<td>Hypothalamus</td>
<td>A set of nuclei below the thalamus that controls pleasure, body temperature, and sleep. It affects feeding, sex, emotional expression, endocrine functions, and movement.</td>
</tr>
<tr>
<td>Integration</td>
<td>In brain science the relating, correlation, or connection of signals to yield a unitary, optimal output.</td>
</tr>
<tr>
<td>Limbic Area</td>
<td>The bottom part of the cerebrum that controls emotions; sometimes called the “emotional brain.”</td>
</tr>
<tr>
<td>Memory</td>
<td>The ability to invoke or repeat a specific mental image or a physical act. There are processes that result in short-term memory and long-term memory. The development of memory depends on the novelty and meaningfulness of the of the learning experience that can then change and strengthen the synaptic process resulting in a change in the neuron and the pathways between neurons.</td>
</tr>
</tbody>
</table>
Myelin Sheath
A fatty layer of glial cells that surround and insulate the neuron’s axon.

Neuronal Bench
The depth of neurons available to act against small strokes, falls, Alzheimer’s disease, and other neurological damage.

Neuron
The major cell making up the brain and nervous system that carries signals to and from the brain and performs much of the brain’s work. These tiny information-processing systems receive and send thousands of signals daily. It is estimated that there are over 100 billion neurons within the brain. A neuron is made up of the nucleus (the body or processing center of the cell where all genetic material is found), the dendrites (the extension receiving information), and the axon (the extension sending information).

Neurolplasticity or Plasticity
The ability of synapses, neurons, or regions of the brain to change their properties in response to usage or different patterns of stimulation. A term used to indicate that the brain is malleable and always changing in response to the environment.

Neurotransmitter
A chemical released from a neuron into the synaptic gap that either turns on or turns off the activity of another neuron. Neurotransmitters are the chief means of communication between neurons.

Nuclei
Closely connected collections of neurons with similar activities, functions, neurotransmitters, and input-output relations; they have a definite boundary.

Prefrontal Cortex
The section of the cortex that is the most forward part of the frontal lobe, located just behind the forehead. It is associated with planning, decision-making, higher-level cognition, attention, and is thought to house the intuitive area of function. It is the last section of the brain to mature.

Receptors
Proteins on the surfaces of cells that bind neurotransmitters, hormones, drugs, and so forth during the synaptic process. They recognize transmitters, and carry out functions to make connections effective.

Reserve Capacity
Enhanced ability to cope with neuronal damage or attrition.

Reticular Formation
To divide, form, or construct to form a network of cells.

Synapse
The specialized site of communication between two neurons; the process by which impulses travel from one nerve cell to another. A synaptic gap becomes the critical connecting structure between neurons that mediates their communication by electrochemical means (i.e., neurotransmitters).

Synaptic Strength
The degree by which neurotransmitter release affects the receiving cell, strengthening or weakening the cell. This alters the establishment of memory and reflects the degree of neural plasticity and the ability to develop in response to the environment.

Unimodal
Regions of the brain with only one type of information such as expressive language, motion, color, or pure tones of sound.

Zone of Proximal Development
The distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance, or in collaboration with more capable peers. (Vygotsky, L. S. (1962). Thought and language. Cambridge: M.I.T. Press.)

Recommended Resources

http://www.RODALESTORE.com
Developing Intelligence
A Brain Matter

1870s
Investigations by Darwin and his cousin Galton established a belief that intelligence was solely inherited, unchangeable, and fixed throughout life.

Binet developed intelligence scales to separate slow learners in schools for a special curriculum. Though he thought intelligence to be educable, his scales and concept of mental age were used to support heritability and constancy of intelligence.

1900s
Piaget drew attention to intellectual development in early childhood and his work supported an interactive view of intelligence. Guilford introduced the Structure of Intellect Model breaking with the tradition of one general (g) factor. Instead he introduced the concept of multiple interrelated factors (120) to explain intelligence. He drew special attention to creativity as an important function of the mental processes.

1920s
Terman revised Binet’s intelligence scales and created the Stanford-Binet Intelligence Test, a popular measure for fixed intelligence. Wilhelm Stern developed the Intelligence Quotient (IQ) to indicate a score on an intelligence test. This score assumed that a normal distribution or Bell Curve exists in the population.

1930s
Hall and Gesell introduced Predeterminism, the concept that there is a genetically predetermined sequence of physical milestones (e.g., sitting up, walking, etc.) that all children experience at the same age regardless of their experiences. It came from their belief that maturation leads learning.

The concepts of the educability of intelligence, inconstancy of IQ, and interactive intelligence requiring both nature and nurture to account for intelligence were supported by the work of Montessori, Wellman, Dennis, and Hunt.

1940s

1950s
Terman revised Binet’s intelligence scales and created the Stanford-Binet Intelligence Test, a popular measure for fixed intelligence. Wilhelm Stern developed the Intelligence Quotient (IQ) to indicate a score on an intelligence test. This score assumed that a normal distribution or Bell Curve exists in the population.
Hawkins explored a new framework for understanding and developing intelligence based on knowledge of brain function and introduced a theory of how intelligence develops within the brain. Behavior can now be seen as the outcome of intelligence, not the definition. The level of brain function may now define intelligence.

Kandel and other neuroscientists across the U.S. extended the concept of intelligence beyond the behavioral aspects to an understanding of intelligence as it operates and develops within the brain.

Sternberg introduced the triarchic concept of intelligence that supports a process-based definition.

Gardner introduced an enhanced theory of multiple intelligences. He defined categories of learners and suggested applications for the classroom. He continued to focus on behavior for the definition of intelligence.

1960s
The work of Diamond, Krech, and Rosensweig in the brain research laboratories at the University of California, Berkeley showed that the brain changes in form and structure dependent on the stimulation from the environment thereby changing the prevalent conceptions of the development of intelligence. The interaction between nature and nurture were proven to critically affect the growth of intelligence and the ability to learn.

1970s
Evidence from brain researchers across the United States supported the interactive concept of intelligence and the importance of environment and nurture to its development.

1980s
Refining Guilford’s work, Gardner introduced an enhanced theory of multiple intelligences. He defined categories of learners and suggested applications for the classroom. He continued to focus on behavior for the definition of intelligence.

1990s
Sternberg introduced the triarchic concept of intelligence that supports a process-based definition.

2004
Hawkins explored a new framework for understanding and developing intelligence based on knowledge of brain function and introduced a theory of how intelligence develops within the brain. Behavior can now be seen as the outcome of intelligence, not the definition. The level of brain function may now define intelligence.
Neuro-anatomical terms now sprinkle the gifted literature like so much intellectual pepper. The reader is left trying to sort out whether these terms are being included to add weight to an argument that it otherwise would not have earned, or if there is neurological literature pertinent to giftedness and gifted education. The intent of this article is to help the reader navigate through the key neurological concepts relevant to giftedness and gifted education. Certain key concepts about how and why the brain is organized the way that it is can help a lay reader spot when an article is well grounded in the neuroscience and when it is just neuro-anatomical frippery. A second goal is to include a quick review of what is known about structural and functional differences in the gifted brain.
A QUICK TOUR OF THE BRAIN

The brain is initially intimidating, but the brain is organized logically and the principles underlying its organization are straightforward. Starting with the brain’s shape and surface, it looks complicated, like an aggressively indented walnut with the surface folded in on itself. But the folds are simply a way to take a broad surface area and shorten the distance between any points on that surface. If you took a piece of scrap paper and drew three or four small x’s scattered across the page and then crumpled the paper, you could see that the folds are an easy way to move all of those surface neurons as close to one another as possible. If you imagine that the x’s on the paper are neurons, you’ve now mastered one of the key organizing principles of the brain—the shorter the distance, the faster the signal transmission from one neuron to another.

There are similar structural principals that organize the internal arrangement of brain nuclei (dedicated processing modules). The closer a nucleus is to the base of the skull and to the spinal cord, the more vital and evolutionarily ancient it is. Over millennia, the brain has flowered from the stalk of the spinal cord. The structures near the base of the brain are nuclei managing survival tasks without your awareness or oversight (e.g., heart rate, respiration, temperature regulation). Damage to this area is incompatible with sustaining life. Again, you may not recognize the name of the nucleus, but if you know where it is located you have a good idea of the kind of function it performs.

Just above these crucial regions, sit the limbic system responsible for emotion, the pituitary gland that controls the entire endocrine system, and a number of nuclei that regulate motor control and the selection and sequencing of physical actions as well as emotional and cognitive patterns. There is little research on these deep structures and giftedness, although it is my clinical hunch that these structures would be implicated in the “over-excitabilities” observed by so many educators, counselors, and parents of gifted children.

FUNCTIONAL ZONES AND THE INTRACRANIAL COCKTAIL PARTY

The neuroscience literature often reads part science and part gossip column. Neuroscientists speak casually about how the “amygdala talks to hippocampus but not to septum” as though they were saying “Bob talks to Lisa but not to Arnold.” The nuclei tend to have reciprocal conversations with other nuclei, sometimes directly and sometimes through intermediaries (a sort of neurological note passing).

Some regions process only a single type of information, such as expressive language, receptive language, motion, color, or pure tones of sound. These areas are referred to as unimodal because they are processing one mode of information. Other areas of the brain are integrative or heteromodal. Their purpose is to integrate information from the various unimodal areas. Heteromodal areas often classify or interpret sensory information.

CORE ORGANIZING PRINCIPLES

Connectivity. The brain is organized along several basic themes. The first is connectivity. Large numbers of neurons need to be able to talk to one another, rapidly and efficiently. So great masses of them are folded to offer maximal proximity and fast signal transmission. Giftedness is associated with enhanced connectivity between neurons. Connectivity can also be enhanced by enriched environments offering play, social opportunities, and exploration. More stimulation is not necessarily better. There is ample research that hours of television exposure by toddlers have a linear relationship with development of Attention Deficit Disorder in childhood. The American Academy of Pediatrics found the data convincing enough to publish a position paper arguing that children under the age of 2 years shouldn’t be watching television. Little children need us to serve as a buffer between them and the processing demands of adult life.

Plasticity. The brain is “plastic,” meaning that it’s malleable and always changing in response to the environment and to the skills it is asked to acquire. This isn’t just a phenomenon of childhood; the brain continues to change in response to the demands you place on it. The way you spend your time and the tasks you learn reshape the connections between neurons and enhance or undermine the likelihood of an individual neuron surviving. Giftedness can, therefore, be similarly enhanced or undone by the environment and by learning activities. The answer to the nature versus nurture question is a typical one; it is “yes.” Life is dynamic and the brain is malleable. There is no blank slate, but abilities and gifts aren’t etched in stone either.

Redundancy. The brain discards nothing; it has redundant processes. As we continued to evolve, none of the older more primitive cognitive tools were tossed. This is most evident in childhood because children rely on more primitive structures to help them in problem solving or understanding the world. Gifted children may worry about the closet monster and they still want their allowance in pennies even if they enjoy learning about dark matter.

This redundancy remains true both structurally and cognitively throughout the lifespan. For children, things have feelings and thoughts. A stuffed bear may feel scared of the dark if it is kept in the closet; or it may be lonely or resentful when it hasn’t gotten its turn to sleep on the pillow. Children, including gifted children, still live in an animistic world. Animism is considered a developmentally appropriate part of early childhood. As adults, we flatter ourselves by thinking that we have moved beyond such a quaint and charming phase, but under stress primitive thinking reemerges. Remember the last time your car wouldn’t start and you kept turning the key while making encouraging comments to your car? (“You can do it. Come on!”) There is even a body of case law dating through the 16th century addressing the relevant punishment for animals or objects that had wounded a human being.

Animism remains part of adult thinking, albeit with an overlay of rational cognition. We remain vulnerable to mass hysteria, fads, advertising, and other forms of social contagion because we imperfectly rational beings with multiple, redundant problem-solving systems each making sense of a situation from its own evolutionary level. We do not know how gifted children progress through these conceptual stages, but most of the research so far...
suggests that high ability and irrationality are intrinsic aspects of being human.

Gifted children appear to be more sophisticated thinkers at their own developmental level. They may have more complex forms or animism at the appropriate developmental age, such as stuffed animal kingdoms with governments, but they don’t appear to vault ahead developmentally. This is why gifted children can show such amazingly immature behavior despite their precocious abilities.

The oddities of neuronal organization have their own intelligence; they are rarely coincidental or purposeless. One of the great advantages of having redundant systems is that it allows people to compensate for neurological injuries or disabilities. One of the challenges in working with “twice-exceptional” individuals is helping them use their strengths to compensate for their deficits; and helping them select environments and careers that play to their strengths and minimize the intrusion of their disabilities.

These redundant systems serve as alternate backup versions of skills that can be pressed into service as needed. For example, we have three balance systems (one in the inner ear, one which detects joint positions, and another which relies on visual cues). All the systems are used to integrate and refine data about your movements through space, but you can still stand upright in the dark if the other systems are intact—albeit with a greater chance of falls and toe stubbing. There are similar redundancies for virtually all cognitive tasks.

The multiple systems often allow gifted children to compensate for deficits effectively when the task demands are simple but as the complexity increases, they may falter. Gifted children who pass through elementary school without incident may struggle as they move through middle and high school years. The brain is adept at compensating invisibly until the task demands become high enough and novel enough that the person is fatigued and less structured during middle and high school years. The gifted child who pass through elementary school without incident may struggle as they move through middle and high school years. The brain is adept at compensating invisibly until the task demands become high enough and novel enough that the person is fatigued and less structured during middle and high school years.

The brain capitalizes on redundant systems even in a neurologically healthy individual. You’ll also find that learning that happens at multiple levels enhances the ability of the brain to create a pattern or protocol for responding to a situation once it has experienced it, and hopefully selecting the right pattern when the setting feels familiar. Maturation is primarily creating patterns and learning to recognize and interpret them correctly. Pattern recognition is our most unique quality. Pattern recognition is the skill we possess that cannot yet be duplicated by the fastest computers. We can recognize the alphanumeric sequence from the swirled background easily; computers cannot. We see the pattern in the noise.

Pattern recognition is something we do constantly as part of our social and cognitive lives. Is this a “hug goodbye” or a “handshake” person? Was that “I’m fine” credible, or did the body language suggest something besides contentment? Children are typically socially graceless and they gain poise through life experience and the regular embarrassment of their parents. They gain it through the gradual accretion of social information and appreciation of social patterns. “Please” and “thank you” are taught not inferred. The gap remains between cognitive ability and wisdom.

WHAT WE KNOW ABOUT THE GIFTED BRAIN

Hebb (1949) thought that intelligence was organized at the level of the neurons and that it had to do with how quickly the systems of neurons could coordinate and adapt to the environment. He was prescient. The primary structural differences that differentiate giftedness include: the speed with which a neuron can signal another neuron; the volume and density of connections between neurons; the efficiency with which the brain performs tasks; and the structural flexibility or plasticity.

Neural speed. Gifted brains are fast. Cognitive processing speed, or mental speed, tends to be fast during problem-solving puzzles. But the speed of transmission between individual neurons is also faster than normal. When researchers looked at IQ and synaptic reflexes (how quickly you can jerk your hand away from a hot stove), they found that gifted individuals have faster reflexes. One of the unique qualities of a reflex is that it is a small circuit from hand to spinal cord to hand (in the case of our stove.) It is three neurons chained together. These neurons are sending signals faster. Researchers like Jensen (1998) have found that the speed of simple movement, such as pressing a button in response to a tone or a light, is faster in highly gifted 13-year-olds than would be expected for their age. He recruited these students from a pool of young teens who attended U.C. Berkeley and found that their simple reaction times were a better match with their college-age intellectual peers than with their same-age peers.

This doesn’t mean that gifted children with normal or subnormal motor speed aren’t gifted, but it appears that many (most) gifted children have more advanced motor control.

Neural expansiveness. The gifted brain is also neuronally expansive. One of the processes of enhancing the number of connections amongst neurons is called arborization, (arbor meaning tree). Healthy neurons are lush and bushy looking with ample connections to other neurons. Unhealthy neurons tend to look stunted, like the Charlie Brown Christmas tree. Arborization is fostered by having enriched environments, ample play, challenge, and exploration, as well as protection from neurotoxins. But this process appears to be true across species.

Gifted children appear to have greater arborization, which means greater connectivity and greater potential connectivity between neurons. Enhanced arborization offers one logical explanation for why gifted kids show enhanced cognitive abilities. If neurons are well connected, they are able to recruit the neurons they are connected to assist in performing a task. Given that we have as many neurons in an individual brain as there are people in China, the more neurons that can be recruited appropriately to process information or send a signal, the better our problem-solving ability.

One of the other benefits is enhanced ability to cope with neu-
ronal damage or attrition. Satz (1993), a neuro-psychologist, coined the term reserve capacity to describe this phenomenon. Essentially, this is the depth of a person’s neuronal bench to borrow a sports analogy. If you have a deep bench, you have many players to draw on if your starters are fatigued or injured. If you have a shallow bench, you demand more of your starters and you have few other resources as they begin to falter. Gifted individuals have a deep neuronal bench, which means they are able to hold up well to small strokes, falls, Alzheimer’s disease, or other neurological wear and tear. Gifted adults should continue to move apart from their normal age cohort as they age because they are better protected against the neuronal ravages associated with older age and illness. The performance of gifted older adults and adults with a normal IQ can be so distinct on neuropsychological measures that the scores of two groups may not even overlap.

Reserve capacity helps in terms of neuronal recruitment, but it also helps in compensating for neuronal injury. Reserve capacity allows a neuron to reroute the signal around a damaged or dead neuron more readily because there are alternate paths available. The more alternatives, the more likely there will be a reasonably efficient option.

Neural efficiency. Conveniently, the brain relies on one source of fuel—glucose. This makes it easy to track which neurons are working hardest because they will be using the most glucose. We can observe this fuel consumption in real time by using radioactive labeled oxygen or glucose and observing which regions “light up” (e.g., functional MRI, PET and SPECT scans work on this basic principal).

The work of Heier (1992) confirmed two interesting findings about giftedness; first, gifted brains are highly fuel efficient. They are the Priuses of the brain world when the tasks are routine or simple. Second, they are able to master novel tasks quickly, and once they have made the task routine they, again, use little fuel.

There was one surprising twist. While their normal metabolic rate of glucose use is quite low, they can show greater surges in glucose use than is typical when a task is novel or challenging. This may be a correlate of the enhanced connectivity; more neurons working means more neurons using fuel. To continue the car analogy, a gifted brain is the Prius with the secret heart of a Ferrari. The gifted brain uses little fuel to tootle around to the supermarket but if it has the need, the horsepower is there. It can use massive amounts of fuel and recruit other neurons to perform at an extraordinary level.

Neural flexibility. The plasticity that leads to neural flexibility is a not unique to giftedness, but it is particularly relevant to gifted educators and parents. Much of the debate centers on the nature versus nurture question. Is giftedness something that can be enhanced or undone by lack of exposure to appropriate challenge? Is there a neurological cost to intellectual apathy or the decisions to take on only the assignments that are “easy A’s”?

Research on the plasticity of the brain suggests that the brain adapts rapidly to demands that are placed on it and that lengthy, challenging apprenticeships change the brain structurally as well as functionally. Individuals who take up a stringed instrument will show an expansion of the area of the brain devoted to sensory perception of the fingertips on the fingering hand, and the expansion will be measurable within 2 weeks. More neurons have been recruited to make subtle tactile distinctions in those fingers.

The brain functions on a “use it or lose it” principle.

CONCLUSION

Intelligence tends to be a trickier concept than it seems. While we will all agree that there is something useful called “smarts,” and some of us clearly have more and others, less of it, trying to locate it in a precise brain region or quality of information processing is more challenging. The development of intelligence depends, in part, on the integrity of foundation skills, such as attention, motivation, judgment, sequencing of a task or movement, and neurologically intact perception and expression of knowledge (e.g., no input or output problems). If any of these foundation abilities are disturbed, then the quality of performances by individuals may accurately reflect their development at the time but fail to tell us what they are capable of performing.

What we seem to get, if we are gifted and neurologically intact, is a faster, well-connected, efficient, expansive, malleable brain that is designed to learn and organize information. These structural differences translate into the quality we call intelligence. The general factor of intelligence (Spearman’s g) can be best thought of as cognitive “stickiness.” If you are a snowball that is 15% more sticky, then as you tumble down a snowy hillside you will be picking up 15% more snow along the way. As you tumble and pack up more snow, you will have a larger surface area; that, in turn, will allow you to pick up even more snow, and so forth, and so forth, and so forth. As you come to a halt at the bottom, the cumulative effect of that increased stickiness will be a snowball that dwarfs its peers.
Similarly, as a gifted child rolls along, he or she will accumulate facts, connotations, skills, patterns, associations, conceptual frameworks, and the like until you have a little person with a surprisingly wide array of information. The information and skill sets that you have act as an armature allowing you to gather new information more easily. If you have a conceptual framework, then gathering new information into it allows you to organize and prioritize what you know. If all information is novel and seems of equal weight because of this, it is more difficult to learn. Learning begets learning. Without that exposure, the child cannot gather as much of that idiosyncratic collection of skills and knowledge along the way. Giftedness is capability, and it can be enhanced or undermined by experience at the level of the neuron.

WHAT CAN BE DONE TO SUPPORT GIFTEDNESS?

Certainly enhancing exposure to challenging material is helpful, but this requires helping a child tolerate challenge. This seems straightforward but most gifted children who are shunted out of gifted programs must leave because of social and emotional difficulties, not because they lacked the intellectual wherewithal. Before talking further about practice and mastery, we need to spend time on how to support a person’s ability to tolerate and seek out challenge. Without that ability in place, challenge just becomes a source of misery.

Modulation and self-modulation. The cortex or outer bark of the brain is, evolutionarily, the most recent. And the most recent section is the frontal cortex that is associated, among other things, with attention, planning, judgment, self-awareness, insight, self-monitoring, and impulse control. If the cortex is immature or injured, the person becomes a bundle of wants and wishes, with little frustration tolerance and little capacity for self-reflection or planning. Three-year-olds throw themselves on the supermarket floor when you won’t buy them gum, by 6-years-old this shouldn’t be happening unless they are ill, very tired, or very stressed. The frontal cortex is also the last to mature, finishing its development during late adolescence. Despite their eloquence, we don’t allow high school students to vote, marry, buy beer, or enter legal contracts for a reason.

Ability to delay gratification turns out to be a better predictor of college performance than SAT scores (2003). Difficulty with frustration tolerance, planning, delaying immediate gratification, and limited self-awareness undermines academic performance, friendships, and relationships with teachers.

Practice, mastery and competence. Winner (1997) coined the phrase, rage to learn, to describe the intensity with which gifted children seek their intellectual passions. Often people accuse parents of pushing their child not realizing that it is usually the child who is charging ahead. This rage to learn is worthy of respect, although we often describe it with pejorative language. We don’t refer to babies as compulsively practicing walking. It’s their developmental task; it’s what babies do. They explore broadly and intensely at their own developmental level, and eventually they achieve mastery of walking.

Simonton (1994) devoted most of his research to the question of eminence and mastery in the arts and sciences. His conclusions were that capacity or potential was a distant second to volume. It takes a decade to master a musical instrument. The 10-year-mark appears to be the basic minimum for expertise across disciplines; ten thousand hours of quality practice, beginning at the age that you begin. Rage to learn, in conjunction with practice, makes the tools of a craft transparent. The paintbrush becomes an extension of your own nervous system. Neurologically, this concept is called automaticity. A task you have mastered requires little fuel and little effort, allowing you to let your mind wander more freely.

Mastery doesn’t develop in a linear fashion; it is marked by plateaus and vertical leaps. For gifted children who are used to things coming easily, having to study or puzzle through a problem is often an unpleasant shock. They often wonder if they were incorrectly identified as gifted, or if they are doing something wrong. Just at the point when they are experiencing challenge, they may stop. Knowing that mastery isn’t a linear progression allows them to tolerate being temporarily mediocre. As one artist wrote, “We have to be willing to paint badly in the service of painting well.” We build our talents into expertise the same way we build our brains, moment-by-moment and challenge-by-challenge.

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SAT (Scholastic Aptitude Test revised edition developed in 2003 by the College Board.)


NADIA WEBB, Psy.D. is a practicing neuropsychologist and faculty member at James Madison University in Harrisonburg, VA. She currently serves on the Board of Directors of Supporting the Emotional Needs of the Gifted (SENG), and consults with the Davidson Institute for Talent Development in their work with profoundly gifted youth. She is credentialed as a Diplomate, American Board of Pediatric Neuropsychology; and by the National Register of Health Service Providers in Psychology; she is Board certified in both pediatric and adult neuropsychology.
The Significance of Enrichment

From the work of Marian Cleeves Diamond

We have learned that there is an interaction between the external and internal environment with the structure of the brain, that different regions of the cortex increase in size as the duration of exposure to the stimulating conditions is extended, that every layer of cortical neurons in the area responsible for visual integration responds to the environment, that the neurons in the cerebral cortex exhibit an impressive amount of plasticity, and that every part of the nerve cell from body to synapse alters its dimensions in response to the environment.

Editor’s note* The following is a compilation of some of the work of Marion Cleeves Diamond. Dr. Diamond is professor of Anatomy at the University of California, Berkeley, and is a former Director of the Lawrence Hall of Science. She has also taught at Harvard, Cornell, and at universities in China, Australia, and Africa. She received the Outstanding Teaching Award and Distinguished Teacher’s Award from the University of California, and is a member of the American Association of University Women’s Hall of Fame. In 1989-90, she received the CASE Award, California Professor of the Year, National Gold Medalist, and was made a member of the San Francisco Chronicle’s Hall of Fame.
These findings clearly demonstrate brain enlargement as a result of brain use.

Just as the cortical neurons become larger in a stimulating environment, they decrease in size when there is less input from the millions of sensory receptors reporting from the body surface and the internal organs. It is just as important to stress the fact that decreased stimulation will diminish a nerve cell’s dendrites as it is to stress that increased stimulation will enlarge the dendrite tree. We have seen how readily the cortical thickness diminishes with an impoverished environment, and at times, the effects of impoverishment are greater than those brought about by a comparable period of enrichment. It is the interaction of the environment with heredity that has changed the brain over millions of years.

Perhaps the single most valuable piece of information learned from all our studies is that structural differences can be detected in the cerebral cortices of animals exposed at any age to different levels of stimulation in the environment. First, we found that young animals placed in enriched environments just after weaning developed measurable changes in cortical morphology. Then, we worked backward in age to the animals not yet weaned and found such changes, and we even found measurable effects of prenatal enrichment. Later, we moved forward in age to learn that the enriched young adult demonstrated an increase in dendritic growth, not only above that found in his impoverished mates, but even above the level of the standard colony animal. In the very old animal, with the cortex following its normal decline with aging, we again found the enriched cortex significantly thicker than the non-enriched. In fact, at every age studied, we have shown anatomical effects due to enrichment or impoverishment.

The results from enriched animals provide a degree of optimism about the potential of the brain in elderly human beings, just as the effects of impoverishment warn us of the deleterious consequences of inactivity. Our ultimate goal in studying the aging animal brain is to bring as much dignity as possible to the aging cerebral cortices of animals exposed at any age to different levels of enrichment. We again found the enriched cortex significantly thicker than the impoverished mates, and at times, the effects of impoverishment are greater than those brought about by a comparable period of enrichment. It is the interaction of the environment with heredity that has changed the brain over millions of years.

We do not yet know the true capacity or potential of the brain. Our data at present suggest that nerve cells benefit from “moderate” sources of stimulation, allowing for new connections to be formed, and thus providing the substrate for more options. Only further studies will provide information on the actual potential of the cerebral cortex to alter its structure with increased stimulation.

It is possible for us to conscientiously train our senses, all of them, at any time in our lives. If we fine-tune the primary sensory areas early, the association cortices might then respond to more subtle differences in a greater variety of ways. Creative ideas could arise from a broader experiential base. The finding of more widespread changes in the brains of enriched rats than in those of rats trained to learn a specific task supports the claims of numerous educators, from Dewey on, that providing a wide variety of experiences to the growing child enhances intellectual development.

Though we have demonstrated the plasticity of the cerebral cortex, we are very much aware that the brain does not work by itself. Healthy support systems (i.e., the cardiovascular, respiratory, urinary, and digestive systems) are essential to the maintenance of the healthy brain.

- The heart and its accompanying blood vessels need to be maintained through balanced diet and exercise.
- With exercise, the connective tissue surrounding the skeletal muscles and blood vessels can remain strong and aid with efficient circulation of the blood.
- The lungs should be free of disease, such as emphysema which can be caused by smoking or breathing air contaminated with pollutants.
- The body needs to take in adequate fluids to keep the kidneys working efficiently; these, in turn, keep the blood free of concentrated waste products.
- The digestive system needs to benefit from strong teeth that can break down food for efficient digestion, and from a fibrous diet to maintain the well-being of the large intestine.

All of this is nothing new. It was Plato who said, back in 400 B.C., that a healthy body promotes a healthy brain and a healthy, healthy body.
Satisfying emotional needs is essential at any age. Our results imply that the two regions of the brain, the limbic system and the cortex, need to work together efficiently for the well-being of the whole individual. Thus it is important to stimulate the portion of the brain that initiates emotional expression, which encompasses the connections between the cerebral cortex and the limbic system, including the hippocampus, amygdala and hypothalamus.

In our studies it was the cortex that responded more readily to the environmental conditions and not those parts of the limbic system that we measured, such as the hippocampus and amygdala. The fact that these structures are less adaptable to a varied environment implies that they are more basic to the survival of the individual, suggesting that emotional well-being may be more essential for survival than intellectual.

Other kinds of stimulation besides mental challenges (e.g., considerable personal attention and other forms of emotional involvement) may be essential to create changes in limbic structures. If this is so, how much more effort should we be making toward giving attention and care to each other? It is most important for the intellectual components of the brain to be taught ways to guide the emotional ones.

The ultimate goal of all of our studies has been to gain a better understanding of human behavior by examining its source, the brain. The simple enriched environmental paradigm allowing rats to interact with toys in their cages produced anatomical changes in the cerebral cortex. Now how do we apply this knowledge for the benefit of people? Since no two human brains are exactly alike, no enriched environment will completely satisfy any two individuals for an extended period of time. The range of enriched environments for human beings is endless. For some, interacting with objects is gratifying; for others, obtaining information is rewarding; and for still others, working with creative ideas is most enjoyable. But no matter what form enrichment takes, it is the challenge to the nerve cells that is important. In one experiment where the rats could watch other rats “play” with their toys but could not play themselves, the brains of the observer rats did not show measurable changes. These data indicate that passive observation is not enough; one must interact with the environment. One way to be certain of continued enrichment is to maintain curiosity throughout a lifetime. Always asking questions of yourself or others and in turn seeking out the answers provides continual challenge to nerve cells.

Finally, now that we have begun to appreciate the plasticity of our cerebral cortex, the seat of the intellectual functioning that distinguishes us as human beings, we must learn to use this knowledge. It must stimulate and guide our efforts to work toward enriching heredity through enriching the environment ... for everyone ... at any age.

REFERENCES

Brain Facts That Make You Go “Hmmmm”

- The adult human brain weighs about 3 pounds (1,300-1,400 g).
- The adult human brain is about 2% of the total body weight.
- The elephant brain weighs about 6,000 g.
- The cat brain weighs about 30 g.
- The human brain has about 100,000,000,000 (100 billion) neurons.
- The octopus brain has about 300 million neurons.
- Unconsciousness will occur after 8-10 seconds after loss of blood supply to the brain.
- Neurons multiply at a rate 250,000 neurons/minute during early pregnancy.
- The weight of an adult human cerebellum is 150 g.
- There are 1,000 to 10,000 synapses for a “typical” neuron.

SOURCE: HTTP://FACULTY.WASHINGTON.EDU/CHUDLER/FACTS.HTML

- An elephant’s brain is about six times as large as a human brain. In relation to body size, however, humans have the largest brain of all the animals (about 2% of body weight).
- The human brain weighs an average of about 1.4 kilograms, or a little over three pounds. A cat’s brain weighs about one ounce.
- Number of neurons in the brain (average): 100 billion
- Number of neocortical neurons lost each day: 85,000
- Albert Einstein’s brain was smaller than average, because he was smaller than average.
- There are 100,000 miles of blood vessels in the brain.

We now know for a fact that the brain continues to produce new neurons throughout our lives, and it does so in response to stimulation. This is referred to as brain plasticity or neuroplasticity, and it is one of the most encouraging of these “brain facts.”

SOURCE: HTTP://WWW.INCREASEBRAINPOWER.COM/BRAIN-FACTS.HTML

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<th>Proportion By Volume (%)</th>
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<th>Human</th>
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</tr>
<tr>
<td>Diencephalon</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
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<tr>
<td>Hindbrain</td>
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<tr>
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<td>10</td>
</tr>
<tr>
<td>Spinal Cord</td>
<td>35</td>
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</table>

(REFERENCE: TRENDS IN NEUROSCIENCES, 18:471-474, 1995)
Imagine a world in which we value wisdom and compassion as much as we do intelligence and logic. Studies of wisdom suggest that individuals who are considered wise have the ability to reflect on their own internal life as well as the internal subjective world of others. Wisdom is more than intelligence in problem solving. To be wise includes a sense of an individual’s connection to other people and to a world larger than the personal self.

How do we help children and adolescents develop wisdom? How do we promote compassionate concern and empathic skills in our youth? In today’s intense educational environment, it may be helpful to state from the outset that recent soon-to-be-published research findings reveal that teaching children the skills of social and emotional intelligence actually fosters superior academic performance. But why would this be the case? Why would learning how to relate compassionately to your peers, how to reflect on the importance of emotions in your own and others’ mental lives, and how to problem solve for effective conflict resolution, each support better intellectual development?

In this article, we will offer you a brief tour into the human mind so that we can attempt to answer some of these pressing questions. We say “pressing” because traditional education has been pressured into focusing on linguistic and logical skills rather than on the basic elements of wisdom. The result is not only students who are limited in a broad range of important but non-academic skills, but also a new generation that lacks the essential emotional intelligence that is fundamental to the development of resilience in life.

WHAT’S THE BRAIN GOT TO DO WITH IT?

It would be easy to share with you some basic facts about brain science that illuminate the nature of memory and learning, but such statements—that we’ll get to in a moment—would be reducing an elegant and intricate connection of the brain to relationships and the mind. Education so often involves the learner having a relationship to a teacher in the form of a person or a text. This relationship both motivates and cultivates the learning of the
When we have an experience, neurons are firing and energy and information are flowing. Effective teaching involves the sharing of energy and information such that the connections among neurons are changed.

The term neuroplasticity refers to the way the brain's connections change in response to experience. Effective teaching can harness the power of neuroplasticity. So while we can be entertained by stimulating television programs or videogames, we may not actually learn much from them. Studies reveal that four major factors enhance synaptic changes in response to experience. The factors include novelty, the focus of attention, aerobic exercise, and emotional arousal. These factors seem to allow an experience to have long lasting impacts on the structure of the brain itself. It is important for teachers to engage the minds of their students in their ongoing relationship experiences so that they can change the students’ brains in a positive direction.

Students need a combination of new interactions and repetition to ingrain experiences into memory. The child who is gifted in a particular area may be a rapid learner who needs very little repetition to have long lasting synaptic changes. In fact, such children often become irritated when teachers use the usual modalities or repetition that many students may require. Therefore, the principles of neuroplasticity for these individuals suggest that synaptic change is rapid and novelty provides an important source of stimulation while challenge is a source of motivation. In addition, those who are considered “gifted” in a particular area may integrate knowledge and skills in that domain across various subjects. In this way, we can say that learning is more integrated in both a vertical (enhanced expertise) and horizontal (cross-domain connections) manner.

Vygotsky (1962) put forward a concept called the Zone of Proximal Development (ZPD). This Zone is bounded on the lower side by what an individual can do on his or her own and on the upper side by what he or she can achieve with the presence and assistance of a teacher. Effective teaching for educators or parents involves being sensitive to the ZPD of those under their care. For example, if a teacher gives instructions beyond the Zone, a student can become lost, frustrated, and stressed. Similarly, if an educator teaches beneath the Zone, students can become bored, irritated, and stressed. Ideal education would give teachers the training and the environmental support to identify the ZPD for each student and offer the kinds of experiences that optimize their learning.

**RIGHT AND LEFT**

You are reading these words that are linguistic packets of information spread out in a linear fashion. This is the nature of our left brain information processing. Fortunately, nature has placed a number of functions on the left that begin with the letter L:

- logical
- linguistic
- literal

The logic of the left is called syllogistic reasoning and involves the seeking of cause-effect relationships in the world. Literal
implies a concrete definition of information. These four Ls of the left hemisphere also develop later, after the third year of life.

In contrast, the right hemisphere is dominant in its growth in the first few years of life and because it does not process verbal language, it is called by some the “non-dominant” hemisphere. Even while attending large conferences, prominent scientists have called the right hemisphere the appendix of the brain, a remnant from the past that does nothing useful in our present lives. This could not be further from the truth.

Recent studies in neuroscience reveal that the right hemisphere is dominant in a number of extremely important processes that we use—or should be using—in our daily lives. These activities include holistic perception in contrast to linear, non-verbal as opposed to linguistic language, spatial and temporal imagery instead of logical processing, and rather than literal there is a wide spectrum of processes that can be described as follows.

The right hemisphere is important for assessing the internal mental state of one’s own and of others’ minds. This capacity can be called mindRead and is the way we use neural firing patterns to create images of the mind, of the self, and others (Siegel, 1999). When we articulate in words such views of the mind, we are now harnessing the left hemisphere’s linguistic processing as well. This raises the important principle that highly sophisticated mental activities involve an integration of neural areas such as the right and left hemispheres.

The right hemisphere is also dominant in the encoding and storage of autobiographical memory. Further, the right hemisphere is the only side of the brain that has an integrated map of the whole body. This latter finding reveals that the flow of information from body-proper to brain moves in the following sequence: body to brainstem to limbic areas to the right hemisphere and then to the left. Given this sequence of information flow, it may not be surprising to find that the right hemisphere is sometimes considered the primary mediator of stress reduction and emotional regulation.

So why would some people say the right hemisphere is non-dominant or just an appendix? Such statements likely emerge from the dominant position in our culture and in our schooling of the linguistic linear logical modality of the left hemisphere. Naturally, this “left mode” may have a predilection for viewing its own processes as not only important but superior over the “irrelevant” activities of the right. For example, various studies reveal that the left hemisphere is literally incapable of perceiving the non-verbal signals of other people. These signals include eye contact, facial expressions, tone of voice, posture, gestures, and the timing and intensity of responses. The left hemisphere is not only blind to these but also does not use these important modes of communication to express itself. The left hemisphere seems to favor “digital definitions” of the world such that things tend to be demarcated as on or off, yes or no, up or down, right or wrong. In this way, the left hemisphere loves clearly defined word definitions whereas the right seems to become active when words have ambivalent meanings such as in their use in poetry. The right hemisphere seems to be both comfortable and drawn to embracing the “analogic spectrum” of the natural world.

In this way, the right hemisphere has been said to see things as they are while the left hemisphere creates categories to classify the world into mind-created artificial divisions to satisfy its need to control and predict outcomes in the world.

EDUCATION, MEMORY AND BRAIN FUNCTION

Neuroscience tells us that both genetics and experience are important in shaping the synaptic connections of the brain. The basic architecture of the nervous system, including the brain, is built upon the blueprint encoded in the genetic information and expressed during the in-utero period and early years of life. Experience after birth activates particular patterns of neural firing that then strengthen the connections among the activated neurons.

The primary area of the brain to develop first is the brainstem that mediates basic physiological regulation, states of arousal, and fight/flight/flee survival reaction under threat. Above this “reptilian” brain and also developing early on is the limbic area, which controls the four basic processes of affective arousal, appraisal of meaning, memory, and attachment relationships. The brainstem and limbic areas together create our motivational drives and emotional states. Quite undeveloped at birth and ready to be shaped by the experiences of interacting with people and the environment is the outer, higher layer of the brain, the neo-cortex. While nature has provided a genetic push for an excess in the numbers of synaptic connections in the cortex, experience serves to maintain those genetically created synapses as well as to create novel synaptic connections.

The right cortex develops first and its architecture is uniquely shaped by the input from the limbic and brainstem areas beneath it. Given that genetics over the last 200 million years has made these sub-cortical structures asymmetric, this difference in the input to the right versus left cortex creates the asymmetry seen in our higher cortical functioning as described above. But what role does experience play in this asymmetry? How do our relationships and our culture influence which areas of the brain we will tend to use more than others?

The basic principle of neuroscience stating that the brain is like a real estate market that capitulates to the highest bidder is a useful idea in addressing these questions. For example, if you think about your own educational experience since third grade, do you recognize an emphasis on one or both hemispheric processes? In our own experiences, we can say that the linear, logical, linguistic, and literal mode was both emphasized and rewarded. Yet very little was offered that supported holistic thinking, imagery, compassion, or self-understanding. In fact, there was so much emphasis on the digital approach to categories and classifications that the right hemisphere’s more analogical and imagery-based processing was not only ignored but also discounted.

What teachers and parents provide for students is a role model for how to access and appreciate all aspects of neural functioning.
While the forceful logic and language-based arguments of a left hemisphere can make the more subtle and reflective right hemisphere shudder, a thoughtful educator and caregiver can intentionally honor both modes of neural processing. One way to embrace this need to integrate these disparate but equally important ways of knowing about reality is through a process called mindful awareness.

THE WISDOM OF MINDFUL REFLECTION

The term “mindfulness” has been used in various ways over the last 2500 years. Found in virtually all cultures in both the East and the West, a practice of mindfulness in which an individual is encouraged to intentionally focus on moment-to-moment experience without grasping onto judgments has been suggested to promote well being. Recently, carefully conducted research has supported these claims and shown that the practice of mindful awareness promotes physiological, interpersonal, and mental health (Kabat-Zinn, 2003). Educators and parents can take advantage of these practices available in a secular approach that helps develop the focus of attention and to integrate the many modalities of neural processing. For example, some studies have shown that with daily mindful practice there is a shift toward an “approach state” such that individuals move towards rather than away from challenging situations. In our own research center at UCLA, we have found that individuals with attention challenges have had highly significant improvements in their executive control of attention through mindful awareness.

Mindful awareness practices can be woven into daily classroom activity and involve various forms of focusing the mind on its own processes. For example, in yoga one maintains an awareness of the awareness of the position of the body. In mindfulness meditation, the practice focuses awareness on awareness of the focus of attention. In all mindfulness practices there is this cultivation of awareness of attention and attention to intention. These practices can be seen to harness the executive functions of a part of the cortex that is extremely important in our lives. This region is called the prefrontal cortex and is involved in at least nine essential functions:

1. bodily regulation 5. flexibility in response
2. attuned interpersonal communication 6. insight
3. emotional balance 7. empathy
4. fear modulation 8. intuition

This list of nine prefrontal functions overlaps completely with the research established outcomes for mindfulness practice. Interestingly, the first seven of these nine have also been proven to be outcomes of secure parent-child attachment relationships. Numerous psychotherapists who are shown this list have enthusiastically supported it as a description of mental well being. This can also been seen as a fundamental list describing the attributes of social and emotional intelligence. In teaching Native Americans from the frontier of Alaska recently, one tribal elder reported that this list overlaps with what her Inuit culture has been teaching as the foundation for wisdom for over 5,000 years.

In modern studies of wisdom (Staudinger & Pasupathi, 2003), researchers have found that those considered wise in a community have the essential features of self-understanding, compassion for others, and a commitment to helping the larger society. Such wisdom likely requires at a minimum a highly developed right hemisphere that perhaps ideally will be working collaboratively with a well developed left side of the brain to be most effective. Such a collaborative integration between the right and left hemispheres would require that the highly constrained classifications and categories that prematurely limit our views of imagination and possibility should be relaxed. Mindful learning—using both traditional approaches of mindful awareness practices as well as more cognitive based mindful learning techniques—can offer a key to promoting the reflection necessary to develop wisdom.
Mindful learning (Langer, 1997) consists of openness to novelty, alertness to distinction across experiences, sensitivity to differing contexts, and awareness of multiple perspectives as well as an orientation to the present moment. Research on these components of a mindful approach to learning suggests that students enjoy the experience more and have enhanced memory retention when taught in a mindful way.

For example, a teacher can use “conditional phrases” such as “maybe,” “could have been,” and “perhaps” rather than “is,” “was,” and “must be.” Although subtle, using such conditional phrases may evoke an alertness in the brain to the world of possibilities rather than shutting down options with the use of more definitive statements. Furthermore, the mindful brain (Siegel, 2007) may actively dissolve prior constraints on learning such that new experiences are perceived with a freshness and vitality that enhances the richness and detail encoded into memory.

Mindful learning also seems to involve both the teacher’s and the student’s focus of attention on the mechanisms of the mind itself. In this way, the student is an active rather than passive participant in the learning experience. Active learning is a more engaging, more rewarding, and more integrating experience for student and teacher alike. But what such mindful learning requires is the intention of the teacher to create an interactive environment with the student in which both are receptive to the open potential to explore the nature of the world and the mind itself. In many ways, such joining between teacher and student creates a companionship in the shared journey toward understanding.

The compassion and self understanding fostered by mindful learning and essential to a wise life have at their heart the reflection of mindsight. Mindsight enables us to see the mind of ourselves and others, to become socially and emotionally intelligent. As we develop this important capacity of reflection, for example, we can see directly that the words we choose can constrain our understanding of the world. Rather than becoming a prisoner of such “premature hardening of the categories,” mindful reflection offers us the chance to live life more fully and more truthfully. Teaching parents and educators these important skills of mindfulness and mindsight offers the promise of cultivating wisdom in the next generation. There is no time like the present moment to begin.

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Siegel, D. J. (1999). The developing mind: How relationships and the brain interact to shape who we are. New York: Gifford Press.

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About the Brain: Facts & Figures

Did You Know?

- There are more than 100 billion neurons within the brain
- There are 10 miles of blood vessels in the brain cortex
- An average neuron has synaptic linkages to 10,000 other neurons
- Average number of glial cells in brain = 10-50 times the number of neurons
- Einstein had seventh order branching of his dendrites while most of us only get to third or fourth order branching.

Comparative Average Brain Weights (Selected)

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<thead>
<tr>
<th>Species</th>
<th>Weight (Grams)</th>
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<tr>
<td>Adult human</td>
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<tr>
<td>Newborn human</td>
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<tr>
<td>Elephant</td>
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<td>Giraffe</td>
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<td>Alligator</td>
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<td>Cat</td>
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<tr>
<td>Gorilla</td>
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<td>Polar bear</td>
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<td>Grizzly bear</td>
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SOURCE: FACULTY.WASHINGTON.EDU/CHUDLER/FACTS.HTML

VARIUS SOURCES

ILLUSTRATION BY KEN VINTON

34 GIFTED EDUCATION COMMUNICATOR SPRING 2008
# From Research Into Action

## RESEARCH FINDING

<table>
<thead>
<tr>
<th>Development of intelligence depends on the interaction between the biological inheritance and environmental opportunities to use this inheritance.</th>
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<tbody>
<tr>
<td>Attention and concentration rely on the impact of the environment on the brain.</td>
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<tr>
<td>Stress produces biochemistry that reduces cerebral cortical function.</td>
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<tr>
<td>The brain responds to novelty, to the unexpected, and to discrepant information.</td>
</tr>
<tr>
<td>The potential of brain development is essentially unlimited for most individuals and the dynamic nature of the brain allows intellectual growth to progress or regress, but does not remain static.</td>
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<tr>
<td>How intelligence is expressed will depend on the individual's genetic pattern and anatomical structure in interaction with the support and opportunities provided by the environment.</td>
</tr>
<tr>
<td>The brain integrates information and builds memory and predictions and generates models of reality. Students' minds do not just record what is taught; the brain makes inferences and predictions. Bright minds require complexity and need exposure to patterns and relationships.</td>
</tr>
<tr>
<td>The brain constructs meaning, it does not just process information or amplify thought.</td>
</tr>
<tr>
<td>The brain attaches emotional significance to information; good learning derives from exciting teaching, as emotional responses are often more important in making cognitive decisions than are our rational processes.</td>
</tr>
<tr>
<td>Optimal learning requires the active involvement of the learner.</td>
</tr>
<tr>
<td>Use of the processes and content of both specializations of the right and left hemispheres of the cerebral cortex are needed for powerful learning.</td>
</tr>
<tr>
<td>Intelligence is developed and supported by experiences that associate and integrate information from the different areas of function in the brain (i.e., cognitive, affective, physical/sensing, and intuitive).</td>
</tr>
<tr>
<td>The brain constantly uses feedback to create connections, store information, and develop intelligence.</td>
</tr>
</tbody>
</table>

## ACTION

| Create stimulating environments and include appropriate challenges that encourage curiosity and exploration. |
| Organize the classroom to include access to a variety and range of materials and activities; psychological safety of all students; support for exploration, and choice. |
| Minimize fear, threat, anxiety, and tension in the learning environment and do not allow such emotions to overwhelm the teaching process. |
| Use novelty to motivate and enhance the process of learning. When asked to drill, or do repetitive activities, the brain responds automatically without thought. While useful for learning some skills, such as times tables, these practices can be counterproductive to higher-level learning. |
| Organize the environment to make continuous progress from the student's level of mastery available and encourage progress beyond grade or age level for all learners guided by their individual rate of learning. |
| Differentiate and individualize instructional planning and teaching allowing each student to respond uniquely. |
| Use interdisciplinary teaching across time and space instead of single goals or objectives involving limited subject matter or isolated events. |
| Create problems to solve and work toward in-depth understanding of the concepts being taught. Integrative, multidisciplinary teaching will prevent the limits to knowledge and understanding brought about by teaching each discipline only as a separate specialization. Didactic teaching alone is no longer justifiable. |
| Make your teaching positive, empowering, and enthusiastic as this way of teaching is highly valuable in the learning process. |
| Plan for the learner to be actively involved with concrete experiences and sensory stimulation in both elementary and secondary classrooms. Use of texts and workbooks alone is not appropriate to teach abstract concepts. |
| Give opportunities for integrative and alternative modes of learning and expression to insures effective learning. |
| Include experiences from all areas of brain function in learning opportunities whenever possible. |

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*From Research Into Action*

—Barbara Clark
Today my anatomy students wanted an example of how I use neuroscience in the classroom, so I launched two examples for their consideration.

1. The brain has evolved into a novelty search engine, constantly on the prowl for new stimuli, new information. Awareness of novelty has tremendous survival value. Take for example one of our ancient cave dwelling ancestors walking back home on a moonless night. A twig snaps in the darkness behind her. Her brain is immediately aware of the novel stimulus and jumps into action.
   A predator? Adrenalin is instantly dumped into her blood vessels. "Fight or flight." She’s ready to run. The faster her reaction, the more likely she’ll live long enough to have offspring. Her genes, along with a brain design tuned for novelty, get passed on to her progeny and then, to us.
   But her brain would ignore the same sound if she’d heard twigs snapping repeatedly over the last 30 nights. Same old sound. Nothing important to attend to there.

2. The human brain abhors repetition. It literally shuts down repetitive stimuli.
   Remember the last time you walked into a donut shop? What a delicious smell. Yet, the cashier unconsciously stopped smelling those yummy donuts within an hour of the beginning of her shift.
   Though we find the smell delectable, her brain no longer finds the stimulus novel enough for continued attention. Her olfactory synapses fill with cholinesterase blocking the impulse from sending the signal any further. The donut shop still smells great, but her brain has shut down that particular signal from her nose.

How does this knowledge of the brain influence the classroom? Math teachers should avoid repetition like the plague. Remember doing all the odd questions at the end of the chapter? Your brain started to shut down after about the 4th problem. I avoid lessons involving rote memory.
   Instead, I look for lessons that engage the mind and body. As a part of a lesson about coronary circulation, the classroom is laid out like a human body while students take on various roles including red blood cells coursing through arteries, veins and capillaries. As they (red blood cells) pass through the lungs, students pick up oxygen (red biconcave disks). As they later pass that oxygen off to brain cells, they become deoxygenated and return to the heart to begin a new cycle.
   Student red blood cells walk through the “body” (class-
Comments from second graders in a classroom environment designed to support the developing brain:

Parker, age 6, surveying the second grade classroom: “My favorite place is my bed…but I like this place second!”

Michael, age 7, while using individual clocks for solving problems about telling time: “You know, this is actually kind of fun!”

This second grade class loved to hold its reading groups on the couch in the library area of the classroom so much that a schedule had to be made so everybody would have a turn each week. Because the class has 20 students and only 4 can fit on the couch at once, this young man needed to make sure his classmates did not use his time by shouting out, “Hey! It’s Table 2 couch sitters turn.”

Whenever the class has managed—as a class—to behave really well, the class gets “Centers Time.” The 12 center signs are put up on posts and the children have 35 minutes of “exploration/activity” time. This is treasured time. The “Centers,” as yet undiscovered by the children, are all academic. Of course, they are also all manipulative.

“Teacher! We haven’t done ‘Morning Board’ yet!” Morning Board is a large bulletin board that is full of daily problems, analogies, and a quote for the day—all to promote thinking. The students like it because a student gets to be the “teacher” and leads Morning Board. It is so enjoyable to the children that it is never missed.

The classroom atmosphere is so emotionally “comfortable” for the students that the following remarks have been heard, “My desk is disgusting, I think I need to clean it out now.” (Good use of self-assessment.)

“Wow! Look at my fossil! It fell apart! I’ll have to figure out how to put it back together like an archaeologist.” (There is no fear of failure.)

When asked for volunteers for sharing the next day, hands shoot up quickly.

“I’ll share tomorrow. I have a shark’s tooth!” (Children are comfortable with volunteering.)

—Christine Hoehner, Second Grade Teacher

Observations from a middle school classroom:

When the classroom is structured and run as a Responsive Learning Environment, the students:

• make greater gains in positive attitude toward school.
• feel more supported by their teachers.
• have a more open relationship with their peers.
• are more enthusiastic about learning.
• learn to function independently and acquire skills for lifelong learning.
• appreciate the climate of acceptance and support.
• feel secure and supported, both cognitively and creatively.
• appreciate being given choice in practices, products, and outcomes.
• make lifelong friendships.

—Barry Ziff, University Instructor

—Toby Manzanares, High School Teacher
Teaching
Our Students
About the Brain

By Susan M. Ryan

Frequently, as I walked through the halls of Churchill High School in Livonia, Michigan, I encountered students who, with a smile, upraised arms, hands in a fist, waved a “Hi Mrs. Ryan.” These were students not only sending a greeting, but reminding me that they understand the power they have over their brains.

Whenever I share information about the brain, I find the participants are fascinated. This goes for children as young as 5-, 6-, and 7-years-old, middle school students who see this information as one more way of figuring out who they are, high school students who become intrigued with the power they can gain, and adults who find it fascinating to begin to understand something “quite mysterious.”

I first became acquainted with the hand model of the brain in a professional development session with Dr. Barbara Clark. I have used her descriptions and exercises countless times, always leaving a session knowing that children and adults have more power to optimize their growing intellect and thus their world.

A standing ovation. I often begin my sessions by asking for a standing ovation. The participants’ act of standing and clapping—and usually smiling—adds so much energy to the room! When used with children, it allows them to move purposefully. It also quickly and positively enhances the chemicals in my brain supporting me in presenting this information. Sometimes I begin by having students stand in a line and give a back-rub to the person in front of them, then turn and give the back-rub back. This
allows relaxation and focus leading to a higher level of glial production that supports an accelerated rate of learning and greater retention of information. I may make all these points later in my presentation so that my audience fully understands the reason for beginning in this manner.

Then, I love to use a quote from The Amazing Brain by Ornstein & Thompson:

It is about the size of a grapefruit. It weighs about as much as a head of cabbage. It is the one organ we cannot transplant and be ourselves. The brain regulates all bodily functions; it controls our most primitive behavior—eating, sleeping, keeping warm; it is responsible for our most sophisticated activities—the creation of civilization, or music, art, science, and language. Our hopes, thoughts, emotions, and personality are all lodged—somewhere—inside there. After thousands of scientists have studied it for centuries, the only word to describe it remains amazing. (1984, p. 21)

Using a fist model. Next, I use Clark’s (2008) fist model to illustrate the form and function of the brain. We begin with making a fist with both hand hands and bringing them together so that the fingernails are touching. (See Looking at the Brain, in this journal, p. 13) I discuss the fibers of the corpus callosum, the connector between hemispheres, the two hemispheres, the visual cortex and the motor cortex, and the language area located just below the middle knuckle on the right hand (left hemisphere). We always marvel at this point about how our own hands can be such a perfect visual model for our own brains.

Using just one fisted hand with the fingers held open, we begin to study the inner workings of the brain. The wrist area represents the brain stem, the oldest portion of the brain that houses the autonomic (automatic) functions of our body. I ask, “Who has been thinking about each beat of your heart or breath you have taken since we began talking?” It is now that they begin to think about those bodily processes that go on without much interest them, good friendships, and being positive.

The lemon tree. To make the workings of the brain stem a bit more concrete, I tell the youngsters we are going for a trip inside our heads, and they are to visually see themselves as I talk them through this journey. I ask them to get comfortable and begin.

Gently close your eyes now and let me take you with me to California to my friend’s home. It is morning—see yourself—you get up and open the front door and walk out into the yard. Notice the blue sky. It’s pleasantly cool, and you can tell it’s going to be a very nice day. Out in front of you in the yard is a lemon tree. Notice the dark green leaves; they have a bit of dew left on them. As you walk toward the tree you will notice bright yellow lemons hanging from the branches. Reach up and take one in your hand and pull it from the tree. Notice its coolness, and the smoothness of the skin. Take your fingernail and poke it, breaking a bit of the skin. Smell the lemon. Now begin to peel back that skin and break the membranes of the lemon. As you pull you can hear the skin break, and you are now exposing the fruit of the lemon. Continue to pull the skin back until you can take your thumbnail and stick it down into the fruit itself, breaking those juice sacs. Let that juice begin to ooze out over your thumb…cool lemon juice is now running down your hand. Take your tongue and put it down into that lemon and let that juice begin to ooze onto your tongue, into your mouth and down your throat…Open your eyes. You don’t have a lemon in your hand…but what are your salivary glands doing? (Clark, workshop exercise)

Using the lemon tree exercise opens discussion and gives students a powerful example of using imagery to create what is normally an autonomic reaction in the brain.

The limbic system. The second area of the brain I introduce is the limbic system located deep inside at the area of the midbrain. It is seen in the hand model by opening the fist and looking at the palm of your hand. Here are the biochemical systems that activate the emotions of the learner. These biochemicals can facilitate a higher level of brain function or inhibit and even shut down learning. The biochemicals support brain function when you are rested, well fed, feel safe, valued, joyful, and find pleasure in your learning experiences. Then the biochemistry facilitates higher brain function. When your basic physical and emotional needs are not being met or when you are anxious, under tension, afraid, bored, or being punished, the biochemicals in your brain do not support higher-level thinking. As information comes into the brain, this area is like a bridge or gateway to higher cortical thought; thus all our learning is tinged with emotion. This actually gives us, as teachers, a biological base for promoting pleasure and joy in learning!

It is at this point that I might ask, “With this new information, what might you do for yourself to help your brain function well?” I want youngsters to consider things such as sleep, nourishment, exercise, techniques for relaxation, identifying things that interest them, good friendships, and being positive.

“I can.” To make the midbrain real and to emphasize the power of this facet of the brain, I have found that another exercise—the “I can” exercise—brings amazement to all ages (Clark, 1986). You will need a willing volunteer to model for the group. Ask the volunteer to hold out her or his arm and allow you to press down on the arm just above the wrist to get an idea of how much strength she or he has Then, with the youngster saying out loud, “I can, I can, I can…” press down again. Usually I find the arm remains quite strong and my pressing has little effect. Try it again using the words, “I can’t, I can’t, I can’t…” This time the arm will go down, sometimes in a very dramatic way! At this point have the participants pair up and try the experiment among themselves!

With the hand model, the cerebral cortex is represented by the
surface of the fists. The cortex is thin, only six layers thick, each layer less than 1/16 of an inch making the cortex about the thickness of six playing cards stacked on top of each other. The cortex of the human brain is very convoluted; the most convoluted brain cortex of any mammal. It is often referred to as gray matter; however, a living brain is pink because there are over 10 miles of blood vessels running through it. The cortex makes up approximately 5/6th of the brain mass. It is here that the sensory information is processed. This is where information is received and stored and where thinking and problem solving occur. This is the seat of speech and language.

The bicycle. An opportunity to process the workings of the cortex can be offered the students by use of the bicycle example.

A package arrives at the house. It is a very big box with a picture of a bicycle on the front—a bicycle that needs assembling. Some individuals might go about this project by opening the box, organizing all the parts into piles on the floor, reading the assembly directions and begin by connecting part A to part B to part C until all the parts are accounted for and the bicycle is ready to ride.

Others might eagerly open the box and spill all the parts out onto the floor. Without a glance at the assembly directions, they begin to put the bike together from their knowledge of “bikeness.” They too would assemble the bicycle and when finished they would put the few extra pieces that didn’t seem to be needed in a bag, tie it to the bicycle handle, and off they would go for a ride!!

This story helps youngsters consider how the cortex may go about the process of thinking and gives them an opportunity to think about their own thinking and problem-solving strategies.

The thumbs in our fist model of the brain represent the prefrontal cortex. It is only found in the human brain. This is where we organize, plan, make decisions, invent, and create. It is this sophisticated structure that allows insight, empathy, and intuitive thought. It is here that the “ah ha” of a bright idea occurs and the “ha ha” of humor! The prefrontal actually can be shut down with too much anxiety or boredom. Ask the students to talk in pairs about a time they played a hunch, listened to their instincts, followed their feelings or relied on their intuition. After youngsters have shared with each other, some may choose to share with the group.

I close my presentation by describing giftedness to these youngsters from the perspective of the highly efficient brain. I tell them that people who are gifted have a more complex cerebral cortex because of greater dendritic branching and a greater number of neural connections. Gifted individuals use more of their prefrontal cortex than most people. They spend more time thinking about the “what ifs.” They may invent and create new things. I tell them that their brains have enormous potential. I remind them that they have the ability to learn anything they put their mind to, do anything they want to do, and become anything they want to become. It is up to them to use their brains well. This is the time to turn the discussion over to the youngsters and ask them to consider those things over which they have personal control that allow for powerful learning to occur.

CONCLUSION

Given the current knowledge regarding brain function, schools can implement the following practices to optimize every youngster's educational experience.

- The environment is safe both physically and emotionally, and all youngsters feel safe, cared for, and liked for themselves.
- The classroom is relaxed but filled with energy.
- The curriculum is integrated with experiences that use all the functions of the brain, with themes and with interdisciplinary content that is focused on relationships and connections.
- The assignments are appropriately challenging; there is the ‘stretch’ that causes dendritic branching and thus brain growth.
- Students are given choices as often as possible and support in decision making.

Teachers can empower youngsters by supporting them in assuming control of their learning. This develops a strong inner locus of control and confirmation of the idea that we are each ultimately in charge of and responsible for our learning and thus for ourselves.

Afterthought. When I read from The Amazing Brain, I pass around a grapefruit and a head of cabbage. What better way to understand the meaning of the analogy to the brain than to consider the size and feel the weight? Typically there is quiet appreciation of these objects as I move through the discussion of the brain. In one presentation, I was delighted to learn how important this strategy actually is. I was working with our high school arts students in the choral room with students sitting on rising tiers. I asked for questions at the end, and the hands of high school students on the highest tiers waved their hands, “We didn’t get to hold the grapefruit and the cabbage!”

REFERENCES


SUSAN M. RYAN is an educational consultant with more than 35 years experience supporting the development of gifted and creative children and adults. She coordinated gifted programming in Livonia Public Schools, K–12 in Livonia, MI; she also developed the preschool gifted program for Schoolcraft Community College’s “Kids on Campus.” Currently Susan is the Consultant to the Charyl Stockwell Academy in Hartland MI where she oversees the overall program development for academically gifted students.
Matt was slight of frame and mighty of mind when I met him. He was in the third grade at the time and spent much of his leisure in correspondence with noted archeologists. This was well before the convenience of e-mail, and he expended considerable effort in writing cursive letters about issues and methods in the field to archeologists who saw his potential and responded in kind. I remember being more amazed at Matt’s tenacity with the pencil than at his knowledge about archeology—although that was stunning as well.
Fast forward several years and Matt landed in my advanced-level 8th grade English class. His frame was still slight as eighth graders go, his mind was still mighty, and his interest in archeology was now shaping his college plans—already pretty focused at thirteen. He wanted to become someone who could pursue the mysteries of the field. He wanted to make a contribution to the field, he said. To that end, he had three colleges in mind—all with stellar archeology departments—and all highly competitive.

The class in which I taught Matt was a hive of energy—kids with lots of opinions, lots of scathingly brilliant ideas about how to do (or how to manage not to do) whatever the day’s work, lots of knowledge. I saw them all as achievers, despite their many differences. Matt apparently saw something else.

One day in early November, Matt’s mom came to see me after school. Matt wanted to drop the class, she said, and added that she didn’t know quite how to handle his request. She seemed as surprised as I was that he was asking for a schedule change. He had so many good friends in the class. He was doing well.

Just as I was having a silent and personalized reaction, “I thought he liked me,” his mom said, “Most of all, I don’t know why he’d want to leave your class. He likes you so much.”

Sounding more mature than I was, I said, “Thanks, but that’s not really the issue. Something is obviously bothering him in a big way, and I guess that’s what we need to figure out.” She agreed, and went home to see if she could help Matt put his finger on what prompted his request. He had so many good friends in the class. He was doing well.

“...I can’t stand that feeling. I think if I were in a regular class, I’d feel smart again.”

—Matt, 8th grade

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Sounding more mature than I was, I said, “Thanks, but that’s not really the issue. Something is obviously bothering him in a big way, and I guess that’s what we need to figure out.” She agreed, and went home to see if she could help Matt put his finger on what prompted his request.

Several days later, Matt came to see me. He said he thought he could explain why he wanted to be in a different English class. It took some time and a few false starts, but ultimately he said, “All my life, I’ve been the smartest kid in the class. In this class, I’m just average. I can’t stand that feeling. I think if I were in a regular class, I’d feel smart again.”

Matt and I talked at length. I recall saying to him that if what mattered most to him in life was maximizing his chances of being #1, he’d need to re-think his college plans. “I suspect you’d have a pretty good chance of graduating first in your class at a community college. That’s much lower in the schools where you want to go. But in those schools, you’d have a much greater chance of breakthrough learning.” He looked at me with eyes that were reflecting both surprise and an uncomfortable understanding. I continued, “Being number one has its merits, Matt, but so does a life of contribution. To be a real contributor, you have to take chances, and as soon as you do that, you’ve risked the status. It doesn’t have to be today, but you’re going to have to make a choice for the long term.”

Matt stayed in the class, but it was an uncomfortable fit for him. Too often he saw students whose insights and skills outstripped his own. Inevitably, those moments made him pull back—made him sulky. Being number one had become something of an addiction. School wasn’t about learning. It wasn’t OK to be a good student. He needed to be the best.

I tried lots of approaches to bring Matt along that year. I talked to him, wrote to him, used examples from well-known people, paid extra attention to him, gave feedback with opportunities for revision before grading work, encouraged him to focus products on topics that interested him, assigned him to work with students who were more interested in learning than in grades and alternately to work with laid back students who just didn’t care about grades.

He stuck it out. At rare times, he seemed to engage with the work. Mostly, however, he continued to hate that he wasn’t clearly the best in the class. We were both glad when summer gave us a break.

Despite its miseries, the year with Matt was good for me. It helped me identify and put a very human face on a problem that is endemic in our schools. It takes on one shape with very bright kids like Matt and another with kids who struggle in school—and even those who do “OK.”

Carol Dweck, a noted scholar and researcher, has given a
professional lifetime to looking at the problem. She writes about it in her book called *Mindset*, written for the general public, as well as in many scholarly pieces. She has found that early in life, people develop one of two mindsets about what leads to success—what it means to be smart. Some people develop what she calls a *fixed mindset*, believing that people who are smart succeed, and that being smart is determined by genetics, opportunity, experience. If you’re smart, you’ll be successful. If you’re not, you won’t.

Other people develop what Dweck calls a fluid or *growth mindset*. Those people come to believe that effort is what determines success. People who consistently try hard, they believe, become smart and ultimately succeed.

For people with a fixed mindset, there’s not much you can do about your fate. Hard work can’t trump biology or economics or family status. For people with fluid or growth mindsets, however, their fate is in their own hands. As Dweck explains, this mindset concludes that just because one person can do something easily and quickly doesn’t mean most other people can’t do it given time and effort.

School, sadly, is a fixed mindset institution. Whether through sins of omission or commission, we set about to figure out who is smart and who is not. Once we have data that make us comfortable, we sort and teach kids accordingly. We tend to give smart kids rich, complex curriculum that demands critical thinking. We expect them to address real issues through real products for real audiences. We set high expectations for them and become their partners in achieving those expectations. We teach them with humor and energy. By contrast, too often we give the not-smart students low-level, drill-based curriculum in highly structured classrooms—often delivered by the newest teachers. We set low expectations for them and are not surprised when they fall short. We teach them with resignation. After all, what can you expect given their backgrounds?

It’s evident that students labeled as not smart would see little reason to expend effort in school. There’s little in schools to give smart kids rich, complex curriculum that demands critical thinking. We expect them to address real issues through real products for real audiences. We set high expectations for them and become their partners in achieving those expectations. We teach them with humor and energy. By contrast, too often we give the not-smart students low-level, drill-based curriculum in highly structured classrooms—often delivered by the newest teachers. We set low expectations for them and are not surprised when they fall short. We teach them with resignation. After all, what can you expect given their backgrounds?

Dweck’s research explains Matt as well. His status had always come from “being smart”—not from effort. Like many other bright kids, Matt had come to believe that smart was something you were or you weren’t. Smart kids don’t have to study—certainly don’t have to work doggedly. Trying hard is evidence that you aren’t smart. Smart and effort are incompatible, and besides, what’s the point of effort? If you’ve got it, you’ve got it. If you don’t, you don’t.

Dweck’s work dovetails in many ways with studies related to what has come to be known as “big fish, little pond effect.” These studies concluded that bright kids in competitive settings often (although certainly not always) develop lower self-concepts—and that those lowered self-concepts linger for a number of years. For these students, the outcome is often a mirror of Matt’s struggle. They conclude that they are not smart, lower their aspirations, and take classes that are easier for them. In other words, rather than believing that effort can significantly enhance their performance and that learning is about growth, not perfection, these students retreat from their possibilities.

And Matt’s dilemma wasn’t a middle school slump. Dweck’s work has found the same phenomenon from preschool through college. The big fish, little pond studies included high school students who took the negative effects of a “fixed mindset” to college with them.

I see Matt in my university graduate students regularly. They come accustomed to being “the best”—a big fish in a little pond. In the new ocean of scholars, their status is less certain. A few students respond with words or actions that say, “Hey, this is kind of cool. I’m really going to have to work here, but if I do, I can see myself taking a quantum leap forward.” Many more students say, “Just tell me what you want in the paper. I just want to get it right”—or “I don’t think I belong here. I don’t have what it takes.” And in an odd way, they’re right.

They have the ability, of course. What they don’t have is a growth mindset—a sense of the possibilities in them, so long as they fuel their potential with persistent effort and a desire to learn rather than to achieve status.

**WHY I WISH I’D KNOWN**

I still think about Matt, and wish I’d been able to discuss *Mindset* with him. I wish I’d had the “big fish, little pond” studies to share with him. What I really wish, however, is that I had understood how I was a part of the fixed mindset orientation of schools. I wish I’d seen how my practices supported competition for status rather than a hunger to learn. I wish I’d been aware how my teaching supported competition against peers rather than against oneself. I wish I had understood how I had been groomed to value “smart” over “effort”—and even groomed to be at peace with teaching some kids as though they weren’t smart.

I’d like to have been more adept at talking with Matt. But what I really wish is that I had been more adept at teaching for the satisfaction of learning and at celebrating effort and growth rather than rankings and grades.

I don’t know whether I could have changed things enough to help Matt, but I do know I’d have been a different teacher—and a better one.

**C**AROL ANN TOMLINSON, Ph.D., teaches at the University of Virginia in the Curry School of Education where she is Professor of Educational Leadership. She is a past president of the National Association for Gifted Children and author of numerous leading books on differentiating curriculum.
Although some operations of the brain are increasingly being understood, intuition retains much of its mystery. Current research is providing some tantalizing clues as to its operation. The theme of this issue is the understanding and application of brain research in education. This Hands-on Curriculum narrows the focus to intuition. A solution to a difficult problem—that “aha” moment—often rises to consciousness unbidden in seemingly unrelated circumstances. Our goal in this transformational idea for a lesson is to acquaint students with the nature of intuition and to stimulate its use through activities that nourish it.

Gifted students can benefit from a heightened awareness of the intuitive part of the thinking process, especially because the products of intuition are valuable, yet elusive. Hence, this challenge—a lesson that goes backward. Like a detective working on a case, the students will be asked to make note along the way of clues that might lead to a learning objective. There are opportunities for discoveries—“guess stops”—as they progress through the lesson. Tell them you will stop the lesson at several points to record their ongoing thoughts, beginning a class journal reflecting intuitive thinking. So, to begin, it was a dark and stormy night….

Seeing a Way Out of the Dark

The usual suspects. Present the following list of words along with the brief definitions (Merriam-Webster’s Collegiate Dictionary, 11th edition):

- inclination—a tendency to a particular aspect
- inkling—a slight knowledge or vague notion
- epiphany—an illuminating discovery
- glimmer—to appear indistinctly
- suspicion—a barely detectable trace
- hunch—a strong intuitive feeling
- feeling—unreasoned opinion or belief
- dream—a visionary creation of the imagination
- hint—a slight indication of the nature of something
- notion—an inclusive general concept

Ask what common characteristic the words have. For example they:

- suggest a piece of a larger picture
- can be used as nouns
- focus on a possible solution to a problem
Discuss and possibly enlarge upon the above list of words. There are overlapping meanings that add to the complexity. If the class would benefit from considering the separate shades of meaning among the synonyms, try placing the words into usage samples:

- <a - of intelligence> (glimmer)
- <a - of a better future> (dream)
- <a - of the answer> (hint)
- <had not the faintest - of what it was all about> (inkling)

Ask for nominations of any words that might be included on the list (vision? clue?), and let the class decide if any of the suggested words qualify. See the mind map on p. 47 for possible additional words. If new words are accepted, agree upon a brief definition using a phrase from the dictionary. The part of the definition selected should avoid stating the shared characteristic, and instead, as much as possible, differentiate the new word from the others.

As a further discussion point, ask why are there so many words associated with seeing a way out of the dark, a possible path forward, a pattern perceived? Is there a connection between this proliferation and the high value of the ability they represent?

**Guess Stop:** This is the most wide-open juncture in the lesson and could yield interesting insights for further study. Record without comment any possible endpoints of the lesson as put forward by the class. This record could be thought of as a progressive journal.

**The lineup.** Looking again at the list, note that these words vary in the magnitude of the insight. Ask what is the range of insight? How small of an idea qualifies? What have been some universal understandings? These can vary from “all I need to know about life I learned in kindergarten” to the latest physics on the composition of everything.

Suggest that the list could be ordered, reflecting this extent of vision, perhaps beginning with hint and ending with dream. There will be legitimate disagreement on the lineup. Briefly break into small groups to decide on an order, indicating with a “1” the least far reaching and continuing with the rest of the inclusions.

Reassemble the class to post and discuss each group’s decisions in columns next to the word list.

**Guess Stop:** At this point, a direction of the lesson is possibly clearer to some students, although the intended goal of understanding intuition is still intentionally misty. Ask the students why they think they were asked to consider the differing range of these connected words. How could this be important? Add any responses to the progressive journal.

**The evidence.** Tell the class that a researcher (Loye, 1983) has divided this extent of vision into three levels: rational, predictive, and transformational. Ask how this set of three words could express differing foundations of known material. One way to express these differing foundations: fitting known things together in a new way (rational); an extension of some known things into a probable trend (predictive); and a vision of how things as yet unknown could be revealed (transformational).

Try breaking the words from the range of the list into these classifications. For example, could a suspicion lead to the rationale behind a criminal case? Could a connect-the-dots hunch about the weather lead to a long-term prediction? Could the dream of a leader encompass a direction for transforming society? See the mind map on p. 47 for possible associations.

The result of this part of the lesson should be lines breaking the original word list into three sections—a new listing, each headed by one of the three classifications:

- rational
- predictive
- transformational

Some of the words might fit into more than one listing.

**Guess Stop:** Here, a guess might involve recognizing levels of forward thinking. The word intuition has not been formally presented as yet, although some guesses might have included it—and we have cited it in one of the definitions among “The Usual Suspects.” The next section of the lesson presents the teacher’s objective, so journal any final guesses from the class about the intended educational goal before continuing.

**The trial.** The full facts of the “case” are now revealed—the denouement of our mystery: acquainting students with the “aha” nature of intuition.

In her textbook Growing Up Gifted (2008), now in its seventh edition, Clark gives special attention to the phenomenon of intuition. She cites the work of Loye (1983) in organizing and analyzing this vital human capacity. Present to the class this fuller excerpt from his work:

- Rational Intuition: “…realigns known information in such a way that new insights emerge…though we know the facts, we see them in a new light.”
- Predictive Intuition: “…enlarges on the rational level by including new and/or suspected information within existing patterns…comes after perhaps months or years of extensive preparation and may appear when the person is relaxed or involved in an entirely different task.”
- Transformational Intuition: “…seems to be using a different kind of sensing…unhellen or in a dream...as if from an outside source…a change in the rate of coherence among…separate regions of the brain…drawing together of all other forms of the intuitive process.”

History abounds with insights that have led to notable consequences, intuitive leaps that have transformed society: the discovery of penicillin, for instance. Some have been insights of a lesser magnitude: the novel applications of our global positioning satellites, or the failure of a glue resulting in the now familiar “Post-it” note.

Assign the students to research other examples of “aha” moments that have contributed to society in some way. Sources could include the Internet or books on inventions. Have them prepare a 5-minute report that:
• identifies the innovator,
• describes the contribution, and
• tells how it was an “aha” moment.

After each presentation, the class should discuss what foundation contributed to the “aha” moment and how the innovation relates to the three dimensions of intuition.

PUTTING INTUITION TO WORK
We have used familiar words to suggest the process of intuition, examined the range of insight, and used an innovative lesson format calling for periodic guesstimates. The result of these exercises should be an elevated awareness of the phenomenon. The following menu of activities provides a resource for further explorations. Choices include:

• The Business of Intuition,
• Seeing the Picture,
• Mind Mapping,
• The Path to Solutions,
• Enhanced Journaling, and
• Intuition in Quotes.

THE BUSINESS OF INTUITION
Though definitions of intuition differ, it has become a recognized phenomenon in many fields; almost everyone agrees it can be developed and nurtured. Among the examples: brain imaging shows that the prefrontal cortex lights up when the subject is creating images or integrating brain functions—both processes that are involved in intuition. Architectural schools stress that in the design process the “aha” moments, or intuition, occurs through incubation or unconscious processing. In business it is the topic of books, seminars, and workshops. It is also used in team building, decision-making, and the development of new products.

The following activity will acquaint students with ways that intuition is nurtured in the work place.

Google is noted for its innovative working conditions and “thinking out of the box.” Fortune magazine lists it under Best Companies to work for and gives readers a look at why (http://money.cnn.com/galleries/2007/fortune/0701/gallery.Google_life/). Use this information to analyze the facts and discuss the details with your students. Aside from the obvious perks, how does this philosophy encourage intuition and creativity? Why doesn’t the freedom cause chaos? What supports for nurturing intuition could be developed from this information? What characteristics does the work environment require of the employees?

SEEING THE PICTURE
In a study by Meier (cited in Ferguson, 1984) college students using mental imagery performed 12% better on immediate recall and 26% better on long-term retention than did the students not using imagery. Just imagine what could happen if they started earlier!

Mental magic. Try an old mentalist magic trick that uses visualization, an important element of intuition. The effect is to have ten objects named by the spectators, and then recalled one at a time, by the performer.

The secret of this feat requires that the magician have a predetermined set of simple images, one for each number. For instance, number four could be a table, and when an object is named for number 4—say, an airplane—the magician mentally fixes the image of an airplane on a table. With practice, the objects can be called for in any order. The performers set of secret images will probably be most vivid if they are self-selected, and can be best remembered if they are simple. For example:

• a balloon (has one string)
• a set of dice
• an easel (3-legged)
• a table (4 legs)
• a star (5 points),

and so on. The more vivid the associations, the easier the recall.

Creating the scene. Be an illustrator and practice the hard part—getting the idea. Pick a story or poem and ask each class member to pretend they have a contract with the publisher to do a colored illustration. Ask the students to close their eyes and imagine the setting as you read aloud a brief selection that is particularly vivid. Without discussing each individual’s perception, provide art materials and a relaxed atmosphere, possibly with appropriate music. Display the results for everyone’s enjoyment. A particularly expressive selection is Chapter 10 of Norton Juster’s Phantom Tollbooth, as Milo conducts the sunset.

Design a playground. Your school has just been given a grant to redesign the playground. Student input has been requested. It must be safe, fit within the given area, and contribute to physical fitness. Invite a local architect to speak with the class about how they move from the vision to a final project. Let the class form teams to do the intuitive envisioning of their own solutions.

Mind Mapping. Do it for your dendrites! Mind Mapping is a valuable tool for generating ideas and their connections. It can be used in addition to or as an alternative for the linear organization of an outline. Using a treelike structure, it resembles the branching of dendrites in your brain, connecting illustrations of key word ideas. The example on page 47 shows a refined mind map of our brainstorming for this lesson.

Present the mind map on a document camera or overhead and explore its structure with the following questions.

• How does a mind map allow for nonlinear thinking?
• Where is the topic of the map located?
• How are subtopics related to the central idea?
• How is the progression of ideas shown?

Mind Map teacher guide. Our mind map of fundamental intuition expresses relationships not readily represented in a unidirectional outline. The overall arc of the layout reads left to right in the aspect of a foundation of increasingly unknown data points.

The central symbol is the transformational miniature fluores-
Mind Mapping is a valuable tool for generating ideas and their connections... it resembles the branching of dendrites in your brain, connecting illustrations of key word ideas.

- green hat—generate new ideas, additional alternatives
- yellow—positive view of things, feasibility, how accomplished and benefits: logically based
- red—emotional response, not based on logic and judgment
- blue—process control: sets agenda for thinking process, next step, summaries, conclusions
- black—denotes the judicial robe of judgment and critical evaluation; precedes final decision

Discuss where intuition is most likely generated. Which stages nourish that intuition? What can be gained from having everyone limiting contributions and comments to the phase of problem solving as you apply it? As you begin the process, indicate which stage you’re at by placing check marks as you progress through the list.

While most brainstorming goes through the same steps, the advantage here is that everyone is in the same mode at the same stage of the process—allowing for deeper analysis of the problem and more opportunities for intuitive solutions.

Enhanced Journaling

Education has long used journaling for recording and improving student work in many disciplines. It is most useful when it encourages students privately to reflect and write about their stages of thinking, as well as their progress—something not often recorded in mathematics.

Liljedahl (2004) writes,

For mathematicians, problem solving is a process that incorporates not only the logical processes of inductive and deductive reasoning, but also the extra-logical processes of intuition, imagination, insight, and illumination. [Liljedahl suggests] ...guiding students’ [mathematics] journaling in such a way that their writing more accurately reflects the erratic to-and-fro of their problem-solving process...the most prominent of which is the elusive nature of the experience—it can happen anywhere at any time,
from experiencing illumination in the shower to being awakened in the middle of the night by a good idea (allacademic.com/meta/p117504_index.html).

Assign math students a challenging multi-step math problem and require that no erasers be used in their search for a solution. All steps must be shown—especially if they lead to a dead end. Have them record all the paths followed: what they did, why they did it, what lead them on that course and what was the link between attempts. Use a document camera or overhead and ask for volunteers to explain their thinking and solutions. If others had a differing solution have them explain it as well.

If a student’s work didn’t result in a solution, have the class analyze the work and predict a path that would be profitable to follow. These nurturing conditions could also be annotated in the margins or in a separate intuition journal.

In How to Think Like Leonardo da Vinci (Gelb, 1998), the author offers the reader a multitude of journaling suggestions.

You can, like Leonardo, facilitate Curiosita by keeping a notebook or journal. Get a bound notebook or journal filled with blank pages. You can use anything from the 89 cent Kmart version to a fancy one with an inspiring image on the front cover. The important thing is to carry it with you everywhere and write in it regularly. Supplement your notebook and scrapbooks or files on diverse areas of interest…on any subject you fancy—science, art, music, food, health…As Leonardo did, use your notebook to record your questions, observations, insights, jokes, dreams and musings (mirror writing is optional).

Art students should keep sketchbooks, writers snatches of overheard dialogue, all of which could be foundations for a later “Aha!” experience.

INTUITION IN QUOTES

Is it easier to talk about intuition than actually to do it? Infinitely. But because intuition is not something you can just take attendance and then do, let us speak of the spark. Plowing the field can’t hurt, seed-wise.

Students rarely have difficulty talking, and here is a set of quotes to foster reactions. The quotes below deal with how people react to and nourish flashes to the mind—and some of the pitfalls of that phenomenon.

What Characteristic Makes “Seeing” A Useful Metaphor?

I shut my eyes in order to see. —Paul Gauguin

Research is to see what everybody else has seen, and to think what nobody else has thought. —Albert Szent-Györgi

Pythagoras used to say life resembles the Olympic Games: a few men strain their muscles to carry off a prize; others bring trinkets to sell to the crowd for a profit; and some there are who seek no further advantage than to look at the show and see how and why everything is done. —Michel de Montaigne

Is There a Way to Seek the Unsought, a Plan for the Unplanned?

I am an idealist. I don’t know where I’m going but I’m on my way. —Carl Sandburg

Fortunately, the wheel was invented before the car; otherwise, the scraping noise would be terrible. —Laurence J. Peter

The essence of success is that it is never necessary to think of a new idea oneself. It is far better to wait until somebody else does it, and then to copy him in every detail, except his mistakes. —Aubrey Menen

Is It Right Because You Thought Of It?

The greatest challenges facing both the arts and education are how to navigate the perilous course between adventure and discipline. —Robert W. Corrigan

Whatever is only almost true is quite false, and among the most dangerous of errors. —Henry Ward Beecher

The truth is more important than the facts. —Frank Lloyd Wright

Here are some search words for further quotes on intuition: creativity, education, ideas, intelligence, learning, thought, truth, wisdom, wonder.

It is possible that mulling over these thoughts on thought will engender an original insight to the mind of the student. Be sure to write it down. And remember:

“A man begins cutting his wisdom teeth the first time he bites off more than he can chew.” —Herb Caen

REFERENCES


ANN MACDONALD and JIM RILEY are the editors of the Hands-on Curriculum department of the Gifted Education Communicator. They taught in the San Diego City School’s Seminar program for the highly gifted.
Mind Over Matter

Brain Research feels like a subject that comes from on high—from the gods on Mount Olympus. It has some mystery. Yet we all talk about it as if it were common place: right brain/left brain, combinations of right and left brain, gray matter/white matter, and discussions about the precision of which parts of the brain are responsible for which actions. Our sophistication today is so advanced compared to a relative short time ago.

The language of the old right/left brain nomenclature is now translated into brain scan vocabulary.

The late great Richard Feynman believed that “ordinary people with common sense are intimidated by [what he called]... pseudoscience.” He believed that “we really ought to look into theories that don’t work and science that isn’t science.” Best of all of his humorous observations is what he called “Cargo Cult Science” named after people in the South Seas who did not connect airplanes with the freight that had landed. They observed some details…but not the very essence.” Best of all of his humorous observations is what he called “Cargo Cult Science” named after people in the South Seas who did not connect airplanes with the freight that had landed. They observed some details…but not the very fundamental awareness of the airplane bringing in the materials. They were a cargo cult people. And what they were missing were the connections.

Believe me, today’s research is not a Cargo Cult collection. The brain research now is precise, specific, full of scientific alphabet soup: CT, EEG, EMG, fMRI, MEG, MRI, PET, SPECT and other scans. The connections seen in these scans of our brains provide the evidence that we have been looking for all these years.

One fine example of connections and brain research with practical applications is NYU’s Child Study Center and its newsletter. Vol. 8 No. 5 is titled Learning Disorders and Brain Organization, but you will also be given the gift of seven pages of organized learning domains (http://www.aboutourkids.org/files/articles/mayJun_0.pdf).

One of the most intriguing studies was initiated by Dr. Francisco Xavier Castellanos, professor of child and adolescent psychiatry at New York University. The study found that in children with ADHD (Attention Deficit Hyperactivity Disorder), a region of the brain—the prefrontal cortex—matured approximately three years later compared to children without ADHD. And there is no evidence that these children ever catch up in this delayed growth. Parents and teachers need to plan for the long run with this information. Although not addressed directly in this study, gifted students who are ADHD will always need curriculum that appeals to their minds while simultaneously addressing their developmental lag. Not an easy task for teachers or parents.

Another study by Kaufmann, Kalbfleisch, and Castellanos more directly addresses gifted children with ADHD. They speak of the danger of ADHD being less apparent because “by virtue of their giftedness, the range of tasks that are perceived as ‘effortless’ is broader for gifted children, which is why their ADHD may be less apparent….” It is interesting to note that a gifted student’s “over-reliance on strengths inadvertently obscures the disability.” The most relevant statement for parents and teachers who deal with daily habits and needs was this: “While emphasizing strengths may highlight a student’s gifts and talents, it does not eliminate the reality of the condition and can, in fact, lead to a worse predicament in which the student distrusts his or her abilities because of the struggle to maintain them. On the other hand, if a student is allowed to acknowledge and experience the disability, he or she may learn appropriate compensatory or coping skills.” The ramifications of this study on our gifted children are profound.

So many studies; so little time to absorb them all. One set of scientists tells us that you can’t see the difference between two brains with a low and high IQ, but another group tells us that they are on the verge of creating imaging techniques that will make traditional intelligence tests obsolete. The detailed reports of studies, varying in their nuances, make fascinating reading. Brain scans are going to make future information even more riveting than it is now.

The “matter” in Mind Over Matter becomes significant in terms of how we deal with our children. We have all this brain research to help us focus in on new ways to guide our parenting, our strategies as teachers, and our curriculum—our “matter.” And while we constantly upgrade our “brain” knowledge, we have to remember that underlying it all is our children’s need for love and discipline and patience—our heart knowledge.

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Brain Research and the Gifted Learner

Brain research advanced significantly in the 1990s and 2000s. Many earlier assumptions have been proved incorrect and we now have more evidence to reach informed judgments. The websites below contain reports of new findings and discussions from a variety of sources including the American Psychological Association, University of California at Irvine, Scientific American, the U.S. National Institute of Health, and others.

Brain’s Left And Right Sides Work Together Better In Mathematically Gifted Youth. [sciencedaily.com/releases/2004/04/040412012459.htm](http://sciencedaily.com/releases/2004/04/040412012459.htm). Science Daily reports on research that confirms the theory that gifted brains communicate better between their hemispheres than average brains of any age. Though the research was limited to middle school math-gifted boys, it’s still interesting reading. The original research and data is available on the American Psychological Association website: Interhemispheric Interaction During Global-Local Processing in Mathematically Gifted Adolescents, Average Ability Youth, and College Students [apa.org/releases/interhemispheric_article.pdf](http://apa.org/releases/interhemispheric_article.pdf) by Harman Singh and Michael W. O’Boyle.

Scientists are using magnetic resonance imaging (MRI) to measure the size of certain structures of the brain including the structure responsible for sensory perception—the superior parietal lobe—and for complex thinking, planning, personality and coordination—the prefrontal cortex. And surprisingly, they report that the brains of smarter people tend to be less active, but more productive, than other brains! Read more in this CNN report, Brain Teaser: Scientists dissect mystery of genius at [cnn.com/2006/HEALTH/09/11/gupta.genius/index.html](http://cnn.com/2006/HEALTH/09/11/gupta.genius/index.html).

More recently, the same University of California, Irvine and University of New Mexico researchers report indications that higher brain ability is related to great brain communication in a paper entitled, Brain Network Related to Intelligence Identified [sciencedaily.com/releases/2007/09/070911092117.htm](http://sciencedaily.com/releases/2007/09/070911092117.htm). These recent research reports find that some of the brain areas related to intelligence are the same areas related to attention, memory, and language. Intelligence may be related to how efficiently the brain processes information.

Intelligence in men and women is a gray and white matter today.uci.edu/news/release_detail.asp?key=1261 While there aren’t differences between men and women in overall general intelligence, researchers report that there are sex differences in the brain, and different areas of the brain relate to intelligence in men and women! Read the research in Brains, Bias, and Biology: Follow the Data, [www.uchicago.edu/pediatrics/faculty/neurology/haier/pdf/23.pdf](http://www.uchicago.edu/pediatrics/faculty/neurology/haier/pdf/23.pdf). Richard J. Haier of University of California, Irvine found that men have more grey matter—information processing centers, while women have more white matter—networking centers. These differences in brain usage explain why men tend to be better at local processing, activities such as mathematics, while women are better at integrating and assimilating information, especially verbal skills and languages.

Another source containing information regarding differences between males and females is, Sex, Math and Scientific Achievement, [sci.am.com/article.cfm?id=sex-math-and-scientific-achievement](http://sci.am.com/article.cfm?id=sex-math-and-scientific-achievement). Diane F. Halpern, Camilla P. Benbow, David C. Geary, Ruben C. Gur, Janet Shibley Hyde and Morton Ann Gernsbacher discuss many issues pertaining to this topic.

Cortex Matures Faster in Youth with Highest IQ. [nih.gov/news/pr/mar2006/nimh-29.htm](http://nih.gov/news/pr/mar2006/nimh-29.htm). In this study, Drs. Philip Shaw, Judith Rapoport, Jay Giedd and colleagues at NIMH and McGill University, working at the National Institutes of Health (NIH), report that more intelligent children and teens do not have larger brains than other children or teens. They found, however, that cortex growth—the thickening and thinning of the thinking part of the brain that takes place throughout childhood—varied based on their intelligence, with the brightest children’s brains reaching maturity later, and having a longer period of development. This longer window of brain development may allow for more high-level thinking and learning!

KIDS KORNER (FOR KIDS OF ALL AGES!) For the kids, let’s start with a quick test. Are you right-brained or left-brained? Think you already know? Check the answer on The Right Brain vs. Left Brain test, [news.com.au/perthnow/story/0,21598,2492511-5005375,00.html](http://news.com.au/perthnow/story/0,21598,2492511-5005375,00.html). Is the dancer spinning clockwise, or counter-clockwise? Check out the list of characteristics associated with each side of the brain’s dominance. Does this describe you?

Let’s see what else you know about your brain and the rest of your nervous system, at Neuroscience for Kids, [faculty.washington.edu/chudler/neurok.html](http://faculty.washington.edu/chudler/neurok.html). Explore the nervous system, from your brain down your spinal column and throughout your central and peripheral nervous system. What’s the difference between the cerebral cortex and the hypothalamus? Take a human brain Fly-Through, and see what’s in each layer of your brain. Discover the differences between he-brains and she-brains, and learn about the effects of chocolate (yes, chocolate!) on the nervous system. You can spend days investigating Neuroscience for Kids and still have plenty left to see!

Now that you’re thinking, let’s exercise that brain with some great brain teasers! Puzzle Playground, [puzzles.com/PuzzlePlayground/WelcomeToPuzzlePlayground.htm](http://puzzles.com/PuzzlePlayground/WelcomeToPuzzlePlayground.htm), offers interactive puzzles for all sorts of brains. Start with the Jigsaw Cells — put the pieces into the puzzle frame.

WEB WATCH
By Carolyn Kottmeyer
Sounds easy, right? I had no trouble getting started, but ran into trouble by the second row of the puzzle. Can you do better? Then try the Square Table Top—can you make the pieces fit? There are lots of other puzzles—word puzzles like The Mars Tour and Message Reading, and matchstick puzzles like The Match Window, plus many more!

Griddlers, griddlers.net. A griddler is a logic puzzle, and a paint-by-number puzzle, all in one. The left and top of the puzzle contain a series of numbers, which describe the patterns of shading in the picture, with each number of squares separated by one or more blank squares. It’s up to you to figure out how those squares are organized in each row and column. Griddlers must be experienced to be understood; they’re really lots of fun and challenge! Select your puzzles, solve them, and even upload your own puzzles for your co-Griddlers to solve!

For a more verbal challenge, try USA Today Frame Games, usaweekend.com/wit/frame_games/. These games go by many names: Rebus, Wacky Wordies, Plexers, and of course, Frame Games. No matter what you call them, they challenge your mind and keep your thinking flexible, and they’re fun for all ages! USA Today’s site isn’t just the four new Frame Games each weekend… click on Frame Games Archive, and there are hours, weeks and years of Frame Game fun!

Optical Illusions are an amazing study of the brain, and how it can be fooled. Two-dimensions pictures appear to be one thing, but are actually another; images hide and fool the eye, and more. Grand Illusions, grand-illusions.com/opticalillusions, contains 6 pages containing dozens of illusions, including the Pictographic Ambiguity, The Queen’s Speech, and others. Some of the illusions even have video samples, to get the true effect. Don’t miss Dr. Angry and Mr. Calm and the Dragon Illusion. (There’s a large Dragon Illusion in the illusions gallery at the Franklin Institute in Philadelphia!)
The good news for parents is that on the Grand Illusions pages, explanations are included.

Knossos Games, homepage.mac.com/boester/, include a variety of thought-provoking original puzzles. Some of you may have seen these games and their creator, Tim Boester, featured quarterly on the back cover of the Johns Hopkins Center for Talented Youth journal, Imagine. cty.jhu.edu/imagine. Just when you’re tired of the same old puzzles, Tim offers us dozens of neat new puzzles, including maze puzzles (with and without rules), layout puzzles, and pure puzzles… and now, text puzzles. They sound boring when I describe them, but I assure you, they are not!

Mastermind, thinks.com/java/mastermind/mastermind.htm, is an old favorite logic game, but this interactive Internet version lets everyone play anywhere there’s a computer. Can you figure out the hidden color code? Hints come in two forms: right color—wrong place, and right color—right place. It’s up to you to deduce which is which. Mastermind is a great introduction to logic for young gifted players!

Puzzle Parlor. www.gamepuzzles.com/pparlor/puzzleparlmm.html, contains interactive versions of some of my favorite GamePuzzles. GamePuzzles are acrylic jigsaw puzzles where the pieces are all geometric shapes, and the puzzles vary from simple to not-yet-proven impossible. Can you assemble the puzzle? Great! Now can you assemble it again, this time with no two pieces of the same color adjacent? Terrific! Now can you assemble it again, this time… you get the idea! The challenges go on and on.

Now you know my secret ways to spend many hours enjoying brain-tickling puzzles on the Internet! For the rest of my “secret stash” of brain teasers, visit Hoagies Kids & Teens: Brain Teasers, hoagiesgifted.org/brain_teasers.htm. ■

CAROLYN KOTTMEYER is the founder and director of Hoagies’ Gifted Education Page hoagiesgifted.org and Hoagies’ Kids and Teens Page hoagieskids.org. She is a winner of the National Association for Gifted Children (NAGC) Community Service Award, and the Pennsylvania Association for Gifted Education (PAGE) Neuber-Pregler Award.
The Journey of the Unexpected
Books Travel, Twist, and Turn

While some people can’t live without books, I live in a castle of books or at least a house full of them. I realized 20 years ago as a first-year, third-grade teacher, that I needed not only to read more books, I needed to own more books. I may have gone a little overboard. I have books everywhere—in every room, sometimes in the oven, under, over, and covering every surface of my house. Mostly they are books for kids—about 15 thousand pounds of them. And as I settle into writing this column, I must confess that the most difficult part is choosing which ones to highlight. For this issue I have chosen a collection of books that have the complexity to invite highly able students to discover new worlds and new formats for story telling.

Since this is my first article for this column, it seems appropriate to begin with a book about discovery and beginnings. Australian award winning children’s book artist Shaun Tan created a series of wordless images reminiscent of vintage photographs for his 2006 book, *The Arrival*. The story follows a man who leaves his wife and child in an impoverished town, seeking better prospects in a far away country across the ocean. On his journey he finds himself in a bewildering city of foreign customs, peculiar animals, curious floating objects, and indecipherable languages. With nothing more than a suitcase and a handful of money, the immigrant must find a place to live, food to eat, and a way to make a living. On his journey he encounters sympathetic strangers and he listens to their histories.

This immigrant’s story has so many dimensions and moves between the realities of change and images of fantasy that readers will be captivated each time they revisit the story. It is so well woven that readers connect to the familiar images of the Statue of Liberty and find that the boundary lines between reality and fantasy are often difficult to discern. In the end we are attached to this man’s journey and in awe of Tan’s beautiful and remarkable exploration of identity, isolation, and satisfaction by means of his wordless pictures.

For students who have not yet explored the world of graphic images and how they tell a story in a graphic novel, this story is an ideal way to introduce several components of content: immigration, change, and identity. For the artists in your classroom, this book provides a model for how to use a sequence of graphic images to tell a story. For more information about Shaun Tan visit [www.shauntan.net](http://www.shauntan.net). To learn more about graphic novels and how to read and create them, students might be interested in reading *Making Comics: Storytelling Secrets of Comics, Manga, and Graphic*...

A unique collaboration of ten authors including Linda Sue Park, Gregory Maguire, David Almond, Eoin Colfer, and six additional authors create, Click, a worldly mystery that centers on the life of a fictional photojournalist, George Keene, also known as Gee. The story begins with the mystery of a wooden box of shells Gee left to his granddaughter, Maggie. As the narrative moves through the past and into the future, Maggie unravels the story of Gee’s tangled life.

Not only is this book a masterpiece of writing, its history provides a bit of intrigue as well. Arthur Levine, an editor at Scholastic, developed the idea of a single book written by ten authors. While many of the authors originally thought that the idea was a bit crazy, each of these highly acclaimed authors from around the world agreed to take a turn at writing a chapter. Linda Sue Park wrote the first chapter and set the stage for possibilities and each subsequent author added another element to the story until Gregory Maguire tied up the previous nine chapters into a cohesive whole.

This unique collaboration of authors and the talent of the editor results in a seamless story that provides a model for writing and negotiating ideas and plots among and across different writers. The nonlinear nature of the story presents a tempting challenge for highly able readers to emulate as they explore the puzzle pieces of Gee’s life. While the story is a pleasure to read, it also has the potential to be used as a model for how writers negotiate aspects of a story when someone else establishes the plotline. With careful reading, students may notice the differences in writing styles for each of the chapters.

For an audio clip of authors Linda Sue Park and Ruth Ozeki reading the chapters they wrote and talking about the book visit npr.org/templates/story/story.php?storyId=14869506.

This was a year of unexpected formats in books for youth. Drawing on his understanding of books and how they work, Caldecott Honor artist Brian Selznick created a 534-page book that he describes as “… not exactly a novel, and it’s not quite a picture book, and it’s not really a graphic novel, or a flip book, or a movie, but a combination of all these things.” The book blends narrative and illustrations to tell the story of Hugo, an orphaned 12-year-old boy who keeps clocks ticking in the Paris train station where he lives in the 1930’s. However, Hugo’s mechanical passion is to repair an automaton (pronounced aw-TOM-ah-than), a self-operating machine belonging to his father but damaged in a fire. To do this he has been stealing small toys from an old toy vendor in the station, later revealed to be the ground breaking French filmmaker George Melies, whose cinematic work was adored by Hugo’s late father.

In a series of illustrated actions and plot explanations, Hugo and the toy vendor’s granddaughter Isabelle, are drawn together to solve intertwining mysteries. Bound so that the book does not close upon itself when open, the reader falls into the book without any words for the first fifty pages; just when you develop a storyline for the images, the words begin to appear to help the reader develop the questions and potential answers. For a sneak peek check out theinventionofhugocabret.com.

While reading graphic novels may be new to students, many of them have read or even written some form of poetry such as haiku. A sijo, a traditional Korean verse form, has a fixed number of stressed syllables and a humorous or ironic twist at the end. Linda Sue Park’s new book of sijo will give advanced readers the chance to fall in love with Korean sijo in Tap Dancing on the Roof: Sijo (Poems). With twists of irony and humor each short poem plays with something unexpected. The poems range from explorations about socks, pockets, nature, months and even words.

**Word Watch**

*Jittery* seems a nervous word; *Snuggle* curls up around itself.

Some words fit their meanings so well: *Abrupt. Airy. And my favorite—*

*Sequipedalian,*

Which means: having lots of syllables.

The final sijo, *Wish* sums up how poems settle in our souls.

*Wish*

For someone to read a poem
Again, and again, and then,

Having lifted it from page
To brain—the easy part—

Cradle it on the longer trek
From brain all the way to heart

In schools all across the country, students read about Cinderella, and while the tale has a tradition in many cultures, students are most familiar with the Disney or the Charles Perrault versions with glass slippers and mice as coachmen; but with over 1000 versions of Cinderella, there is always room for at least one more. Newbery winner Paul Fleischman and illustrator Julie Paschkis provide readers with a Cinderella journey that travels around the world in Glass Slipper, Gold Sandal: A Worldwide Cinderella.

In Fleischman and Paschkis’ international retelling of the tale, the story is woven from one culture to another with every element enticing the reader to explore the world. The story details may surprise the reader—“then a crocodile swam up to the surface and in its mouth was a sarong made of gold…(Indonesia) a cloak sewn of king fisher feathers (China)…a kimono red as silk (Japan).” After Cinderella realizes that she has nothing to wear but rags to the palace to visit the king who is in search of a queen (Zimbabwe), readers will find comfort in the resolution of the tale.

In another form of the unexpected, the central characters in Newbery award winning E. L. Konisburg’s newest book *The
Mysterious Edge of the Heroic World remind us that not all friendships are predictable and that events are often related. Amedeo Kaplan and his mother have moved from New York City to St. Malo, Florida where he hopes to discover something—anything. He meets William Wilcox who is helping his mother clean out the home of Aida Lily Tull Zender, the richest woman in St. Malo; she's a former opera singer whose history includes a piece of art, heroism, and the Nazis during World War II.

Amongst Zender’s things, Amedeo finds a signed Modigliani drawing which he recognizes from an art exhibit curated by his godfather, Peter Vanderwaal. The subject of the exhibit was modern art that had been banned by the Nazis. Amedeo is eager to uncover the history behind the drawing—the origin of which links the retired opera singer, the Vanderwaals, and the Nazi occupation of Amsterdam. Readers of previous Konisburg books will find multiple levels of satisfaction in this book.

Moving back in time and away from the United States and German history to the other side of the world, we find Revolution is Not a Dinner Party. In it, cookbook and children’s picture book author, Ying Chang Compestine, shares elements of her childhood experience. The book tells the story of nine-year-old Ling and the changes in her family’s life when Comrade Li, one of Mao’s political officers, moves into their apartment. Readers may find the novel so believable they may think they are reading an autobiography. Reading the author’s notes and historical background will help readers set the context for the novel and provide topics they may wish to explore in a deeper level.

2007 was a year of unexpected journeys in the world of books for youth with new formats and potential paths to read and explore, unanticipated worlds that connect to the past, present, and the future. With over 7000 books for youth published last year it is impossible to highlight all the great books available, but these are a few for starters. And for those looking forward to future books by authors you love, 2008 promises new titles in children’s literature including many new picture books, middle grade and young adult novels, as well as graphic novels, and high quality nonfiction titles that will be worthy of flashlight reading. ■

Postnote*
The Invention of Hugo Cabret received the 2008 Caldecott Medal. This is the first time that a 534 page illustrated text has received an award that recognizes distinguished illustrations. For a complete list of the 2008 American library Association Youth Media Award and Honor winners (including the Caldecott, Newbery, Coretta Scott King, Printz, and Sibert Pura Belpre awards) visit www.ala.org.

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**Book Information**

**Revolution is Not a Dinner Party**

*Mystery is Not a Dinner Party* - A Novel
Ying Chang Compestine
Henry Holt, 2007
ISBN 9780805082074, Ages 10-Up

**Glass Slipper, Gold Sandal: A Worldwide Cinderella**

Paul Fleischman, Illustrated. Julie Paschkis
Henry Holt, 2007
ISBN 9780805079531, Ages 9-12

**The Mysterious Edge of the Heroic World**

E.L. Konisburg
Atheneum, 2007
ISBN 978141694430, Ages 10-14

**Click**

Linda Sue Park et al
Scholastic, 2007
ISBN 9780439411387, Age 12-Up

**Tap Dancing on the Roof: Sijo (Poems)**

Linda Sue Park, Illustrated Istvan Banyai
Clarion, 2007
ISBN 9780618234837, Ages 4-8

**The Invention of Hugo Cabret**

Brian Selznick
Scholastic, 2007
ISBN 9780439813785, Ages 9-12

**The Arrival**

Shaun Tan
Arthur A. Levine/Scholastic, 2007
ISBN 9780439895293, Ages 9-up

**How to Read and Make Graphic Novels**

**Understanding Comics: The Invisible Art**

Scott McCloud
Harper, 1994
978-0060976255

**Making Comics: Storytelling Secrets of Comics, Manga, and Graphic Novels**

Scott McCloud
Harper, 2006
978-0060780944
The Female Brain

By Louann Brizendine
Hardcover, $24.95, 279 pp.

REVIEWED BY BARBARA CLARK

I was amazed by the information provided in this book and wondered why I had never known, never heard about, nor even thought to ask about it before. When I did ask those I thought would already know—medical doctors, science teachers, intelligent men and women—they didn't know either. Yet here, written in a clear, well-documented, straightforward manner is a wide range of information that all of us at every age need to know. There are astounding facts to ponder like:

• Every brain begins as a female brain and only becomes male 8 weeks after conception when excess testosterone floods the male-to-be's system.
• Males and females actually use different brain areas, pathways, and circuits to experience the world resulting in huge differences in what they notice, respond to, and believe. The same events and locations are perceived differently. The perceptions are neither right nor wrong; just different, often significantly different.
• Much of the difference in interests, goals, concerns, behaviors, and preferences between men and women are built into their physiology, especially the organization and functions of their brains.

The author, a neuropsychiatrist brings together the results of recent pertinent research to focus on the functioning of the brains of women through the most significant times of their lives. Feelings and behaviors that seemed familiar but
unexplainable are shown to be the natural consequences of living and growing up as a woman. For a woman it is a revelation. For men, seeing from a different perspective, it provides a wealth of knowledge about what and how, but mostly why they see things so differently. The understanding of self and others alone makes this book a wealth of insight, but combined with the specifics and details of lives of men and women, their strengths and weaknesses, it makes this a really must read, especially for teenagers and their mothers and fathers. The part the environment plays and the suggestions for experiences that enrich that environment are valuable and will be appreciated by educators at home and at school. But most valuable is the possibility that men and women, boys and girls might understand each other better, with the most exciting possibility that we might understand ourselves better and be far more gentle with each other.

BARBARA CLARK, Ed.D. Emeritus Professor California State University, Los Angeles.

Enriching the Brain

By Eric Jensen
Hardcover, $24.95, 330 pp.

REVIEWED BY BARBARA CLARK

Beginning with the theories of fixed intelligence, long discounted, but still too often believed and used as the basis for organizing and planning learning experiences, the author presents reasons why such beliefs are limiting all of our educational practices from early childhood to senior citizens homes and doing immeasurable harm. He points out that the revolutionary discoveries about the dynamic nature of the brain make it untenable to continue to act as though the brain cannot develop or change.

His goal is to clarify and forcefully present the case that, because the human brain is dynamic and changing, the way we teach, parent, and run our schools matters. The learning experiences schools provide can dramatically affect over 90% of all learners. If educators are not taking advantage of this new knowledge and utilizing it in their classrooms, Jensen claims they are “committing malpractice.” His purpose is to offer reasons for enriching the classroom learning experiences and present the reader with strategies to support such change.

In this book, enrichment is seen as, “a positive biological response to a contrasting environment, in which measurable, synergistic, and global changes have occurred.” (p. xii) Throughout, the author considers the following factors critical to maximizing the positive effects of the environment:

- physical activity
- novel, challenging, and meaningful learning
- coherent complexity
- managed stress levels
- social support
- good nutrition
- sufficient time

In addition to the children in the regular classroom the author presents material for children in poverty, those with special needs, and those identified as gifted. Specific examples are given from schools engaged in enriching their students and from parents focused on enrichment in the home, especially during early childhood.

In his discussion, as is often the case, intelligence is defined by the behaviors that are the outcomes of having intelligence, rather than the processes that lead to the development of intelligence.

Genetics play a role in its development, but he finds that experience creates the greatest and most complex variations in the brain and the growth of intelligence. The human brain is seen to be experience-dependent. The theories of intelligence discussed include the “g” factor theory, IQ theory, the theory of multiple intelligences, triarchic theory, and the theory of emotional intelligence. Even “street smarts” finds a place in this discussion. Measurement of intelligence is included.

Beginning with the concepts of malleability and neuroplasticity, a research-based discussion of the rapidly-changing brain takes the reader from conception through infancy and primary years to the dramatic changes of adolescence. The part that guidance, choice, and experience play in healthy development is highlighted. The reader is asked to look at the developing brain starting at infancy, moving through a summary of growth and development. The brain at risk is highlighted with suggestions for remediation. From information on the effects of poverty, learning disabilities, and other special needs, to an exploration of exceptional brains, the author clarifies his thesis that enrichment is essential and should become educational policy.

A review of the components of enriched environments and the resulting effects on the learner includes directions for developing such an environment. Emphasizing his commitment to the implementation of positive enriching experiences as essential for optimal growth and development, Jensen strengthens his case by providing a multitude of ways to organize schools and classrooms, examples of enriching activities, and doable supportive suggestions for successfully bringing enrichment into the lives of all children.

The reader will learn a great deal from Enriching the Brain. It is well documented and covers a wide range of material providing a solid knowledge base about the brain
and building a repertoire of strategies, methods, and ideas that can support and enrich the brain's optimal development.

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Reclaiming the Lives of Gifted Girls and Women

By Joan Franklin Smutny
ISBN: 978-0-89824-360-4

REVIEWED BY ELAINE S. WIENER

Joan Smutny is a familiar name to gifted education. She is the director of the Center for Gifted, National-Louis University in Evanston, Illinois. This Center enrolls thousands of children and young people in summer and weekend programs. The amazing fact about this Center is that these programs, year after, constitute the largest series of programs for gifted students in the United States.

The beauty of Joan Smutny’s books is that she gathers together other educators’ thoughts as she honors them, interlaces her own original ideas, and emerges with a succinct 100-page fixit guide that we could carry with us all the time. The reading feels new, and it made me feel like re-learning became new learning.

The question posed by Reclaiming the Lives of Gifted Girls and Women is: “How can gifted girls, who are so susceptible to the demands and pressures of society, develop the ability to understand and remain true to themselves as they move through adolescence into adulthood?” In 33 pages you will see where we’ve been, how we got there, and what defines the needs of today’s girls and women. The information is as fresh as if it were written for the first time in gifted education. The 15-page resource-bibliography compiles a rare all-girl related list.

And then! The magic solutions—just what we need. Here are some samplings:

- Provide a wider range of options within a given assignment to incorporate personal interests and allow talents to reveal themselves. This makes it harder for our girls to hide their gifts.
- Create safe environments that de-emphasizes competition.
- Use portfolios to evaluate their work.
- Allow creative thinking as well as art projects to decrease competition.
- Collect information from parents and others about the girls’ strengths and challenges.
- Practice clustering when possible. Knowing other girls with similar abilities provides camaraderie.
- Practice free yourself from the expectations of others and walk away from the games that others insist you play, even though you have no interest or aptitude for such games.
- Collect information from parents and others about the girls’ strengths and challenges.
- Practice clustering when possible. Knowing other girls with similar abilities provides camaraderie.
- Free yourself to play your own games in your own way in such a manner as to make the best possible use of your strengths, your potentialities.

“Do not waste a lot of expensive, unproductive energy in trying to be well-rounded. Master the skills of interdependence, giving freely of your strength. What you give in this way is far more valuable than all you could give with mediocre performances of achievements for which you have no aptitude or will.

People are generally highest motivated for the things that they...
do best.” (Torrance, 1982a, p.35)

If you are a fervent devotee to the details of Dr. Torrance’s life—everything he thought, said, believed, taught, and reflected upon, this might be the book for you, especially if you were researching his fine life as you would in a thesis.

However, if you understand, as those who worked with him certainly understood, how passionate he was... how loving he was... how patient he was...how he internalized his hurts and pains into mature Zen-like understanding of human nature... and above all how creative he was, then a biography of his life should have that same passion and style and gripping rhythm and poetry to capture his whole essence into words. This book does not do that.

ELAINE WIENER is Associate Editor for Book Reviews for the Gifted Education Communicator. She is retired from the Garden Grove Unified School District GATE program. She can be reached at: esw.ca@worldnet.att.net.

Let’s Kill Dick and Jane

By Harold Henderson

REVIEWED BY ELAINE WIENER

Let’s Kill Dick and Jane. What a chilling title! After all, Dick and Jane were icons in reading texts for decades. They were my childhood playmates. Although I understand the shock value of this title, I wish the title had addressed the real objective: What would be the final effective replacement for an ineffective reading process? Despite this slight literary criticism, this is a beautifully written analysis of a mystery—the mystery of how a program so obviously wise and valuable could be such a threat to the world of education, including other publishers and educators themselves.

Harold Henderson is a staff writer at the Chicago Reader and was the ideal biographer of the Open Court Publishing world because he approached this mystery as the journalist that he is. Let’s Kill Dick and Jane is, indeed, a mystery because a simple, honorable idea evolved into a journey of politics and endurance with stubborn ideology. Mr. Henderson was given access to the Open Court archives to follow the intricacies of this story. And intricate it is the word.

Reading has always been a problem in education. The texts are either too difficult or too easy, depending upon the background of the students in the classroom. The creators of the Open Court reading procedure had a precise process which they believed could teach reading to all levels of students while enthralling them with marvelous literature. (This was very advantageous for gifted students in regular classrooms or even in gifted classrooms where reading levels always were varied.) And this was no small task. Open Court required diligent in-service for teachers. It also necessitated commitment and belief in the concept. That, too, was no small task.

This fine idea should have been welcomed as a successful approach to how to teach reading. The program should have been allowed to prove itself on a large scale—as it did in small arenas over and over and over around the country. Never should it have had to go through the trials and tribulations it experienced, ending up by selling to a competitor to avoid bankruptcy. This story is a blot on the education profession!

The story of Open Court speaks for itself in the following thoughts:

‘Traditionalists’ in education value order, intellect, and excellence... They gravitate toward movements like phonics in beginning reading and back to basics in math.

‘Progressives’ in education value freedom, self-expression, and equity...

They gravitate toward movements like look-say or whole language in reading and constructivist math.

Harold Henderson points out that each of these philosophies has a firm grip on only part of the truth. He makes us aware that...thoughtful educators, regardless of label, seek to develop their students’ intellect and character.

Furthermore, This book argues that American public education is dominated by a culture that resists both ideologies, a culture that maintains a status quo that is mediocre by either standard.

We have been through so much in the education profession with so much outside and inside interference. At this point there is no blameless group...and perhaps because of that we really can’t blame anyone. And while we are not blaming anyone, we also can’t seem to solve anything.

What should be means becomes ends in themselves, while the ends are neglected.

This whole story reminds me of an old saying:

When you’re up to your “eyeballs” in alligators, it’s difficult to remember that your original objective was to drain the swamp.

Also be aware that it is to the McGraw Hill Publishing Company’s credit that they stayed pure to the teachings of Open Court and have made a success of publishing the books after they bought the company in 1996.

ELAINE WIENER is Associate Editor for Book Reviews for the Gifted Education Communicator. She is retired from the Garden Grove Unified School District GATE program. She can be reached at: esw.ca@worldnet.att.net.

Editor’s note: The review above is reprinted here due to an omission in its first printing in our Winter 2007 issue.
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Gifted Education Communicator
Information and practical solutions for parents and educators

Gifted Education Communicator is designed to be a practitioner’s journal—providing you with the information and strategies to apply the theory, research, and best practices in the field. Noted leaders and experienced parents address a broad range of themes and issues related to educating and parenting the gifted. The high quality of articles has made the journal a highly respected publication in the field of gifted education. You’ll find these regular features in each issue of Gifted Education Communicator:

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Practical, fundamental information about the needs of gifted learners of all ages.

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These 36 articles provide much-needed help. They are a “best of” from the last seven years of the Gifted Education Communicator, the national publication of the California Association for the Gifted. With contributions from respected scholars as well as new experts in the field, this book is sensitive, positive, and packed with ideas and up-to-date facts.

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